

Impact of the Russia–Ukraine war on grain and fertilizer supply: Evidence from Kenya

Shadrack Muthami Mwatu 

Kenya Institute for Public Policy
Research and Analysis (KIPPRA),
Nairobi, Kenya

Correspondence

Shadrack Muthami Mwatu, Kenya Institute for
Public Policy Research and Analysis (KIPPRA),
Nairobi, Kenya.

Email: smwatu@kippra.or.ke;
muthamimwatu@gmail.com

Abstract

This paper examines the impact of the Russia–Ukraine war on grain and fertilizer supply to Kenya as the sixth largest economy in Africa using the Regression Discontinuity estimator on monthly data spanning from January 2017 to August 2022. The share of the quantity and value of cereals and fertilizer imports by Kenya from Russia and Ukraine in the total quantity and value of cereals and fertilizer imports by Kenya from world are utilized. The share of freight and insurance costs on grain and fertilizer imports by Kenya from Russia and Ukraine in total freight and insurance costs on grain and fertilizer from world have also been used. After controlling for sensitivity and incorporating depreciation of the exchange rate and a dummy on drought as covariates, the results indicate the war has had insignificant impact on imports of grain and fertilizer by Kenya though the impact is negative for grain but positive for fertilizer. The findings have policy implications touching on need for African countries to diversify import sources for grain and fertilizer, enhance productive capacities through investment on irrigation, strengthen diplomatic ties with existing import sources for grain and fertilizer, and invest in climate action to tackle drought incidences.

KEYWORDS

fertilizer, grain, impact

1 | INTRODUCTION

Kenya is the 6th largest economy in Africa¹ and is larger than the combined GDP of 21 out of the 54 economies in Africa (African Development Bank, 2021).² Further, using the share of imports to GDP as a measure of openness of an economy, 20 in every Kenyan Shillings 100 earned in GDP are spend on imports (Kenya National Bureau of Statistics, 2022), implying that Kenya has linkage to world economies through trade. With climate change witnessed through persistent droughts where 11 counties in Kenya experienced severe droughts in 2022 (National Drought Management Authority, 2022), the country's food productivity is becoming constrained. This has made it necessary for the country to turn to importing agricultural commodities as an adaptation mechanism (Giulioni et al., 2022). Due to recurrent droughts, for instance, Kenya's maize production fell from 36.7 million bags in 2021 to 34.3 million bags in 2022 (Kenya National Bureau of Statistics, 2023). The decline in domestic production has made it necessary to turn into importing to ensure food security and sustain welfare. Specifically, imports of food commodities have increased by 8% over the last 5 years.

The country's average annual rainfall has generally been poor with most regions witnessing below average precipitation (Kenya National Bureau of Statistics, 2023). Despite bearing an adaptive potential for countries to sustain food security and national welfare in face of climate change, the allocative role of trade is, however, prone to shocks like the Russia-Ukraine war, which has largely affected trade logistics. The outcome could be a rise in cost of living and a deterioration in consumer welfare.

Before February 2022 when the war started, grain and fertilizer imports by Kenya from Russia and Ukraine were smaller than what the African country was importing from other parts of the world especially for the period 2017–2021 (Figure 1). The implication is that the war could have less pronounced impact on imports of cereals (grain) and fertilizer by Kenya given the East African economy had existing alternative import sources for the commodities. Izzeldin et al. (2023) note the negative impact of the war on markets subsided over time, while Liadze et al. (2022) hold that geographical location was a key determinant of the impacts of the war experienced by different countries with countries closer to war zone being the most impacted.

Figure 2 further reveals that the main cereals imported by Kenya from Russia and Ukraine are wheat, meslin, buckwheat, barley, and maize. Moreover, the largest share of Kenya's imports of wheat, meslin, buckwheat, and barley comes from rest of the world (RoW), followed by Russia and Ukraine, while the largest share of Kenya's imports of maize comes from Africa, followed by RoW and then Russia and Ukraine combined. The largest share of Kenya's imports of rice comes from RoW, followed by Africa, and the largest share of the country's imports of grain sorghum comes from RoW, followed by Africa, while the largest share of Kenya's "other cereals" comes from Africa.³ For fertilizer, the bulk of Kenya's imports (76.2%) come from RoW with Russia supplying only 15.6%, while Africa supplies Kenya with 8.1% (Figure 3). Again, the implication is that Russia and Ukraine account for only a small portion of Kenya's grain and

¹See Figure A1.

²Kenya's GDP (102,427 USD million) is larger than the combined GDP of 21 African Economies (95,427 USD million). These 21 economies include Namibia, Congo, Rwanda, Equatoria Guinea, Mauritania, Togo, Somalia, Sierra Leone, Eswatini, Djibouti, Burundi, Liberia, Central African Republic, Eritrea, Lesotho, Gambia, Cabo Verde, Guinea-Bissau, Comoros, Seychelles, and Sao Tome and Principe.

³This analysis covers the period from January 2017 to August 2022.

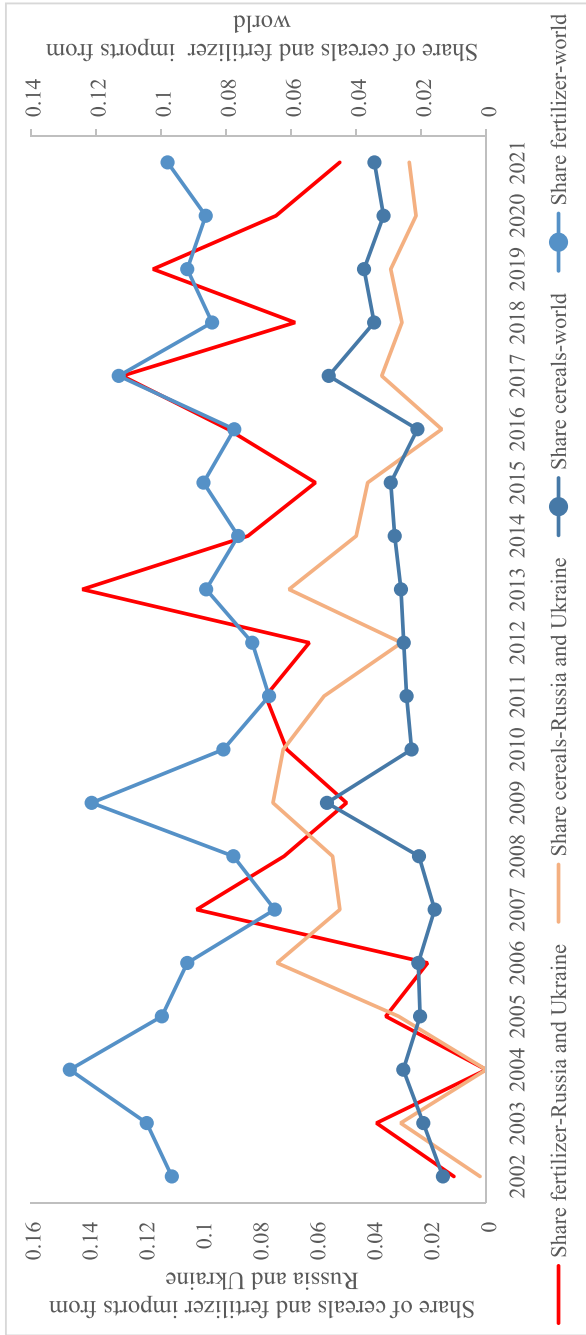


FIGURE 1 Share of cereals and fertilizer imports by Kenya from Russia and Ukraine and world. Source: Analysis based on data from International Trade Centre (ITC).

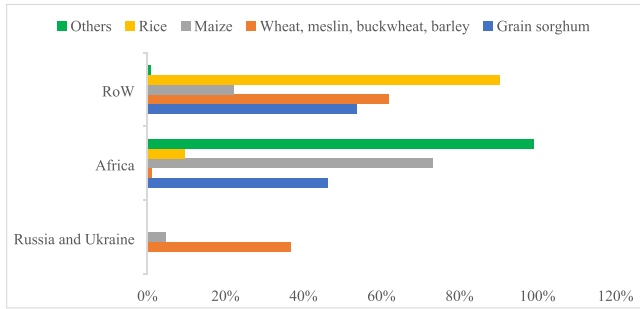


FIGURE 2 Kenya’s main cereals imports and sources. *Source:* Analysis based on customs data obtained from Kenya Revenue Authority (KRA).

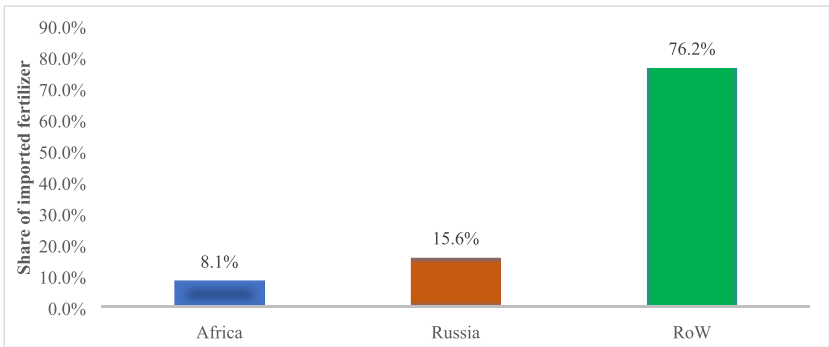


FIGURE 3 Kenya’s imports of fertilizer from various sources. *Source:* Analysis based on customs data obtained from Kenya Revenue Authority (KRA).

fertilizer imports and the war may not have very pronounced impact on importation of the commodities by Kenya as the country could turn to the existing alternative import sources.

Has the Russia–Ukraine war significantly impacted Kenya’s access to imports of cereals and fertilizer? Using monthly customs data spanning between January 2017 and August 2022, this study endeavors to answer this question. Specifically, the study tests the hypotheses⁴ below:

- H1.** The impact of the war on quantity of grain and fertilizer imports by Kenya is not significant.
- H2.** The impact of the war on value of grain and fertilizer imports by Kenya is not significant.
- H3.** The impact of the war on freight costs for grain and fertilizer imports by Kenya is not significant.
- H4.** The impact of the war on insurance costs for grain and fertilizer imports by Kenya is not significant.

⁴The hypotheses (H1–H4) are tested at the 1%, 5%, and 10% levels of statistical significance.

The rest of the work is organized as follows: Section 2 reviews relevant literature—both theoretical and empirical; Section 3 documents the data used and stylized facts; Section 4 presents the empirical methodology and results; Section 5 proffers a conclusion and discussion of the results, and Section 6 draws implications for policy. One key limitation of the study is that although the findings could be extended to other developing countries like Kenya, caution should be exercised, as individual economies have varying degrees of reliance on imports from Russia and Ukraine and individual economies have varying degrees of diversification of import sources. Climate change has also disproportionately affected other developing economies and their reliance on cereals imports may not be prominent.

2 | LITERATURE REVIEW

2.1 | Supporting theories

2.1.1 | Consumer theory

Cereals are largely final consumer goods that sustain consumer welfare by guaranteeing food security.⁵ They can be produced domestically or be imported. Even when domestic production is sufficient to cater for domestic demand, differences in variety between domestically produced cereals and foreign substitutes could still drive cereals imports. This could even be stronger if consumers have liberty to maximize utility by revealing their tastes and preferences over local cereals and imported substitutes (Kim & Niem, 2011; Kokko & Tingvall, 2014; Streletskaia et al., 2023). The argument for intra-industry trade on cereals commodities notwithstanding, Kenya is a net food importer (Kenya National Bureau of Statistics, 2023). This exposes consumers to welfare uncertainties linked with external shocks like the Russia–Ukraine war especially if the shocks are proximal to key import sources for food commodities.

The consumer theory postulates that consumers are rational economic actors striving to satisfy welfare (utility) from consumption of substitutable commodities (Pantzar, 1996; Thaler, 1980). In this study, consumers are assumed to maximize utility from consumption of local cereals or imported substitutes given a certain level of disposable income. Consumption choices are driven by availability, affordability, and differences in variety. Persistent droughts in the country adversely affect availability and affordability of domestically produced cereals and consumers resort to imported substitutes. However, external shocks like the Russia–Ukraine war disrupt import logistics and consequently affect availability of imported cereals. This risks food security and further deteriorates welfare of the consumer.

2.1.2 | Producer theory

This theory is applicable to fertilizer as an input in the production process. Producers endeavor to maximize agricultural output using a mix of inputs and given a cost outlay (Emerson, 1973; Stevenson, 2016). For countries like Kenya, which are largely reliant on imported fertilizers, logistical bottlenecks related to shocks like the Russia–Ukraine war affect availability and

⁵The consumer theory is suitable, given cereals are final consumer goods that constitute the consumption basket and satisfy consumer's utility. In this study, the theory is applicable to cereals.

affordability of fertilizer as a production input. The war as a shock, for instance, drove up prices of imported fertilizer (Kenya National Bureau of Statistics, 2023). The witnessed rise in prices of the commodity raised cost of agricultural production. It then reduces the marginal returns from engaging in agricultural production, and this makes agriculture unattractive. The outcome of the reduced agricultural production due to a rise in cost of inputs makes the country even more reliant on importation of substitute agricultural commodities to ensure food security.

2.2 | Empirical literature

Ahn et al. (2022) have examined the impact of the Russia–Ukraine war on international grain and oilseed trade using commodity level data. The results demonstrate that imports of grain and oilseeds from Ukraine were 78.2% below the counterfactual Ukraine between February and July 2022. Further, they observe that the war drove substantial trade diversion, mainly benefitting countries in North America and Europe. The current study argues that the change in direction of trade in favor of countries in North America and Europe affected terms of trade making major currencies like the US dollar appreciate with the effect being depreciation of currencies for developing countries. Using an event-study methodology, Chortane and Pandey (2022) also observe that the war had asymmetric impacts on currencies across the world with currencies of advanced economies appreciating the most. The study also notes that the war had muted impact for global grain and oilseed markets in terms of quantities traded. Event studies mainly rely on cross-sectional data for a specific point in time compared to the current study that utilizes time series data. The current study extends this analysis by using the regression discontinuity technique to impact evaluation with application to Kenya and focusing on grain and fertilizer.

Some studies have examined the impact of the war on world's stock and equity markets (Ahmed et al., 2022; Boubaker et al., 2022; Boungou & Yatie, 2022; Diaconasu et al., 2022; Rose et al., 2023; Silva et al., 2023), and a gap exists on the impact of the war on grain and fertilizer through commodity futures whose impact is transmitted through the pass-through effect of exchange rate adjustment. The war negatively impacted world's stock markets, and the impact was more pronounced among countries bordering Ukraine and Russia as well as United Nations members who condemned the war. Given grain and fertilizer are traded in commodity exchange markets, this study extends the work by examining the impact of the war on grain and fertilizer as key commodity futures highly affected by exchange rate adjustments emanating from change in terms of trade and the associated supply chain risks attributed to the war. Supply chain risks manifest in freight, and insurance costs as risks associated with the war are priced through higher insurance premiums, while a change in direction of trade has implications on freight costs. Izzeldin et al. (2023) have also examined the impact of the war on global financial markets and find that stock and commodities markets responded sharply to the invasion but gradually stabilized over time. The gradual stabilization of the markets indicates that the war could generally have muted impact on access to agri-food commodities. Wheat was one of the most affected commodity given the outstanding exporter status of Russia and Ukraine. Studies have also examined the impact of the war on economic costs across geographical locations and find that Europe is the region most affected by the war given its proximity to Ukraine and Russia and its reliance on energy and food supplies from the two countries (Braun et al., 2023; Hall, 2022; Liadze et al., 2022). The war has also contributed to global inflation. The inflation relates to rise in prices of food and energy among advanced economies and has a pass-

through effect to inflation levels in developing economies. This raises cost of living and makes grain and fertilizer more expensive. Given geographical proximity to the war zone appears to be a key determinant of the size of the impact of the war on different countries, the current study argues that the war is expected to have muted impact on grain and fertilizer supplies to African countries. The war is especially expected to have muted impact if the importing countries have existing alternative import sources for grain and fertilizer.

Lin et al. (2022) demonstrate that the war led to reduction in production of wheat, disruptions in harvesting and distributing the grain, disruptions in production and distribution of fertilizer, and a rise in prices. These disruptions encouraged a change in direction of trade as countries which were reliant on imports of grain and fertilizer from Ukraine and Russia turned to other sources. Mahlstein et al. (2022) further note countries not implementing sanctions against Russia would benefit from some trade diversion but would experience larger costs from trading with Russia. African countries have largely been non-partisan regarding the conflict as most of them have not officially identified with any side of the conflict and have advocated for peace negotiations to end the war. Studies have also demonstrated that droughts predispose countries to food insecurity and make them more reliant on food imports (Arndt et al., 2012; Hameed et al., 2020; Singh, 2016).

Overall, this study contributes to the literature on the impact of the Russia–Ukraine war on grain and fertilizer supply to African economies and possible policy options for governments. Further, majority of the studies that have examined the impact of the war have used event-study approach. This study makes contribution to the literature and policy options for governments utilizing the regression discontinuity approach to impact evaluation with focus on Kenya as key African economy.

3 | DATA AND STYLIZED FACTS

3.1 | Data

The study used monthly customs data obtained from the Kenya Revenue Authority (KRA) and monthly exchange rate (Kenya Shilling per US dollar) obtained from the Kenya Central Bank (CBK).⁶ The data span 68 months from January 2017 to August 2022. The data are appropriate in generating evidence on the impact of the Russia–Ukraine war on grain⁷ and fertilizer supply (exports) from Russia and Ukraine to Kenya as one of the largest economies in Africa.⁸

For both cereals (grain) and fertilizer, key variables used capture exported (supplied) value and quantity, freight and insurance costs, the exchange rate, and a dummy variable indicating months in which the country was experiencing severe drought. The dummy variable on drought incidences in Kenya is constructed using information obtained from the National Drought Management Authority (NDMA), which provides monthly drought updates at the national level. The dummy variable is coded with “1” and “0,” where “1” indicates months in which Kenya as a unit was declared to have experienced droughts and “0” indicates months in which the country was not declared by the Authority to have experienced drought. The dummy variable is therefore indicative of drought incidences for Kenya as a unit as opposed to

⁶These data sources are credible, given they are the main custodians of customs and exchange rate data, respectively.

⁷The study uses the term grain and cereals interchangeably.

⁸The unit of observation is therefore the country.

isolated regions or administrative units.⁹ The study does not control for drought incidences in Russia and Ukraine because existing evidence shows high levels of irrigation and utilization of irrigation technology among ex-members of the Soviet Union (Higgins et al., 1988). Existing evidence shows irrigation agriculture is still low in Kenya accounting for a mere 16% of the irrigation potential (Kanda & Lutta, 2022). The implication is that drought incidences would adversely affect cereals production and demand for fertilizer in Kenya but would not have adverse effects on Russia and Ukraine because they have larger investment in irrigation and utilization of irrigation technology.¹⁰ The exchange rate is considered because it is one of the channels through which the pass-through effect of an appreciating US dollar due to war-related change in terms of trade affects ability of developing economies like Kenya to pay for imports. The dummy on drought is also considered as a measure of climate change, which threatens viability of the country's largely rain-fed agriculture and in effect threatens food security, further making the country reliant on cereals imports.

The quantity of grain and fertilizer imported by Kenya from Russia and Ukraine is considered because a depreciation of the Kenyan Shilling against the US dollar makes imports more expensive and thus affects the quantity imported.¹¹

Freight and insurance costs are highly responsive to shipping shocks and risks like the Russia–Ukraine war. For instance, the blockade of Ukraine's black seaports by Russia in the early months of the war, coupled with policy actions against Russia by the European Union (EU) in the form of sanctions on Russian ships may have resorted in change in shipping routes, thus affecting freight costs, or increased the uncertainty and risk of ships ferrying grain and fertilizer being confiscated and this affects insurance costs. The quantity and value of grain and fertilizer exports by Russia and Ukraine are also affected by blockade of seaports and policy measures like sanctions on ships. The quantity of grain exported could rise when the value of exported grain declines because of cereal donations¹² to African countries including Kenya. The shock related to the war and the resultant disruption in supply chains would be reflected in freight and insurance costs, and the quantity and value of imports of cereals and fertilizer.

3.2 | Stylized facts on cereals

The variable on cereals exports is measured as the share of cereals imported by Kenya from Russia and Ukraine in Kenya's total cereals imports from world. The variable captures both the value¹³ and quantity¹⁴ of cereals imports by Kenya.¹⁵ Insurance costs are measured as the share of insurance costs for cereals imported by Kenya from Russia and Ukraine in total insurance costs for Kenya's cereals imports from world. Freight costs are measured as share of freight

⁹For details, see link to NDMA <https://www.ndma.go.ke/index.php/resource-center/national-drought-bulletin>

¹⁰Demand for fertilizer and production of cereals in Russia and Ukraine would rarely be affected by incidences of drought.

¹¹The implication is that the imported value could rise partly because of a depreciation in the local currency against the US dollar even when the imported quantity is not changing much.

¹²Donations are exempt from shipping restrictions.

¹³The raw variable before taking shares is measured in Kenyan Shilling.

¹⁴The raw variable before taking shares is measured in Kilograms.

¹⁵The logic is that what is exported by Russia and Ukraine is entered as imports at the point of entry into the Kenyan territory.

costs for cereals imports from Russia and Ukraine in Kenya's total freight costs for cereals imports from world. The exchange rate is measured in terms of Kenyan Shillings per US dollar.

The summary statistics are broken down into the period before commencement of the war (January 2017–January 2022) and the period after its commencement (February–August 2022) for which the data used covers. Both Russia and Ukraine exported grain (cereals) to Kenya before commencement of the war. After the war started in February 2022, however, there were no cereals imports from Ukraine by Kenya. The stylized facts reveal that the share of the value of cereals exported by both Russia and Ukraine to Kenya before commencement of the war accounted for 20.9% of Kenya's total cereals imports from world. However, after the commencement of the war, the share of the value of cereals exports to Kenya decreased to account for only 2.9% of Kenya's cereals imports from world. The decline is explained by the stoppage of imports from Ukraine after Russia's invasion and blockade of Ukraine's black seaports. This has food security implications for Kenya as a major African economy. To bridge the cereals demand, Kenya turned to existing alternative sources for supply, and this meant a change in direction of cereals trade.

The share of the quantity of cereals exported by Russia and Ukraine to Kenya increased marginally from 22.8% before start of the war to 23.9% after its commencement. Given the share of the value of cereals imports by Kenya from Russia and Ukraine in Kenya's total cereals imports from world declined, the share of the quantity of cereals coming from Russia and Ukraine could only increase if the country received cereals donations. This is explained by the blockade and mining of Ukraine's black seaports by Russia between February and July 2022 when a grain deal was signed.¹⁶ During this period, however, Russia exported cereals to Kenya.

The share of insurance costs on cereals imports from Russia and Ukraine in total insurance costs on cereals imports from world declined from 15.7% before start of the war to 4.3% after its commencement, while the share of freight costs on cereals imports from Russia and Ukraine in total freight costs on cereals imports from world declined from 26.6% before start of the war to 4.5% during the war. The decline in both insurance and freight costs for Kenyan imports of cereals from Russia and Ukraine supports the decline in the value of cereals imports from Russia and Ukraine during the war, and this means the observed rise in the quantity of cereals coming from Russia after start of the war could be explained by cereals donations. The exchange rate was Ksh 104.8 per US dollar before start of the war, but the local currency depreciated further to Ksh 116.9 per US dollar after the commencement of the war. The depreciation of the local currency makes imports more expensive. This could translate to a decline in the value of cereals imports. The decline in insurance and freight costs for imports of cereals by Kenya from Russia and Ukraine is consistent with the observation that after the war commenced, there were no cereals imports by Kenya from Ukraine.¹⁷ Since cereals are a staple food in Kenya, the fall in imports from Ukraine due to blockade of its black seaports triggered a rise in cereals imports from other existing sources.

More specifically, the share of the quantity of cereals imported by Kenya from Russia and Ukraine in total quantity of cereals imported by Kenya from world fell by 17 percentage points from 20% in 2021 to 3% in the first 8 months of 2022. At the same time, the share of the quantity of cereals imported by Kenya from Africa in total quantity of cereals imported by Kenya from world increased by 8 percentage points from 23% in 2021 to 31% in the first 8 months of 2022.

¹⁶The grain deal was mediated by Turkey and the United Nations.

¹⁷Insurance and freight costs are tied to the value of the goods imported, and as such, a decline in the value of cereals imported especially from Ukraine would also translate to a decline in both the freight and insurance costs.

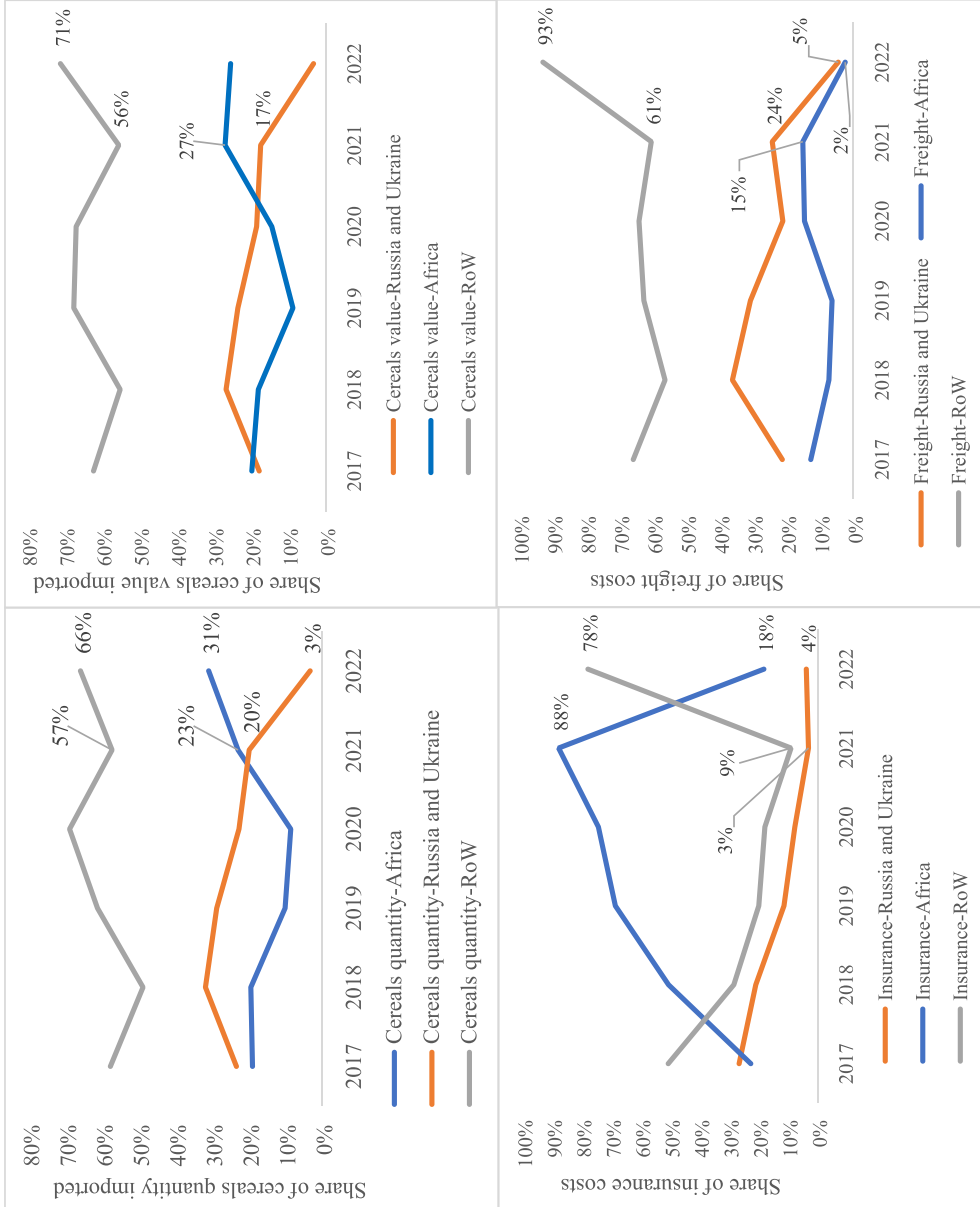


FIGURE 4 Share of Kenya's cereals imports from various sources. Source: Analysis using customs data from KRA.

Further, the share of the quantity of cereals imported by Kenya from RoW¹⁸ in total quantity of cereals imported by Kenya from world increased by 9 percentage points from 57% in 2021 to 66% in the first 8 months of 2022. This points to an important aspect of trade diversion for cereals (change in direction of trade) away from Russia and Ukraine to other sources especially within Africa and RoW due to the war between Russia and Ukraine. Insurance and freight costs on cereals imports by Kenya from RoW increased steadily after the commencement of the war, further reinforcing the argument on change in direction of cereals trade driven by the war (Figure 4).

3.3 | Stylized facts on fertilizer

Exports of fertilizer are measured as the share of fertilizer¹⁹ imported by Kenya from Russia and Ukraine in Kenya's total fertilizer imports from world. The stylized facts reveal that Ukraine did not export fertilizer to Kenya after the war started but Russia did. The evidence reveals that the share of the value of fertilizer exported by Russia to Kenya in Kenya's total fertilizer imports from world increased marginally from 16.6% before start of the war to 16.9% after start of the war. Further, the share of the quantity of fertilizer exported by Russia to Kenya in Kenya's total fertilizer imports increased from 17.5% before start of the war to 19.5% after start of the war. The share of insurance costs on fertilizer exported by Russia to Kenya in total insurance costs on fertilizer imported by Kenya from world increased from 17.0% before start of the war to 28.2% after start of the war, while the share of freight costs on fertilizer exported by Russia to Kenya in total freight costs on fertilizer imported by Kenya from world increased from 20.7% before start of the war to 25.7% after start of the war. The rise in insurance and freight costs on fertilizer imply a rise in imports of fertilizer from Russia in comparison to other sources. This could also mean that Russia diversified her markets for fertilizer with onset of sanctions by the EU and its allies on Russia towards more friendly countries especially those from Africa. Russia's seaports were not blockaded the country's exports of fertilizer, and cereals were exempted from policy interventions in the form of sanctions (Table 1).

Figure 5 further corroborates the summary statistics in Table 2 in that the value and quantity of fertilizer imports by Kenya from Russia and Africa rose marginally while imports from RoW remained high. Fertilizer was excluded from the sanctions imposed by the European Union, United States, and allies on Russia. Insurance costs on fertilizer imports by Kenya from Russia increased,²⁰ but insurance costs on fertilizer imports by Kenya from Africa and RoW fell drastically.²¹ To reduce the risk of ships being seized, Russia in collaboration with countries like Iran embraced new trade routes spanning Sea of Azov, Don River in Russia, Caspian Sea, and ultimately into the Indian ocean.²² The change in trading route is reflected in freight costs on fertilizer imports by Kenya from Russia, which fell drastically after commencement of the war, but freight costs on fertilizer imports by Kenya from RoW²³ increased partly due to usage of longer shipping routes.

¹⁸Rest of world here excludes Russia and Ukraine, and Africa.

¹⁹Both in value and quantity.

²⁰Partly due to the risk that Russian ships would be seized if they did not sail on neutral waters.

²¹Partly due to these other import sources becoming less risky.

²²Iran's geographical location allows Russia to safely transport goods via the corridor through Iranian territory to Asia, India, and Africa without incurring risk of Western sanctions.

²³Excluding Africa.

TABLE 1 Summary statistics on cereals.

Variable	Before February 2022 ^a				
	Obs. ^b	Mean	Std. dev	Min	Max
Export value	61	.209	.187	0 ^c	.719
Export quantity	61	.228	.223	0	.780
Insurance	61	.157	.191	0	.792
Freight	61	.266	.236	0	.849
Exchange rate	61	104.762	3.478	101.301	116.96
Drought	61	.5902	.4959	0	1

TABLE 1 (Continued)

Variable	From February 2022				
	Obs.	Mean	Std. dev	Min	Max
Export value	7	.029	.051	0	.119
Export quantity	7	.239	.157	0	.476
Insurance	7	.043	.077	0	.192
Freight	7	.045	.082	0	.208
Exchange rate	7	116.96	0	116.96	116.96
Drought	7	.5714	.5345	0	1

Source: Analysis based on customs data from Kenya Revenue Authority (KRA) and Central Bank of Kenya (CBK).

^aFebruary 2022 is the time point when the Russia–Ukraine War commenced.

^bThe observations are in months across all the tables.

^cExplain the months in which there was 0 value of imports

4 | EMPIRICAL METHODOLOGY AND RESULTS

4.1 | Empirical methodology

The study examines the impact of the Russia–Ukraine war on grain (cereals) and fertilizer supply to Kenya as a key African economy. Quasi-experimental approach to impact evaluation deploying the *Regression Discontinuity* technique is used. The technique has previously been used in impact evaluations in social science research and has strengths in that results from the method mimic those generated through randomized experiments (Bloom, 2012; Imbens & Lemieux, 2008; Lee, 2008; Lemieux & Milligan, 2008; Pei et al., 2022). Hall (2022) argues that the Russia–Ukraine war is disruptive shock and this makes the Regression Discontinuity technique appropriate for the analysis. Moreover, the regression discontinuity estimation technique embraced in this study is more suitable compared to other quasi-experimental techniques like difference-in-differences in that the data used are not only time series but also that time is the running variable and treatment starts at a particular threshold in time—February 2022 when Russia's invasion of Ukraine commenced (Anderson, 2014; Auffhammer & Ryan, 2011; DePaola et al., 2013). The regression discontinuity approach is therefore a suitable tool for this analysis compared to the difference-in-differences technique, which is suitable when the data are cross-

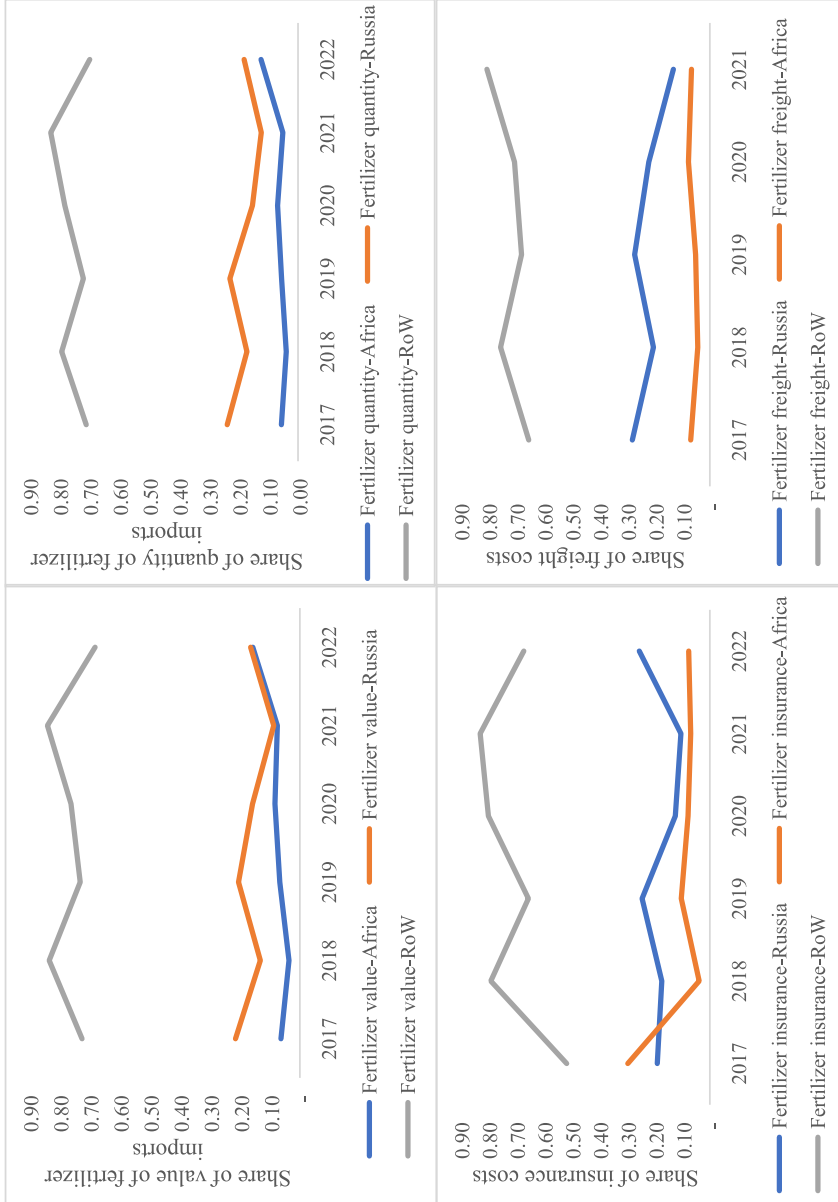


FIGURE 5 Share of Kenya's fertilizer imports from various sources.

TABLE 2 Summary statistics on fertilizer.

Variable	Before February 2022				
	Obs.	Mean	Std. dev	Min	Max
Export value	61	.166	.215	0	.841
Export quantity	61	.175	.218	0	.863
Insurance	61	.170	.219	0	.848
Freight	61	.207	.219	0	.811
Exchange rate	61	104.762	3.478 ^a	101.301	116.96
Drought	61	.5902	.4959	0	1

TABLE 2 (Continued)

Variable	From February 2022				
	Obs.	Mean	Std. dev	Min	Max
Export value	7	.169	.139	.017	.368
Export quantity	7	.195	.157	.022	.442
Insurance	7	.282	.263	.018	.714
Freight	7	.257	.189	.025	.551
Exchange rate	7	116.95	0	116.96	116.96
Drought	7	.5714	.5345	0	1

Source: Analysis based on customs data from Kenya Revenue Authority (KRA) and Central Bank of Kenya (CBK).

^aNote that the exchange rate has the largest standard deviation, meaning it has the largest variability from mean. The largest variability has been making imports more expensive and thus contributing to the high cost of import both cereals and fertilizers.

sectional or panel with multiple sets of groups in which some are treated and others are untreated (Fricke, 2017; Zeldow & Hatfield, 2021).

4.2 | Results

4.2.1 | Cereals

Figure 6 reveals that the value of cereals exports by Russia and Ukraine to Kenya declined indicating a rise in cost of importation partly driven by depreciation of the Kenyan Shilling against the US dollar used in paying for imports. Through change in terms of trade, the war saw major currencies especially the US dollar appreciate, while currencies for developing countries like the Kenya Shilling depreciated. The quantity of cereals exported, however, rose, indicating African economies especially Kenya received cereals donations. This could explain the rise in quantity exported but a decline in value of cereals at the same time. Another important stylized fact emanating from Figure 6 is that when the value of cereals exports by Russia started to rise,²⁴ the quantity of cereals exports sharply declined, signifying a potential stop in cereals donations after a grain deal was agreed in July 2022. The share of freight and insurance costs

²⁴The period after the invasion.

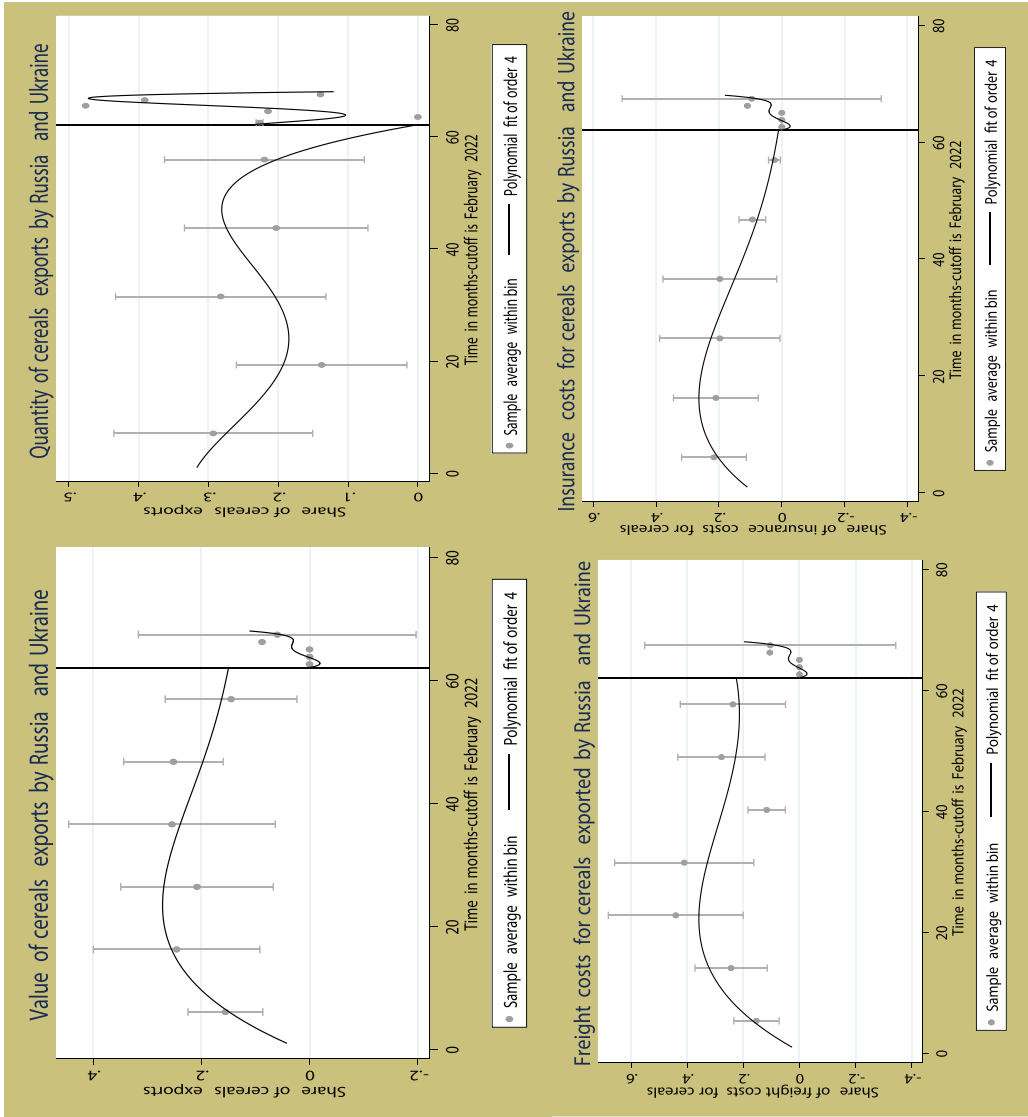


FIGURE 6 Cereals exports by Russia and Ukraine to Kenya.

for cereals exported by Russia in total freight and insurance costs on cereals from world declined during the early months of the war before they took an upward trend. The decline in the share of insurance costs for cereals exported by Russia was, however, less pronounced compared to freight costs. The initial decline explains the stoppage of cereals exports by Ukraine in the early months of the war when Ukraine's black seaports were blockaded, while the rise in the second quarter of 2022 explains the removal of black seaports blockade after the United Nations and Turkey mediated a grain export deal signed by both Russia and Ukraine and the consequential uptick in export activity by Ukraine. Before the start of the war, the bulk of combined cereals exports by Ukraine and Russia came from Ukraine. After the start of the war and the resultant blockade of Ukraine's black seaports that stopped Ukraine's exports of grain, Russia stepped up grain exports to Kenya to fill the gap emanating from stoppage of Ukrainian cereals exports in the first quarter of 2022.

Table 3 presents results from analysis using the Regression Discontinuity technique. The exchange rate (Kenya shilling per US dollar) was used a covariate given that depreciation of local currencies within African economies driven by change in terms of trade associated with the war among major economies especially the United States translates to weakening of local currencies, and this makes imports especially cereals and fertilizer imports more expensive. A dummy variable on drought was also included as a covariate with the reasoning that the prolonged periods of drought experienced in Kenya during the review period made it even more necessary to import cereals to bridge the domestic production gap for cereals, which constitute the main staple food in the country. *The results are presented for the estimation with and without the covariates, as well as the estimation controlling for sensitivity.*

Before controlling for sensitivity

The results from the estimation before controlling for sensitivity reveal that majority of the variables (log export value, log freight costs, and log insurance costs) all have a negative coefficient except log export quantity, which has a positive coefficient. Further, it is only log export value and log freight costs that are statistically significant. The implication is that the impact of the Russia-Ukraine war on cereals has been felt largely through freight costs and export value. These variables are highly sensitive to supply shocks. Due to weakening of the local currency, cereals imports became more expensive, and expenditures on importation of cereals declined. Specifically, before controlling for the covariates, the results indicate that the war decreased the share of the value of cereals imports by Kenya from Russia by 0.142% but increased the share of the quantity of cereals imports by 0.102%, while the share of freight and insurance costs on cereals imports by Kenya from Russia decreased by 0.196% and 0.033%, respectively.

Upon controlling for the exchange rate and the dummy on drought as a measure of climate change, however, the statistical significance for *log export value* and *log freight costs* disappears. Moreover, all the coefficients become positive, meaning presence of prolonged droughts have led to increase in cereals imports even in presence of the war. The rise in the quantity and value of cereals imports by Kenya is also explained by the fact that cereals are a staple food and thus have inelastic elasticity of demand. The rise in both the quantity and value of cereals imports by Kenya from Russia in total imports by Kenya from world after the war started is explained by the fact that whereas Ukraine's seaports were blockaded, Russia's seaports were not, and Russia was still able to supply (export) cereals. The rise in insurance and freight costs of rise in both export activity for cereals by Russia and rise in risk of potential sanctions and seizure of Russian vessels especially on unfriendly waters. Specifically, while controlling for the exchange rate and drought as a measure of climate change, the results indicate that the Russia-Ukraine

TABLE 3 Regression discontinuity for cereals^a for exports by Russia and Ukraine

	RD results before controlling for sensitivity			RD results controlling for sensitivity				
	Log export value	Log export quantity	Log freight costs	Log insurance costs	Log export value	Log export quantity	Log freight costs	Log insurance costs
Standard	-.1419** ^b (-1.9126)	.1015 (1.3050)	-.1958** (-2.2176)	-.03319 ^c (-1.3908)	-.08496 (-0.6805)	.1253 (1.3591)	-.0977 (-0.6351)	-.0298 (-1.1665)
Using covariates ^d	.0201 (0.3297)	.0603 (0.9740)	.0169 (0.2346)	.0030 (0.1212)	-.0399 (-0.4271)	.0399 (0.5377)	-.0391 (-0.3436)	-.0214 (-0.4956)
Observations	68	68	68	68	68	68	68	68

^aSharp RD estimates using local polynomial regression.

^bThe impact of the Russia–Ukraine conflict on cereals imports becomes insignificant after controlling for exchange rate as a covariate, and the insignificance means that although the conflict has led to a reduction of imports of cereals, other factors especially change in terms of trade, which has seen the US dollar appreciate and consequently made currencies of developing countries including the Kenyan Shilling to depreciate significantly with the outcome being increase in cost of importation, which has limited imports.

^cThe fall in insurance costs was not significant, and this means insurance costs remained relatively high owing to the rise in risk and uncertainty of shipping after the United States and European Union and allies imposed sanctions on Russian ships.

^dCovariate used is the exchange rate

* $p < .1$, ** $p < .05$, and *** $p < .01$.

war increased the share of the value and quantity of cereals imports by Kenya from Russia by 0.020% and 0.060%, respectively, while the share of freight and insurance costs on cereals imports increased by 0.017% and 0.003%, respectively.

After controlling for sensitivity

On controlling for sensitivity, however, no variable is statistically significant both in the estimation controlling for the covariates and the one without. The variables retain the signs as in the estimation without controlling for sensitivity and without controlling for covariates. Specifically, the results for this estimation indicate that the Russia–Ukraine war reduced the share of the value of cereals imports by Kenya from Russia by 0.085%, but the share of the quantity of cereals imports increased by 0.125%, while the share of freight and insurance costs on cereals imports by Kenya from Russia declined by 0.098% and 0.029%, respectively.

The signs for the coefficients for the estimation controlling for sensitivity and controlling for covariates, however, change drastically compared to those for the estimation without controlling for sensitivity but controlling for covariates—in that all the coefficients now become negative except the share of the quantity of cereals imports from Russia, which remains positive. Specifically, the share of the value of cereals imports by Kenya from Russia decreased by 0.039%, but the share of the quantity of cereals imports by Kenya from Russia increased by 0.039%, while the share of freight and insurance costs in cereals imports by Kenya from Russia decreased by 0.039% and 0.021%, respectively (Table 4).

The results from the estimation controlling for both sensitivity and covariates are more robust and thus reliable. The positive coefficient for the share of the quantity of cereals imports by Kenya from Russia is explained by the argument that Russia stepped up cereals exports to bridge the supply gap created by Ukraine being unable to export cereals after the black seaports were blockaded. With the prolonged droughts witnessed in Kenya, cereals demand became even stronger. The negative coefficient for the share of value of cereals imports by Kenya from Russia is explained by the argument that the depreciation of the Kenyan Shilling made cereals imports more expensive while the ensuing supply uncertainties for imports from Russia drove up prices. This is also explained by the argument that, although cereals are a staple food in Kenya and thus would be expected to have inelastic elasticity of demand, Kenya had existing alternative sources from which she could source cereals from (this is supported by the stylized facts discussed earlier). The increase in the share of the quantity of cereals imported from Russia is therefore partly explained by the argument that Russia gave cereals donations to Kenya. The negative coefficients for the share of value of cereals and freight and insurance costs on cereals imports from Russia are indicative of a decline in import activity from Russia by Kenya and an uptick of import activity for cereals from alternative sources that were existing (this is also supported by the stylized facts discussed earlier). Overall, one of the inferred impacts of the Russia–Ukraine war is change in direction of trade.

4.2.2 | Fertilizer

The share of the quantity and value of fertilizer imported by Kenya from Russia in the total quantity and value of fertilizer imports by Kenya from world registered sharp increase immediate after the war started and have retained an upward trend (Figure 7) after the grain deal between Russia and Ukraine with mediation by United Nations and Turkey in July 2022. The grain deal had provisions excluding Russian fertilizer exports from sanctions and other

TABLE 4 Regression discontinuity results for fertilizer^a exports by Russia

	RD results before controlling for sensitivity				RD results controlling for sensitivity			
	Log export value	Log export quantity	Log freight costs	Log insurance costs	Log export value	Log export quantity	Log freight costs	Log insurance costs
Standard	.1093* (1.7329)	.1343* (1.8827)	.1695** (2.0144)	.1822 (1.1876)	.0803 (1.2181)	.0955 (1.309)	.090 (0.9854)	.0480 (0.2619)
Using covariates ^b	.0736 (1.1415)	.0799 (1.0725)	.0665 (0.7515)	.0816 (0.6033)	.0701 (1.0663)	.0809 (1.0536)	.0632 (0.6886)	.0450 (0.3105)
Observations	68	68	68	68	68	68	68	68

^aSharp RD estimates using local polynomial regression.

^bCovariates used are the exchange rate and a dummy on drought.

* $p < .1$, ** $p < .05$, and *** $p < .01$.

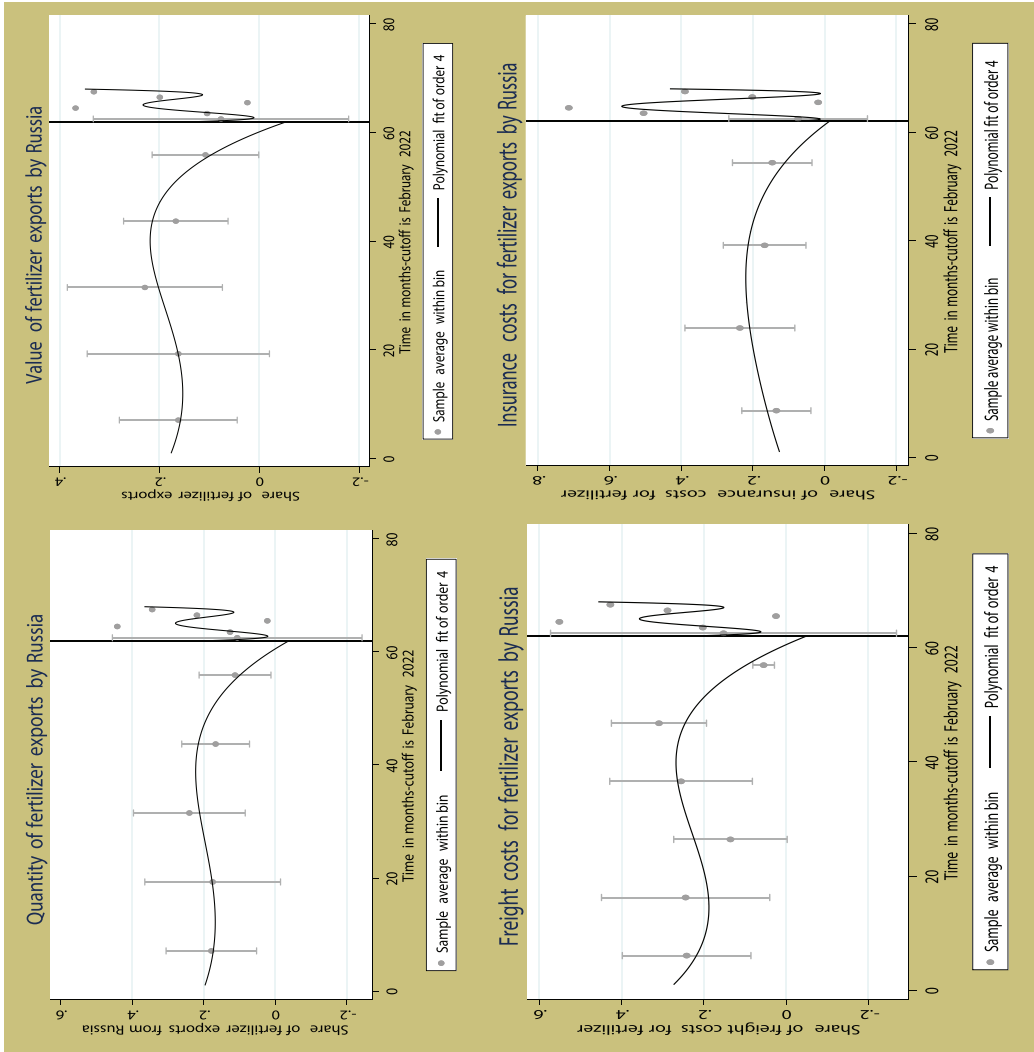


FIGURE 7 Fertilizer exports by Russia to Kenya.

restrictive measures especially those implemented by the EU in collaboration with allies. Freight costs for fertilizer exports by Russia rose more than the rise in insurance costs in the early months of the war, but insurance costs later rose more sharply than the rise in freight costs partly driven by removal of restrictions on fertilizer exports and partly by resumption of traditional shipping routes after the black sea route was demined and opened for ship voyage. Another important explanation for why exports of fertilizer to Kenya rose was that it was a planting season in Kenya from March 2022 and fertilizer was in high demand.

Before controlling for sensitivity

For fertilizer, all the variables have positive coefficients both in the standard estimation as well as in the estimation controlling for covariates. Moreover, the share of the value and quantity of fertilizer imports by Kenya from Russia and the share of freight costs on fertilizer imports were significant in the estimation before controlling for covariates. After controlling for the covariates, the statistical significance disappears.

Specifically, the share of the value and quantity of fertilizer imports by Kenya from Russia increased by 0.109% and 0.134%, while the share of freight and insurance costs on fertilizer imports by Kenya from Russia increased by 0.169% and 0.182%. This rise coincides with higher demand for fertilizer by Kenya to meet the needs for the planting season. It is also explained by the argument that Russian fertilizer was exempted from sanctions, Russia's seaports were unblockaded and that the country has comparative advantage in producing and supplying fertilizer. The statistical significance disappears covariates on exchange rate and drought because whereas the depreciation of the Kenyan Shilling raised cost of importation, continued expectations for droughts in the country reduced demand for fertilizer, given the country's agriculture is highly rain-fed. The share of the value and quantity of fertilizer imports by Kenya from Russia increased by 0.074% and 0.079%, respectively, while the share of freight and insurance costs on fertilizer imports by Kenya from Russia increased by 0.067% and 0.082% after controlling for the covariates.

After controlling for sensitivity

All the coefficients have a positive sign but are insignificant. The share of the value and quantity of fertilizer imports by Kenya from Russia increased by 0.080% and 0.096%, respectively, while the share of freight and insurance costs on fertilizer imports increased by 0.090% and 0.048%, respectively, in the standard estimation. After controlling for the covariates, the share of the value and quantity of fertilizer imports by Kenya from Russia increased by 0.070% and 0.081%, respectively, while the share of freight and insurance costs on fertilizer imports increased by 0.063% and 0.045%, respectively. The rise in fertilizer imports from Russia is also explained by a move to increase supplies by Russia and fill in the gap emerging from Ukraine stopping exports of fertilizer due to blockade of the black seaports.

5 | CONCLUSION AND DISCUSSION

5.1 | Conclusion

The study examined the impact of the Russia–Ukraine war on grain and fertilizer supply to Kenya as one of the largest economies in Africa using monthly customs data obtained from the Kenya Revenue Authority. The findings from the tested hypotheses indicated that the war had

significant impact on cereals imports by Kenya and the associated freight costs, but the statistical significance disappeared after controlling for sensitivity.

The stylized facts and findings reveal that both Russia and Ukraine exported cereals and fertilizer to Kenya before commencement of the war. After the war started, however, Ukraine stopped exporting cereals and fertilizer especially during the first 7 months of the war when her black seaports were blockaded, but Russia continued to supply Kenya with both cereals and fertilizer. Moreover, the share of cereals and fertilizer imports by Kenya from Russia and Ukraine before start of the war were smaller than the share imported from other parts of the world. The results also reveal that Russia stepped up to fill the gap created by Ukraine being unable to export cereals and fertilizer after her ports were blockaded.

5.2 | Discussion of the results

While controlling for sensitivity, the results from the Regression Discontinuity estimation indicate that the war did not have a significant impact on supply of cereals and fertilizer to Kenya due the fact that Russia's seaports were still operational, cereals and fertilizer were largely exempted from sanctions, Russia turned to new supply routes, and that Kenya had other reliable import sources that were in existence. Lin et al. (2022) have argued that the war encouraged a change in direction of trade by turning to other sources as economies moved to cushion themselves from risks associated with the war. Some countries also avoided implementing sanctions against Russia with an aim of benefiting from the consequential change in direction of trade (Mahlstein et al., 2022).

Despite the impact of the war being insignificant when controlling for sensitivity and covariates on the exchange rate and drought, it had a negative impact on the value of cereals imports and freight and insurance costs on cereals. This is partly so due to Kenya resorting to existing alternative sources for grain. This finding is consistent with the documented stylized facts. Hennessy (2023) has also argued in favor of diversification of supply chains as channel for cushioning countries against external risks. In contrast, the war had a positive impact on the value and quantity of fertilizer imports by Kenya as well as freight and insurance costs on fertilizer. Despite continued drought in Kenya during the review period, the high demand for fertilizer is explained by the argument that the government was preparing stock in readiness for the planting season. The fact that trade, despite being a channel for adaptation to climate change, is prone to unforeseen external shocks like the war has incentivized governments in developing countries to increase investments on irrigated agriculture to increase domestic food production.

6 | POLICY IMPLICATIONS

The findings have policy implications touching on a need for countries to continue diversifying import sources for cereals and fertilizer, enhance productive capabilities for cereals and fertilizer especially through targeted investments on irrigation agriculture and investment in productive of organic fertilizer, strengthen diplomatic and economic ties with existing alternative import sources for cereals and fertilizer to eliminate potential barriers to accessing the commodities, advocate for negotiations to resolve the war, sustenance of current grain deal between Russia and Ukraine under mediation of the United Nations (UN) and Turkey, and deliberate action to invest in climate action to address drought incidences. Trade is an adaptation channel in periods



of drought, and this implies a need to embrace fair trade agreements for enhanced access to food commodities in the wake of climate change manifested in persistent droughts.

ORCID

Shadrack Muthami Mwatu  <https://orcid.org/0000-0002-6137-129X>

REFERENCES

- African Development Bank. (2021). African statistical yearbook. Abidjan.
- Ahmed, S., Hasan, M., & Kamal, R. (2022). Russia-Ukraine crisis: The effects on the European stock market. *European Financial Management*, 29, 1–41. <https://doi.org/10.1111/eufm.12386>
- Ahn, S., Kim, D., & Steinbach, S. (2022). The impact of the Russian invasion of Ukraine on grain and oilseed trade. *Agribusiness*, 39(1), 291–299.
- Anderson, M. (2014). Subways, strikes, and slowdowns: The impacts of public transit on traffic congestion. *American Economic Review*, 104(9), 2763–2796.
- Arndt, C., Farmer, W., Strzepek, K., & Thurlow, J. (2012). Climate change, agriculture, and food security in Tanzania. *Review of Development Economics*, 16(3), 378–393. <https://doi.org/10.1111/j.1467-9361.2012.00669.x>
- Auffhammer, M., & Ryan, K. (2011). Clearing the air? The effects of gasoline content regulation on air quality. *American Economic Review*, 101(6), 2687–2722.
- Bloom, H. S. (2012). Modern regression discontinuity analysis. *Journal of Research on Educational Effectiveness*, 5(1), 43–82. <https://doi.org/10.1080/19345747.2011.578707>
- Boubaker, S., Goodell, J., Pandey, D., & Kumari, V. (2022). Heterogenous impacts of wars on global equity markets: Evidence from the invasion of Ukraine. *Finance Research Letters*, 48, 1–8, 102934. <https://doi.org/10.1016/j.frl.2022.102934>
- Boungou, W., & Yatie, A. (2022). The impact of the Ukraine-Russia war on world stock market returns. *Economic Letters*, 215, 1–3, 110516. <https://doi.org/10.1016/j.econlet.2022.110516>
- Braun, E., Braun, E., Gyimesi, A., Iloskics, Z., & Sebestyen, T. (2023). Exposure to trade disruptions in case of the Russia-Ukraine conflict: A product network approach. *The World Economy*, Early View. <https://doi.org/10.1111/twec.13417>
- Chortane, S., & Pandey, D. (2022). Does the Russia-Ukraine war lead to currency asymmetries? A US Dollar tale. *The Journal of Economic Asymmetries*, 26, 1–11, e00265. <https://doi.org/10.1016/j.jeca.2022.e00265>
- DePaola, M., Vincenzo, S., & Mariatiziana, F. (2013). The deterrent effects of the penalty points system for driving offences: A regression discontinuity approach. *Empirical Economics*, 45, 965–985. <https://doi.org/10.1007/s00181-012-0642-9>
- Diaconasu, D., Mehdian, S., & Stoica, O. (2022). The reaction of financial markets to Russia's invasion of Ukraine: Evidence from gold, oil, bitcoin, and major stock markets. *Applied Economics Letters*, 30, 1–5. <https://doi.org/10.1080/13504851.2022.2107608>
- Emerson, D. (1973). Optimum firm location and the theory of production. *Journal of Regional Science*, 13(3), 335–347. <https://doi.org/10.1111/j.1467-9787.1973.tb00410.x>
- Fricke, H. (2017). Identification based on difference-in-differences approaches with multiple treatments. *Oxford Bulletin of Economics and Statistics*, 79(3), 426–433. <https://doi.org/10.1111/obes.12178>
- Giulioni, G., Giuseppe, E., & Pasqui, M. (2022). Global coordination of wheat sowing: A possible policy against climate variability. *World Food Policy*, 9(1), 6–27. <https://doi.org/10.1002/wfp2.12052>
- Hall, D. (2022). Russia's invasion of Ukraine and critical agrarian studies. *The Journal of Peasant Studies*, 50, 1–17. <https://doi.org/10.1080/03066150.2022.2130263>
- Hameed, M., Ahmadalipour, A., & Moradkhani, H. (2020). Drought and food security in the middle east: An analytical framework. *Agricultural and Forest Meteorology*, 281(15), 1–10, 107816. <https://doi.org/10.1016/j.agrformet.2019.107816>
- Hennessy, A. (2023). The impact of Russia's war against Ukraine on Sino-European relations. *Journal of European Integration*, 45(3), 559–575. <https://doi.org/10.1080/07036337.2023.2201497>
- Higgins, G., Dieleman, P., & Abernethy, C. (1988). Trends in irrigation development, and their implications for hydrologists and water resources engineers. *Hydrological Sciences Journal*, 25(3), 393–406. <https://doi.org/10.1080/00221688709499278>

- Imbens, W., & Lemieux, T. (2008). Regression discontinuity designs: A guide to practice. *Journal of Econometrics*, 142(2), 615–635. <https://doi.org/10.1016/j.jeconom.2007.05.001>
- Izzeldin, M., Muradoglu, Y., Pappas, V., Petropoulou, A., & Sivaprasad, S. (2023). The impact of the Russia-Ukrainian war on global financial markets. *International Review of Financial Analysis*, 87, 1–13, 102598. <https://doi.org/10.1016/j.irfa.2023.102598>
- Kanda, E., & Lutta, V. (2022). The status and challenges of a modern irrigation system in Kenya: A systematic review. *Irrigation and Drainage*, 71(1), 27–38. <https://doi.org/10.1002/ird.2700>
- Kenya National Bureau of Statistics. (2022). Economic survey. Nairobi.
- Kenya National Bureau of Statistics. (2023). Economic surveys (various issues). Nairobi. Retrieved from <https://www.knbs.or.ke/publications/>
- Kim, T., & Niem, L. (2011). Product quality, preference diversity and intra-industry trade. *The Manchester School*, 79(6), 1126–1138. <https://doi.org/10.1111/j.1467-9957.2010.02210.x>
- Kokko, A., & Tingvall, P. (2014). Distance, transaction costs, and preferences in European trade. *The International Trade Journal*, 28(2), 87–120. <https://doi.org/10.1080/08853908.2013.830941>
- Lee, D. (2008). Randomized experiments from non-random selection in U.S. house elections. *Journal of Econometrics*, 142(2), 675–697.
- Lemieux, T., & Milligan, K. (2008). Incentive effects of social assistance: A regression discontinuity approach. *Journal of Econometrics*, 142(2), 807–828. <https://doi.org/10.1016/j.jeconom.2007.05.014>
- Liadze, I., Macchiarelli, C., Mortimer-Lee, P., & Juanino, P. (2022). Economic costs of the Russia-Ukraine war. *The World Economy*, 46, 1–10. <https://doi.org/10.1111/twec.13336>
- Lin, F., Li, X., Jia, N., Feng, F., Huang, H., Huang, J., Fan, S., Ciais, P., & Song, X. (2022). The impact of Russia-Ukraine conflict on global food security. *Global Food Security*, 36, 1–6, 100661. <https://doi.org/10.1016/j.gfs.2022.100661>
- Mahlstein, K., McDaniel, C., Schropp, S., & Tsigas, M. (2022). Estimating the economic effects of sanctions on Russia: An allied trade embargo. *The World Economy*, 45(11), 3344–3383. <https://doi.org/10.1111/twec.13311>
- National Drought Management Authority. (2022). National drought bulletin. Nairobi. Retrieved from <https://www.ndma.go.ke/index.php/resource-center/national-drought-bulletin>
- Pantzar, M. (1996). Rational choice of food: On the domain of the premises of the consumer choice theory. *Journal of Consumer Studies & Home Economics*, 20(1), 1–20. <https://doi.org/10.1111/j.1470-6431.1996.tb00232.x>
- Pei, Z., Lee, D., Card, D., & Weber, A. (2022). Local polynomial order in regression discontinuity designs. *Journal of Business & Economic Statistics*, 40(3), 1259–1267. <https://doi.org/10.1080/07350015.2021.1920961>
- Rose, A., Chen, Z., & Wei, D. (2023). The economic impacts of Russia-Ukraine war export disruptions of grain commodities. *Applied Economic Perspectives and Policy*, 45(2), 645–665. <https://doi.org/10.1002/aep.13351>
- Silva, T., Wilhelm, P., & Tabak, B. (2023). Trade matters except to war neighbours: The international stock market reaction to 2022 Russia's invasion of Ukraine. *Research in International Business and Finance*, 65, 1–25, 101935. <https://doi.org/10.1016/j.ribaf.2023.101935>
- Singh, G. (2016). Climate change and food security in India: Challenges and opportunities. *Irrigation and Drainage*, 65(51), 5–10. <https://doi.org/10.1002/ird.2038>
- Stevenson, R. (2016). Institutional economics and the theory of production. *Journal of Economic Issues*, 21(4), 1471–1493. <https://doi.org/10.1080/00213624.1987.11504712>
- Streletskaia, N., Maruyama, S., Queisser, S., Cole, S., Stelick, A., & Lim, J. (2023). How information leads consumers to select specialty foods when tasting is not an option. *Food Quality and Preference*, 105, 1–9, 104769. <https://doi.org/10.1016/j.foodqual.2022.104769>
- Thaler, R. (1980). Towards a positive theory of consumer choice. *Journal of Economic Behavior & Organization*, 1(1), 39–60. [https://doi.org/10.1016/0167-2681\(80\)90051-7](https://doi.org/10.1016/0167-2681(80)90051-7)
- Zeldow, B., & Hatfield, L. (2021). Confounding and regression adjustment in difference-in-differences studies. *Health Services Research*, 56(5), 932–941. <https://doi.org/10.1111/1475-6773.13666>

How to cite this article: Mwatu, S. M. (2023). Impact of the Russia–Ukraine war on grain and fertilizer supply: Evidence from Kenya. *World Food Policy*, 1–25. <https://doi.org/10.1002/wfp2.12064>

APPENDIX A



FIGURE A1 GDP at current market prices in 2020 for African Economies (USD million). Source: Analysis based on data from African Development Bank (AfDB).