Chapter 6

CONFLICT-INDUCED TRADE DYNAMICS: A GRAVITY FRAMEWORK ANALYSIS OF SUDAN'S AGRICULTURAL EXPORTS

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Long before the April 2023 eruption of armed conflict between the Sudanese Armed Forces (SAF) and the Rapid Support Forces (RSF), Sudan's economy was crippled by conflicts. The country's agricultural production and productivity, internal trade, exports, and overall macroeconomic performance have all been adversely affected, and disruptions to the agrifood system, food insecurity, poverty, and malnutrition will likely remain if the conflict continues.

Conflicts cause insecurity and instability, reduce investor confidence, and often lead to trade embargoes, sanctions, and border closures imposed on the country experiencing the conflict.[1] Sustained efforts were made to improve Sudan's position within the global economy during the 2019–2021 period of transition toward democracy, including macroeconomic stabilization measures, pursuit of debt relief, promotion of public–private partnerships and global trade agreements, capacity building in the agriculture and industry sectors, and the provision of social protection programs (Bacchetta et al. 2021; Elobaid and Alhelo 2023). However, the October 2021 coup led to renewed embargoes and a reduction in Sudan's participation in global trade (Khalifa 2020), as well as a decline in investor confidence and increased domestic market uncertainty. The most recent conflict has further undermined progress in economic growth and human capital development, and the Sudanese economy remains hampered by disruptions to domestic production, damaged infrastructure, high trade costs, limited access to markets and essential services, and broken supply chains.[2]

Sudan is known for its major exports, including numerous agricultural products—gum arabic, millet, sesame, livestock, meat, and cotton—as well as gold (Asare et al. 2021). Nonetheless, between 2015 and 2023, the country

1 See Marano et al. 2013; Ali 2013; Seid et al. 2021; Caramuta et al. 2023; Siddig et al. 2023; Taralashvili 2024.

2 See Abiad et al. 2018; Didier 2020; Rauschendorfer and Shepherd 2020; Li et al. 2021; Seid et al. 2021; Fernandes et al. 2023; Siddig et al. 2023; Taralashvili 2024.

had a significant deficit in its merchandise trade balance, coupled with a steady decline in inflows of foreign direct investment (FDI) and in its trade openness (UNCTAD 2024). Moreover, the ongoing conflict within Sudan has cut off direct access of the RSF and western Sudan to Port Sudan, the main export port. This has important implications, as international trade plays an essential role in a country's economic development,[3] and it can reduce poverty and malnutrition, improve food security and food trade balances, and enhance the accessibility of diverse and nutritious food (Kornher and Kalkuhl 2019).

Despite extensive research on the relationship between conflict and trade globally, no previous empirical work has quantitatively investigated the impact of Sudan's ongoing civil war on its agricultural export performance. This is a significant gap in both the empirical literature on conflict economics and the policy understanding of how intrastate conflicts affect economic activities in these states and their potential to participate in the global market. This study addresses this gap by providing the first quantitative analysis of the impact of Sudan's 2023 civil war on the country's agricultural trade performance, with a particular focus on the country's major food crops and livestock exports.

Our analysis makes three key contributions to the empirical literature. First, we apply a structural gravity modeling framework with a two-way fixed effects estimator, using a difference-in-differences approach that compares Sudan's export performance to that of its major African competitors as a synthetic control group. Second, we provide evidence by disaggregating export effects based on the geographic production patterns of different commodities, distinguishing between products mainly produced in areas controlled by the RSF and those produced in SAF-controlled areas. This disaggregation allows us to empirically identify which agricultural export products—including sesame, groundnuts, livestock, sorghum, and cotton—have been most severely affected by the ongoing conflict. Third, using the product-specific analysis—based on the geographic division of Sudan into areas controlled by the RSF and SAF—we also make a contribution to the conflict–trade literature, showing how territorial control and access to export infrastructure shape conflict impacts on trade performance and providing critical insights for the design of postconflict recovery policies.

The rest of the chapter is structured as follows: The next section provides some background on the impact of the conflict on Sudan's agrifood system.

3 See Sakyi et al. 2018; Sakyi and Afesorgbor 2019; Li et al. 2021; and Taralashvili 2024.

We then review conceptual frameworks on conflict and trade as well as the related empirical literature. The following section describes the data and methodology, including stylized facts on the performance of border and transport efficiency, logistics performance, and trade cost indicators in conflict and nonconflict countries. We then discuss the results and conclude with policy suggestions.

Conflict and Sudan's agrifood system

Domestic agricultural production has been severely affected by the conflict in Sudan (Kirui et al. 2023; Wahlstedt and Sulieman 2024). In 2023, the country's cereal production fell 46 percent below the previous year's, with the most severe declines (up to 80 percent below average) occurring in the conflict-ridden Greater Kordofan and Darfur regions (FAO 2024). According to Kirui and colleagues (2023), 40 percent of farmers reported that they could not adequately prepare for the 2023 summer planting season because of conflict-related factors, including the inability to procure essential inputs such as seeds and fertilizers. These challenges, compounded by adverse weather conditions and increased input prices, have led to a concerning reduction in cultivated land area (Kirui et al. 2023). The displacement of farmers from conflict areas also continues to disrupt farming production, practices, and livelihoods; 28 percent of surveyed farmers were displaced in 2023 (Kirui et al. 2023; FAO 2024; Wahlstedt and Sulieman 2024).

The geographically dispersed nature of the conflict in Sudan, coupled with the control of regional trade routes by the warring factions, significantly limits agricultural activities in both the SAF- and RSF-controlled areas. Well-functioning checkpoints, taxation, and customs authorities are critical for the efficient movement of goods; the control of this trade infrastructure by different factions affects the transaction costs associated with the movement of goods between these regions. While the RSF controls many parts of Darfur and Kordofan in the west, the SAF maintains a stronger presence in nonconflict regions in eastern Sudan, including Port Sudan and ports in Suwakin (Abushama et al. 2023; SPARC 2025). This situation impedes the operation of production and trade networks within the agrifood system, particularly in RSF-controlled areas, which may lead to stronger impediments in these areas. Merchants surveyed in 2025 confirm these disruptions; they report road blockages, high transport costs, checkpoint fees, and restricted trade routes throughout Sudan (Kirui et al. 2023). In conflict zones, domestic traders are disproportionately affected by informal taxation systems and unofficial fees

imposed by nonstate actors. This is particularly alarming given the country's heavy reliance on inland trucking, which accounts for 95 percent of food transportation (Abushama et al. 2023). Exporters operating within the nonconflict regions where federal trade regulations are largely upheld (Kirui et al. 2023) are also affected, further exacerbating the challenges to Sudan's agrifood system and overall economy.

Related literature and empirical evidence

The relationship between intrastate conflict and trade

While several studies have focused on the impact of *interstate* conflict on trade,[4] researchers have also often highlighted a negative relationship between *intrastate* conflict and trade performance.[5] Researchers have also shown that intrastate conflict impairs state economic capabilities, reducing the purchasing power of residents and decreasing per capita gross domestic product (GDP) and production activities (see Marano et al. 2013 and, on Sudan, Siddig et al. 2023).

The empirical literature also shows that intrastate conflict leads to a decline in the volume and/or intensity of trade (exports and imports) between neighboring countries. For instance, a recent study of the internal conflict in Sudan reported that neighboring countries, including Chad and South Sudan, were significantly affected by reduced Sudanese exports (Siddig et al. 2023). Looking at the relationship between conflict and trade across 134 countries, Marano and colleagues (2013) found that intrastate conflict has negative impacts on both imports and exports, but the impact is greater in conflict-affected exporting countries than conflict-affected importing countries, because conflict reduces production capacity.

Conflict affects trade and the export capacity of economies through several channels. It disrupts supply chains and transportation networks essential for market access by damaging or destroying infrastructure such as ports, roads, and airports, making it difficult to transport goods both domestically and internationally.[6] Relatedly, trade costs rise because traders may need to

4 See Fuchs and Klann 2013; Marano et al. 2013; Heilmann 2016; Du et al. 2017; Didier 2020; Li et al. 2021; and Estrada and Koutronas 2022.

5 See, for example, Didier 2020; Collier 2003; Koubi 2017; Marano et al. 2013; Qureshi 2013; Karam and Zaki 2016; Seid et al. 2021; Siddig et al. 2023.

6 See Cali et al. 2015; Abiad et al. 2018; Caramuta et al. 2023; Fernandes et al. 2023; Siddig et al. 2023.

use alternative routes or pay higher costs to transport their products. Higher trade costs in turn reduce their potential to participate competitively in international trade (Didier 2019; Rauschendorfer and Shepherd 2020; Seid et al. 2021; Siddig et al. 2023; Taralashvili 2024).

Conflict causes a deterioration in investors' confidence and the business environment (Marano et al. 2013; Siddig et al. 2023), a decrease in human capital (Calì et al. 2015; Rauschendorfer and Shepherd 2020; Siddig et al. 2023), displacement of labor and skills shortages (Spittaels and Weyns 2014; Calì et al. 2015; Rauschendorfer and Shepherd 2020; Seid et al. 2021), imposition of sanctions by the international community (Afesorgbor 2019; Nguyen and Do 2021; Estrada and Koutronas 2022; Bove et al. 2023; Doan and Tran 2023; Larch et al. 2024), and informal trade isolation, as the private sector withdraws (Lin et al. 2019; Siddig et al. 2023).

In addition, the political uncertainty created by conflict deters both domestic and foreign investors, who fear risk to their investments and anticipate disruptions to business operations (Marano et al. 2013; Siddig et al. 2023). This can lead to a redirection of investments to safer options, thus decreasing productivity, including in export sectors (Collier and Duponchel 2013; Siddig et al. 2023).

Conflict also weakens a country's export capacity and trade by decreasing the workforce and skill level of workers, that is, the human capital (Rauschendorfer and Shepherd 2020; Seid et al. 2021; Siddig et al. 2023). Additionally, the labor supply often decreases as conflict displaces young workers in export-oriented industries (Calì et al. 2015; Rauschendorfer and Shepherd 2020; Seid et al. 2021). Thus, industries in conflict areas may experience long-term skill and labor gaps that diminish their competitiveness.

Beyond these internal factors, the export capacity of a conflict-affected country may also be constrained by sanctions, imposed by the international community, that restrict access to global markets (Afesorgbor 2019; Nguyen and Do 2021; Bove et al. 2023; Larch et al. 2024). Generally, the sanctions imposed on conflict-affected countries aim to limit a country's ability to trade in certain products, access financial services, and participate in international trade agreements, which in turn weakens its ability to export (Afesorgbor 2019; Bove et al. 2023). For instance, the imposition of financial restrictions makes it difficult for firms to acquire loans internationally, which are often vital for maintaining export operations.

Informal trade isolation occurs as foreign companies and investors pull out of conflict-affected regions due to security concerns. Studies by Lin and colleagues (2019) and Siddig and Ahmed (2023) observed that the withdrawal of

foreign firms and investors reduces FDI, which is crucial for expanding export capacity, especially for low- and middle-income countries. Reduced FDI limits the resources required for expansion and innovation, which can lead to lower production volumes and decreased competitiveness of industries located in conflict-affected regions in the long run (Lin et al. 2019).

Similarly, informal traders and workers are often vulnerable to risks such as violence, extortion, and harassment during conflict, as well as logistical barriers due to damaged transport infrastructure (Abushama et al. 2023; Benjamin 2023; Lewis et al. 2019; Siddig et al. 2023). These risks often deter these traders and workers from doing business in conflict-affected countries, leading to a decline in trading activities with neighboring countries (Lewis et al. 2019).

Summary of the empirical evidence review

The empirical literature shows that conflict has a negative impact on trade (exports and, to a lesser extent, imports), and that different types of conflict have different impacts on trade (see for example, Caramuta et al. 2023; Fernades et al. 2023; Marano et al. 2013; Siddig et al. 2023; Taralashvili 2024). Although a negative impact of both interstate and intrastate conflict on trade performance was largely reported by researchers, the evidence above shows that their impact on trade performance in terms of magnitude differs, depending on the intensity and duration of the conflict (Fuchs and Klann 2013; Heilmann 2016; Marano et al. 2013; Siddig et al. 2023). The negative effects of intrastate conflict translate into higher trade costs and lower institutional export capacity as the comparison of standard trade indicators between conflict-affected and non-conflict-affected countries has shown (Marano et al. 2013; Siddig et al. 2023).

The negative effects of interstate conflict on factors such as infrastructure, trade costs, investors' confidence, sanctions, and informal trade isolation tend to be smaller than effects of intrastate conflict on international trade because interstate conflict is often disputed within a structure of international rules and usually has a narrow geographical focus not involving the entire territory of a society (Collier et al. 2003; Marano et al. 2013). In contrast, since intrastate conflict occurs within a country and directly affects specific regions and/or population groups, it leads to extensive damage to the affected country's human capital, including skills and knowledge, and social capital, as well as transportation and communication infrastructure, and governance policy support for firms' productive activities, which all decrease a country's ability to trade (Marano et al. 2013; Seid et al. 2021; Siddig et al. 2023; Taralashvili 2024).

Given that the social capital and policies and institutions that support international trade are destroyed during intrastate conflict, the impact on a country's trading potential tends to be more pervasive and damaging than is the case with interstate conflict (Collier and Hoeffler 2004; Marano et al. 2013; Siddig et al. 2023). We conclude that conflict will lead to the largest reduction in trade levels if it occurs within one (or both) trading economies, given its direct impact on their productive resources.

Methodology and data

This section presents the methodology and data employed in analyzing trends in the trade costs for conflict and nonconflict countries and then describes the empirical approach used in the gravity model analysis.

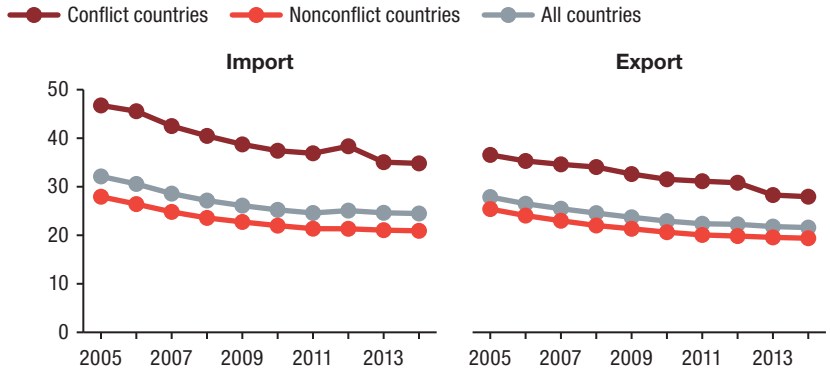
Trade costs in conflict and nonconflict countries

This subsection presents the method used to analyze the trends in trade costs across conflict and nonconflict countries. The indicators covered border and transport efficiency, logistics performance, and direct trade costs. For each indicator, we computed sample averages, capturing the overall level, as well as the annual percentage changes over the sample. The border and transport efficiency indicators used are time to export, time to import, cost to export, cost to import, number of documents to export, and number of documents to import. The tariff rate is used as the indicator for tariff costs. We use the overall Logistics Performance Index score. We then compare the conflict and nonconflict countries to highlight differences in trade cost patterns.

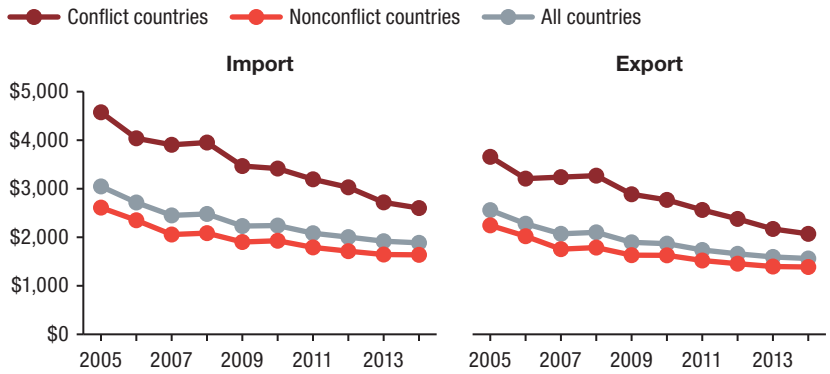
To select the conflict-affected countries, we used the Armed Conflict Location and Event Data (ACLED) conflict index (with categories of extreme, high, and turbulent levels of conflict) , and the World Bank's classification of countries in terms of fragility, conflict, and violence (ACLED 2023; World Bank 2024a). A global sample of 48 conflict countries was compared with the performance of 113 nonconflict countries for the years 2007–2022 for logistic performance indicators, 2005–2014 for border and transport efficiency indicators, and 2014–2021 for tariff costs. The selection of countries and time period was driven by data availability. In the case of the border and transport efficiency indicators, consistent comparable data were only collected until 2014, after which methodological changes affected data consistency and cross-country comparability. Figures 6.1 and 6.2, as well as Tables 6.A1 and 6.A2 in the appendix to this chapter, present the trends in trade cost indicators for conflict and nonconflict countries.

FIGURE 6.1 Average time and costs to export and import

Panel A: Time to import (left) and export (right) in days



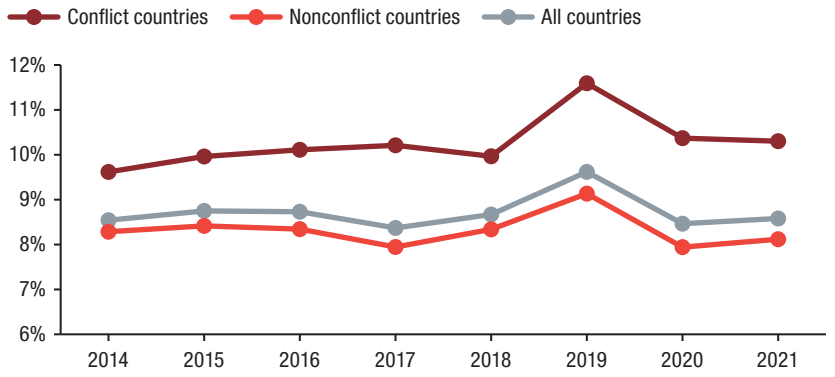
Panel B: Costs to import (left) and export (right) in US$ per container



Source: Authors' illustration based on data from World Bank (2024a).

Figure 6.1 shows the evolution and performance of time and costs to trade, while Figure 6.2 shows the tariff rates. The mean values for all indicators, including the logistics performance index, are summarized in Tables 6.A1 and 6.A2. Trade costs and applied tariff rates are generally higher in conflict countries as compared to nonconflict countries. For example, while on average in conflict-affected countries, exports (imports) require approximately 7(9) documents, 32(39) days, and US$2,774 ($3,435) per container, requirements in nonconflict countries are 6(7) documents, 21(23) days, and $1,675 ($1,963). The average applied tariff rate is 10 percent for conflict-affected countries and

FIGURE 6.2 Average tariff rate, most favored nation, simple mean, all products (%)



Source: Authors' illustration based on data from the World Bank (2024a).

8 percent for nonconflict countries. Logistics Performance Index scores range from 1 (lowest performance) to 5 (highest performance), with higher values indicating more efficient logistics and lower trade costs. The overall logistics performance index for conflict-affected countries is 2.6, while that of nonconflict countries is 2.9. From this analysis, we conclude that trade costs are generally higher in conflict-affected countries.

Econometric approach

Looking at Sudan, we use a standard structural gravity model to examine bilateral export trade flows from the country to its trade partners before and during the civil war that started in 2023. To identify the possible effect of the civil war on Sudan's export performance, we employ a difference-in-differences analysis framework with multiple pretreatment periods using the two-way or three-way fixed effects model. Our baseline model takes the following form:

$$\ln Y_{ijpt} = \beta_0 + \gamma(G_1 \times P_{2023}) + P_t\delta + G_i\theta_1 + G_j\theta_2 + G_{ij}\theta_3 + T_p\theta_4 + \varepsilon_{ijpt} \quad (1)$$

where subscripts i and j are exporters and importers, respectively; t denotes the time period; and p is the product. Y_{ijpt} is the dependent variable denoting the values of exports from country i to country j for product p. P_t are time fixed effects. Cross-sectional fixed effects (written in vectors) are denoted as G_i (exporter fixed effects), G_j (importer fixed effects), and T (product fixed

effects). G_{ij} denotes exporter-importer (country-pair fixed effects). δ, θ_1, θ_2, θ_3, θ_4 are the corresponding coefficient vectors. The exporter-importer fixed effects capture all time-invariant gravity variables of the dyadic relationship between i and j, such as distance, common language, and existence of a free trade agreement, among others. $G_1 \times P_{2023}$ is 1 if the exporter is Sudan (i=1) and the year is 2023 and represents the treatment measured by γ.

The two-way (or three-way) estimator reduces to the simple difference-in-differences estimator if only two periods are considered. The consistent estimation rests on the parallel trend assumption, which postulates that all unobserved variation in y is absorbed by cross-sectional and time fixed effects but unrelated to time-varying cross-sectional variation. That is, in our case, the product-level (and exporter-importer) export trends for all i are identical before the civil war. This is a strong assumption that proves difficult to falsify. To remove trend heterogeneity, we use a synthetic control group (i=i+1) approach. In doing so, we select five exporters per product (HS-6 level) as the control group. We choose the five largest African exporters (other than Sudan) for each product. Hence, other than i=1 for Sudan, i (i=2,3,4,5,6) may vary across different products. More intuitively, we compare Sudan's export performance with the export performance of its closest African competitors before and after the onset of the civil war.

As pointed out by several studies from the gravity literature (Baier and Bergstrand 2007; Yotov et al. 2018; Freeman et al. 2025), bilateral trade is subject to importer- and exporter-specific determinants that may vary over time. This outcome is referred to as multilateral resistance terms (MRTs). Our model (1) does not include MRTs because otherwise the treatment effect is absorbed by the MRTs. To be more precise, the single MRT for Sudan in 2023 represents our treatment, but including all MRTs would yield a comparison of the treatment to a specific MRT base category, which will not identify the treatment effect. Hence, we are only able to control for time-invariant MRTs in this model.

As discussed in the introductory sections of this chapter, we expect that the effect of the onset of the civil war in 2023 could have either positive or negative effects on Sudan's export performance, depending on the production location of the respective product. In particular, agricultural products produced in the area controlled by the RSF may have less access to the international market because of limited access to the main export port. We test this hypothesis using a triple difference-in-differences framework interacting with a dummy variable that is 1 if the product is mainly produced in RSF-controlled areas with the treatment effect from equation (1).

$$\ln Y_{ijpt} = \beta_0 + \gamma(G_1 \times RSF_p \times P_{2023}) + P_t\delta + G_i\theta_1 + G_j\theta_2 + G_{ij}\theta_3 + T_p\theta_4 + \varepsilon_{ijpt} \quad (2)$$

where fixed effects are as in equation (1), RSF_p denotes a dummy variable that is 1 if the product is mainly produced in the RSF-controlled area. Thus, γ becomes a triple difference-in-differences instead of the difference-in-differences estimator.

Using the triple difference-in-differences approach in equation (2) allows us to compare Sudan's exports of products from RSF-controlled areas with SAF-controlled areas. Technically, it is possible to combine the importer and product fixed effects with the time fixed effects without absorbing the treatment effect. Due to the high correlation between these fixed effects with the treatment, we also estimate equation (1) with importer-time and product-time fixed effects separately for products from RSF-controlled and SAF-controlled areas. By doing so, we avoid the treatment effect being limited to the comparison between exports of some products (as the treated units) and other products (as the untreated units) of the same exporter: Sudan. One reason is that parallel trends are more realistic to hold across different countries than across different products. In this case, equation (2) changes to:

$$\ln Y_{ijpt} = \beta_0 + \gamma(G_1 \times P_{2023}) + G_i\theta_1 + G_jP_t\theta_2 + G_{ij}\theta_3 + P_tT_p\theta_4 + \varepsilon_{ijpt} \quad (3)$$

where P_tT_p and G_jP_t are importer-time and product-time fixed effects, respectively. G_jP_t is the MRT_j (importer-year fixed effects).

Equations (1) to (3) can be estimated either by the ordinary least squares (OLS) or the Poisson pseudo maximum likelihood (PPML) estimators. We use the PPML that applies logarithmic transformation to the dependent variable (Y) and can better deal with the inflated number of zero bilateral trade flows and general forms of heteroscedasticity (Santos Silva and Tenreyro 2006). Thus, in essence, we interpret the treatment coefficient as written in equation (1) to (3) and obtain percentages in exports by (e^γ−1)*100.

Data description: Sudan's top agricultural exports

In this study, we select Sudan's top 20 agricultural exports during the period between 2018 and 2022 (before the onset of the civil war) to include in the analysis. To identify these products and the top five African exporters (other than Sudan) of these agricultural commodities, we used the BACI dataset by CEPII (Gaulier and Zignago 2010). Table 6.1 shows Sudan's top agricultural exports and lists the five African competitors considered.

TABLE 6.1 Sudan's major agricultural export products between 2018 and 2022 (HS-6)

	HS-6 code	Product name	Export value (US$ millions) (2018–2022)	Main African competitors
1	120740	Oil seeds: sesamum seeds	622.72	Nigeria, Niger, Ethiopia, Tanzania, Togo
2	10410	Sheep, live	330.10	Namibia, Mali, Djibouti, Somalia, Ethiopia
3	120242	Groundnut	304.10	Senegal, Ethiopia, Tanzania, Egypt, Malawi
4	520100	Cotton	194.02	Burkina Faso, Côte d'Ivoire, Benin, Egypt, Cameroon
5	130120	Gum arabic	125.35	Nigeria, Chad, Senegal, Mali, Egypt
6	10613	Mammals: camels, live	77.12	Somalia, Niger, Ethiopia, South Africa, Djibouti
7	120770	Oil seeds: melon seeds	73.51	Morocco, Ghana, Tanzania, Kenya, Egypt
8	10290	Bovine animals, live	50.53	Niger, Egypt, South Africa, Ethiopia, Rwanda
9	71320	Vegetables, leguminous: chickpeas	35.50	Egypt, Ethiopia, Morocco, Tanzania, Malawi
10	121490	Forage products	30.29	South Sudan, Egypt, Ethiopia, Nigeria, South Africa
11	71360	Vegetables, leguminous: pigeon peas	31.38	Malawi, Tanzania, Mozambique, Uganda, Kenya
12	230230	Bran, sharps and other residues	31.04	Uganda, Tanzania, Mozambique, Nigeria, Kenya
13	150810	Vegetable oils: groundnut oil	28.89	Nigeria, Senegal, Sierra Leone, Gambia, South Africa
14	20120	Meat: of bovine animals, cuts with bone	26.21	Ethiopia, Namibia, Kenya, Eswatini, South Africa
15	121410	Lucerne (alfalfa) meal and pellets	14.60	South Africa, South Sudan, Namibia, Egypt, Ethiopia
16	20410	Meat: of sheep, lamb carcasses	14.49	Kenya, Ethiopia, South Africa, Egypt, Tanzania
17	100790	Cereals: grain sorghum	13.64	Kenya, South Africa, Uganda, Tanzania, Ethiopia
18	20421	Meat: of sheep	12.09	Ethiopia, Namibia, Tanzania, Kenya, South Africa
19	20110	Meat: of bovine animals	11.88	South Africa, Egypt, Ethiopia, Tanzania, Botswana
20	10229	Cattle, live	3.82	Botswana, Somalia, Namibia, South Africa, Mali

Source: Authors based on BACI data (Gaulier and Zignago 2010).

We note that the BACI dataset is updated later than official UN statistics because data entries are scrutinized to mirror export and import flows between two countries. At the time of the analysis in December 2024, the 2023 data were not published and, therefore, the BACI data were unsuitable for the examination of the effects of the onset of the civil war in 2023 on Sudan's export performance. For this reason, we use data from the World Bank's World Integrated Trade Solution (WITS) (2024b). WITS, however, is solely based on COMTRADE data and so is missing several values. To reduce the number of missing values, we downloaded import trade flows of reporter j from the African exporter i (Sudan + countries listed in Table 3). Import data usually measure actual trade flows more accurately than export data because the exporting country lacks information on the final destination of shipments. With very few exceptions, these data are complete. We consider the period 2018 to 2023, which yields 174,960 observations (20 products × 6 years × 6 exporters × 243 importers). In our approach, we only utilize observations if there is trade at any point over the six-year period (in any of the 20 products) between the exporter and the importer. Removing the constant zero trade flows leaves us with 38,244 observations.

Data description: Regional production of export goods in Sudan

The disruption of Sudan's export trade routes has affected exports of different agricultural products, depending on the production location of the different crops. The SAF and RSF's dominance over production in different regions is attributed to various factors (Abushama et al. 2023; Resnick et al. 2026). The RSF's direct and indirect ownership of land in the Darfur and Kordofan regions is a determining factor in those regions, impacting agricultural production and trade of key cash crops, such as gum arabic and groundnuts (Abushama et al. 2023). The SAF controls agricultural production facilities and land in regions including Northern state as well as state-owned enterprises in Khartoum, Aj Jazirah, White Nile, and River Nile states (Abushama et al. 2023). We infer that the warring parties continue to control regions where their businesses are dominant (Resnick et al. 2026), as well as the trade routes serving these locations.

Further, we mapped Sudan's agricultural production by state using data from IFPRI's Spatial Production Allocation Model (SPAM) (IFPRI 2024) and the Ministry of Livestock (2021), as summarized by Alfadul and colleagues (2024). Shapefiles and subnational population statistics were obtained from the Humanitarian Data Exchange (HDX 2024). These maps include a rough characterization of the frontline between the RSF and SAF based

on the Sudan War Monitor.[7] Accordingly, we define all Darfur states and North Kordofan as RSF-controlled and northern and eastern Sudan as SAF-controlled. Khartoum, West Kordofan, and South Kordofan are considered disputed and are not assigned to either faction. Based on this classification, we compute per capita livestock ownership and production for the total area controlled by the RSF and SAF, respectively. The details are presented in Table 6.A3 in the appendix to this chapter. When no data were available, we relied on other publications. Data for sheep (RSF), camel (RSF), sorghum (RSF), groundnuts (SAF), sesame seeds (SAF), melon seeds (SAF), alfalfa (SAF), vegetable oil (SAF), and cotton (SAF) show a relatively clear picture. Figures 6.3 and 6.4 provide maps of sheep ownership and sesame production. For forage products and cattle, there is no clear tendency. While information on per capita livestock ownership gives an indication of export origin, it is unclear where meat processing takes place, but we have considered meat to originate from the same areas as the live animals. Table 6.2 summarizes the classification of products into the RSF- and SAF-controlled areas (henceforth RSF and SAF products).

This classification, based on past data, may not be perfectly accurate. The COVID-19 pandemic and the evolving conflict may have led to changes in production patterns that are not reflected in the SPAM data. For instance, there have been reports that sorghum production has increased in eastern Sudan in recent years (Osman et al. 2025). Therefore, we also disaggregate econometric results by product type to allow a more nuanced discussion.

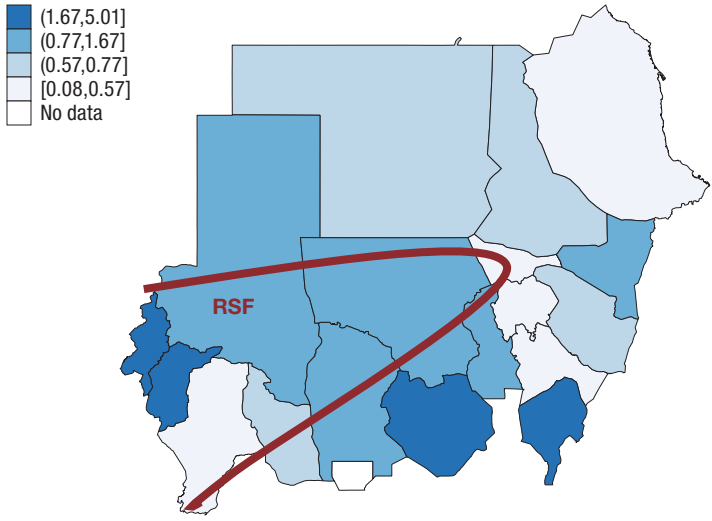
Results and discussion

In this section, we present and discuss the empirical results of the gravity models described in the previous section. First, we look at the general results of the two-way fixed effects model using the simple difference-in-differences framework. Second, we show disaggregated results from the model using the triple difference-in-differences framework and subsample regressions, and then discuss the results.

Table 6.3 shows a positive but insignificant association (when including controls) between the civil war and Sudan's agricultural exports for both models estimated by OLS and PPML. The coefficient estimates are substantially lower if we control for exporter, importer, exporter-importer, and product

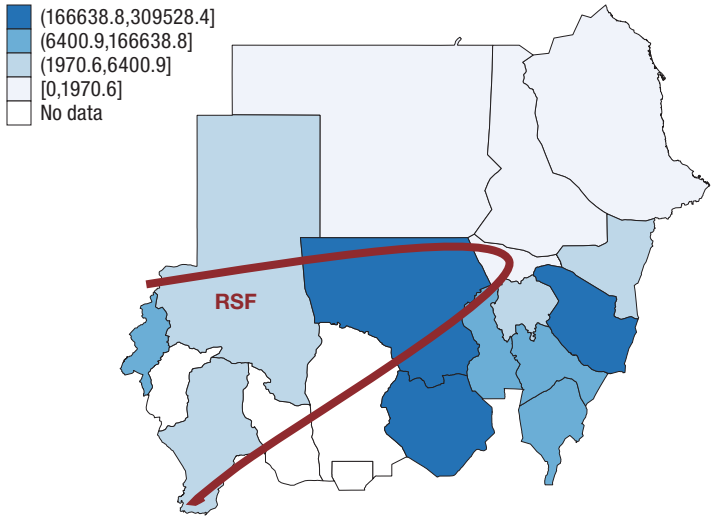
7 The Sudan War Monitor data are also used by international media such as *The Economist* (ACLED, 2023).

FIGURE 6.3 Per capita sheep ownership in Sudan



Source: Authors' illustration based on Alfadul et al. (2024).

FIGURE 6.4 Per capita sesame production in Sudan



Source: Authors' illustration based on IFPRI (2025).

TABLE 6.2 Classification of agricultural products into RSF- and SAF-controlled areas

HS-6	Product	RSF	SAF	Neither RSF nor SAF	Source
10229	Cattle, live	0	0	1	Alfadul et al. (2024)
10290	Other than cattle, live	0	0	1	Alfadul et al. (2024)
10410	Sheep, live	1	0	0	Alfadul et al. (2024)
10613	Camels, live	1	0	0	Alfadul et al. (2024)
20110	Meat, bovine	0	0	1	Alfadul et al. (2024)
20120	Meat, bovine	0	0	1	Alfadul et al. (2024)
20410	Sheep, meat	1	0	0	Alfadul et al. (2024)
20421	Sheep, meat	1	0	0	Alfadul et al. (2024)
71320	Vegetables, chickpeas	0	0	1	IFPRI (2024)
71360	Vegetables, pigeon peas	0	0	1	IFPRI (2024)
100790	Sorghum	1	0	0	IFPRI (2024)
120242	Groundnuts	0	1	0	IFPRI (2024)
120740	Oil seeds, sesame	0	1	0	IFPRI (2024)
120770	Oil seeds, melon	0	1	0	IFPRI (2024)
121410	Alfalfa	0	1	0	Mwendia et al. (2023)
121490	Forage products	0	0	1	Mwendia et al. (2023)
130120	Gum arabic	0	0	1	UNOPS (2024)
150810	Vegetable oil, groundnut	0	1	0	IFPRI (2024)
230230	Bran, sharps	0	0	1	Mwendia et al. (2023)
520100	Cotton	0	1	0	IFPRI (2024)

Source: Authors' compilation based on sources listed in the table.

Note: Details on the underlying data and methodology can be found in Table 6.A3 in the annex to this chapter.

TABLE 6.3 General war effects on Sudan's agricultural exports

Independent variables	(1) OLS	(2) OLS	(3) PPML	(4) PPML	(5) PPML
Sudan ×war	280,375	66,396	1.080**	0.173	0.187
	(192,498)	(48,821)	(0.491)	(0.117)	(0.121)
Observations	38,244	38,244	38,244	38,244	37,734
Year FE	Yes	Yes	Yes	Yes	Yes
Exporter FE	No	Yes	No	Yes	Yes
Importer FE	No	Yes	No	Yes	Yes
Importer-year FE	No	No	No	No	No
Exporter-importer FE	No	Yes	No	Yes	Yes
Product FE	No	Yes	No	Yes	Yes
Product-year FE	No	No	No	No	No

Note: Robust standard errors in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$ In column (5), we exclude Saudi-Arabia. OLS = ordinary least squares estimator; PPML = Poisson pseudo maximum likelihood estimator.

TABLE 6.4 War effects on Sudan's agricultural exports disaggregated by RSF- and SAF-controlled products

Independent variables	(1) PPML	(2) PPML	(3) PPML	(4) PPML
Sudan ×war×RSF	−0.499			
	(0.444)			
Sudan ×war		-0.530		0.296**
		(0.484)		(0.140)
Sudan ×war×SAF			0.353***	
			(0.129)	
Observations	38,244	1,806	38,244	7,920
Year FE	Yes	Yes	Yes	Yes
Exporter FE	Yes	Yes	Yes	Yes
Importer FE	Yes	No	Yes	No
Importer-year FE	No	Yes	No	Yes
Exporter-importer FE	Yes	Yes	Yes	Yes
Product FE	Yes	Yes	Yes	No
Product-year FE	No	No	No	Yes
Subsample (RSF vs. SAF)	ALL	RSF	ALL	SAF

Note: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. PPML = Poisson pseudo maximum likelihood estimator.

fixed effects. For interpretation, a coefficient estimate of 0.173 is equivalent to a treatment effect of 18.6 percent, but this effect is not statistically significantly different from zero.

We present the results of the triple difference-in-differences approach in Table 6.4, columns (1) and (3), using both RSF and SAF as the third dummy variable. In both cases, the reference group is non-RSF and non-SAF products. We clearly see that there is a difference between the RSF and SAF products. The treatment effect in the triple difference-in-differences framework is positive and statistically significant for SAF products and negative but not statistically significant for RSF products. Specifically, the treatment effect for SAF products is between 34.4 and 42.2 percent. Both the regressions based on the triple difference-in-differences framework and the subsample analyses produce the same results.

We further analyze the treatment effect across different product categories, estimating our model for subsamples of different products, as reported in Table 6.5. Namely, we analyze sorghum, vegetables and vegetable oil, live animals and meat, and oilseeds (sesame seeds, groundnuts, and melon seeds). We find that the treatment effect is positive and statistically significant for

TABLE 6.5 War effects on Sudan's agricultural exports disaggregated by type of product

Independent variables	(1) Sorghum	(2) Vegetables and veg. oil	(3) Live animals and meat	(4) Oilseeds
Sudan ×war	–3.370***	0.556***	–0.834**	0.257*
	(0.938)	(0.124)	(0.391)	(0.144)
Observations	266	1,520	2,835	8,668
Year FE	Yes	Yes	Yes	Yes
Exporter FE	Yes	Yes	Yes	Yes
Importer FE	No	No	No	No
Importer-year FE	Yes	Yes	Yes	Yes
Exporter-importer FE	Yes	Yes	Yes	Yes
Product FE	No	No	No	No
Product-year FE	Yes	Yes	Yes	Yes

Note: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

vegetables and vegetable oil, as well as oilseeds, but negative and statistically significant for sorghum as well as live animals and meat. Notably, sorghum is an RSF product, as are live animals and meat. Oilseeds are SAF products. Vegetables and vegetable oils are neither RSF nor SAF products. The treatment effect is largest for sorghum (–96.5 percent) but also substantial for the other products (oilseeds +29.3 percent). Sorghum is almost exclusively produced in Darfur in western Sudan.

Why are these results (partly) unexpected, meaning not in line with most of the literature presented at the beginning of this chapter? We argue that there are three major reasons: First, Sudan has had a war economy since the onset of the civil war in 2023. Second, sanctions imposed by importing countries are expected to have negative impacts on exports but perhaps not in all cases (Gutmann et al. 2023; Larch et al. 2024). Third, we stress the importance of infrastructure and access to international ports for exports, as outlined early in the chapter.

War economies tend to be short-sighted and divert resources to war financing, including through disinvestment and expansive lending (Collier 1999), and there is ample evidence that natural resources are often a major source of war financing (Le Billon 2001). In Sudan, import data from Sudanese trade partners suggest that gold exports have continued in 2023 and 2024 despite the civil war (official statistics are not available). Gold is found in Darfur, North Kordofan, and Red Sea states. Further, exports from RSF-controlled areas are facilitated by an airfield in neighboring Chad, controlled by international political allies of the RSF. Against this background, it may be less

surprising to see that Sudan's agricultural exports have grown, at least in the short run. Besides export revenues from trade with allied partners, there are few options for either Sudanese war faction to finance their operations and meet their need for weapons.

While sanctions have been shown to reduce agricultural exports (Larch et al. 2024), the impact on Sudan's exports is likely minimal. Sudan has been sanctioned by Western countries and the United Nations for much of the past three decades. The literature shows that effects of sanctions decrease over time as actors begin to cope with the constrained situation and develop strategies to work around the sanction mechanisms (Gutmann et al. 2023; Larch et al. 2024). In addition, sanctions have led to a diversion of Sudan's trade from Western sanction sender countries (that is, those imposing sanctions) to trade partners in the Middle East and North Africa region that have not imposed sanctions, such as Saudi Arabia, Egypt, and the United Arab Emirates. Therefore, it can be considered unlikely that additional financial and trade sanctions would have a substantial effect on Sudan's costs of trade and agricultural exports.

The literature also suggests that trade in conflict countries will decrease because value chains are disrupted, infrastructure is destroyed, movements and transport become more difficult and expensive, and sanctions cause additional restrictions or prohibit transactions and trade. Our results provide evidence for continued but reduced exports of live animals and meat. This decrease may reflect the difficulty in accessing Port Sudan to export products originating from RSF-controlled areas, and the fact that most slaughterhouses are located in large urban centers (such as Khartoum), which are disputed areas. In addition, trading livestock and meat is more complicated than trading bulk commodities, such as sesame seeds and groundnuts, requiring additional infrastructure such as cooling facilities. Yet, the reductions in exports were not as severe as one might expect. This may be because meat trade in eastern Sudan has been resilient against the conflict and recovered quickly following reductions in the first half of 2023. For instance, Saudi Arabia supported the relocation of veterinary facilities and the establishment of a new modern slaughterhouse in River Nile state (Nougud 2024).

Conclusion

In this study, we investigate the short-run impact of Sudan's civil war on the country's agricultural export performance in 2023 with the aid of a structural gravity model. We employ a two-way fixed effects model based on the

difference-in-differences and triple difference-in-differences framework using Sudan's top African export competitors as a synthetic control group. The study results are interesting and somewhat surprising, with diverse regional and policy implications of global relevance, especially for other war-torn and neighboring countries of the developing world.

We find that, on average, agricultural exports in Sudan were higher in 2023 than would have been expected based on the trends of Sudan's agricultural exports and the exports of other African countries, but this is not statistically significant. We cannot ascertain whether this is causally linked to war activities, but our additional analyses show that exports of products mainly produced in SAF-controlled areas increased significantly in 2023, controlling for all trends. These products include sesame, groundnuts, cotton, and other oilseeds. In contrast, exports of products mainly produced in RSF-controlled areas, including animals and sorghum, decreased in 2023.

This outcome clearly shows that the impact of civil war on agricultural trade is not only influenced by location-specific conditions but also product-specific characteristics. Following the onset of the civil war, Sudan's agricultural export performance has been very product-specific, with increased exports of products from northern and eastern Sudan, areas that are controlled by the SAF, in 2023. While these results are positive in part, it is important that farmers benefit from continued agricultural exports during the civil war period, and agricultural export capacity will be essential for postconflict recovery. Therefore, critical infrastructure should be protected by both factions during the conflict. In sum, conflict impacts on trade are highly product- and location-specific, determined primarily by access to trade infrastructure. We see this in Sudan because Port Sudan, Sudan's single most important international export port, and the surrounding areas are controlled by the SAF, while the RSF has no direct access to Port Sudan, which constrains exports from RSF-controlled areas. Saudi Arabia, Sudan's largest trade partner, has helped to establish export infrastructure outside the disputed Khartoum area, primarily in SAFcontrolled areas, thereby further strengthening the export capacity of areas under SAF control relative to RSFheld regions

Our study highlights the critical importance of maintaining trade infrastructure. In particular, the findings suggest a role for development of resilient and efficient trade infrastructure in both war-torn and neighboring countries. This calls for strengthening regional integration agreements that will both support dialogue meant to end civil wars and also support investment in trade policies and rules that favor the development of trade infrastructure needed for postconflict agricultural recovery.

Our findings further show that the Sudanese export economy is resilient to the effects of the war. Access to the international market is essential to provide farmers with decent farm incomes and help them survive economically in the civil war period. In addition, we show that the civil war has only limited impacts on economic activities in some parts of the country—these could support an economic recovery process after the war ends. However, Sudan's economy is increasingly a "war economy," and international humanitarian organizations, such as Human Rights Watch and Amnesty International, have reported that both factions bypass the arms embargo to import weapons (HRW 2024; Klomegah 2024). Stable or even increasing export earnings would likely facilitate further imports of weapons. However, currently, we lack information about the extent to which farmers benefit from continued exports and whether the SAF and RSF exploit farmers to increase the export revenue needed to fund weapon purchases. This warrants further research beyond the econometric analysis of trade flow trends discussed here.

There are a few limitations to our study. First, we analyze the civil war's impact on official exports only in the very short run. In April, at the onset of the civil war, many of the export deals for 2023 were already sealed and many of the shipments for international destinations were likely already at the port facilities. Furthermore, war-induced supply chain disruptions and agricultural labor shortages will have affected the 2023 agricultural season and 2024 exports, not 2023 exports. It is essential to continue monitoring trade flows as data are published. Second, in our analysis, we neglect informal cross-border trade because of the lack of data. It is likely that large shares of intra-African exports, for example, sorghum, have shifted from the formal to informal sector. Hence, we may overestimate the decline of trade in products mainly produced in RSF-controlled areas. Last, while we provide explanations for our findings, more research is required to understand how conflicts disrupt international supply chains and affect exports as well as earnings. This knowledge is needed to design sanction mechanisms that do not harm vulnerable populations, either directly through income losses or indirectly through exploitation in the war economy.

References

Abiad, A., K.V. Baris, J.A. Bernabe et al. 2018. "The Impact of Trade Conflict on Developing Asia." ADB Economics Working Paper Series No. 586. ADB (Asian Development Bank). https://www.adb.org/publications/impact-trade-conflict-developing-asia

Abushama, H., D. Resnick, K. Siddig, and O.K. Kirui. 2023. "Political and Economic Drivers of Sudan's Armed Conflict: Implications for the Agri-Food System." Sudan SSP Working Paper 15. IFPRI. https://hdl.handle.net/10568/137896

ACLED (Armed Conflict Location & Event Data). 2023. "Sudan Situation Update: November 2023 | RSF Expands Territorial Control as Ceasefire Talks Resume in Jeddah." *ACLED Updates* (blog), November 3. https://acleddata.com/update/sudan-situation-update-november-2023-rsf-expands-territorial-control-ceasefire-talks-resume

Afesorgbor, S.K. 2019. "The Impact of Economic Sanctions on International Trade: How Do Threatened Sanctions Compare with Imposed Sanctions?" *European Journal of Political Economy* 56:11–26. https://doi.org/10.1016/j.ejpoleco.2018.06.002

Alfadul, H.,K. Siddig, M. Ahmed, H. Abushama, and O. Kirui. 2024. "Sustainable Livestock Development in Sudan: Challenges, Opportunities, and Policy Priorities." Sudan SSP Working Paper 19. IFPRI. https://hdl.handle.net/10568/151697

Ali, H.E. 2013. "Estimate of the Economic Cost of Armed Conflict: A Case Study from Darfur." *Defence and Peace Economics* 24 (6):503–519. https://doi.org/10.1080/10242694.2012.723154

Asare, J., S. Awad, S. Logan, P. Mathewson, and C. Sacchetto. 2021. *Sudan in the Global Economy: Opportunities for Integration and Inclusive Growth*. IGC (International Growth Centre). https://www.theigc.org/publications/sudan-global-economy-opportunities-integration-and-inclusive-growth

Bacchetta, M., V. Cerra, R. Piermartini, and M. Smeets. 2021. "Trade and Inclusive Growth." IMF Working Papers WP/21/74. IMF (International Monetary Fund). https://www.elibrary.imf.org/view/journals/001/2021/074/article-A001-en.xml

Baier, S.L., and J.H. Bergstrand. 2007. "Do Free Trade Agreements Actually Increase Members' International Trade?" *Journal of International Economics* 71 (1):72–95. https://doi.org/10.1016/j.jinteco.2006.02.005

Benjamin, N. 2023. *Dealing with Informality in Conflict and Fragile Settings*. Technical Report. DCED (Donor Committee for Enterprise Development). https://www.enterprise-development.org/dealing-with-informality-in-conflict-and-fragile-settings/

Bove, V., J. Di Salvatore, and R. Nisticò. 2023. "Economic Sanctions and Trade Flows in the Neighborhood." *The Journal of Law and Economics* 66 (4):671–697. https://doi.org/10.1086/725678

Calì, M., W. Harake, F. Hassan, and C. Struck. 2015. The Imp*act of the Syrian Conflict on Lebanese Trade*. World Bank. https://hdl.handle.net/10986/21914

Caramuta, C., A. Grosso, and G. Longo. 2023. "Logistics Chain Responsiveness to War Impacts: A Case Study in North Adriatic Region." *Case Studies on Transport Policy* 14:101086. https://doi.org/10.1016/j.cstp.2023.101086

Collier, P. 1999. "On the Economic Consequences of Civil War." *Oxford Economic Papers* 51 (1):168–183. https://doi.org/10.1093/oep/51.1.168

Collier, P., and M. Duponchel. 2013. "The Economic Legacy of Civil War." *Journal of Conflict Resolution* 57 (1):65–88. https://doi.org/10.1177/0022002712464847

Collier, P., V.L. Elliott, H. Hegre, A. Hoeffler, M. Reynal-Querol, and N. Sambanis. 2003. *Breaking the Conflict Trap: Civil War and Development Policy*. World Bank. https://hdl.handle.net/10986/13938

Collier, P., and A. Hoeffler. 2004. "Aid, Policy and Growth in Post-Conflict Societies." *European Economic Review* 48 (5):1125–1145. https://doi.org/10.1016/j.euroecorev.2003.11.005

Didier, L. 2019. "The Impact of Conflict on Trade in Services: A Sector-Level Analysis." *Comparative Economic Studies* 62 (1):34–48. https://doi.org/10.1057/s41294-019-00095-y

Doan, N.T., and M.H. Tran. 2023. "Quantifying the Effect of Economic Sanctions on Trade in Cultural Goods." *International Economic Journal* 37 (3):401–423. https://doi.org/10.1080/10168737.2023.2220300

Du, Y., J. Ju, C.D. Ramirez, and X. Yao. 2017. "Bilateral Trade and Shocks in Political Relations: Evidence from China and Some of Its Major Trading Partners, 1990–2013." *Journal of International Economics* 108:211–225. https://doi.org/10.1016/j.jinteco.2017.07.002

Elobaid, A.H., and A. Alhelo. 2023. "Post-Conflict Reconstruction, Stabilization and Growth Agenda for Sudan." ERF Policy Brief No. 122. ERF (Economic Research Forum). https://erf.org.eg/publications/post-conflict-reconstruction-stabilization-and-growth-agenda-for-sudan-2/

Estrada, M.A.R., and E. Koutronas. 2022. "The Impact of the Russian Aggression against Ukraine on the Russia-EU Trade." *Journal of Policy Modeling* 44 (3):599–616. https://doi.org/10.1016/j.jpolmod.2022.06.004

FAO (Food and Agricultural Organization of the United Nations). 2024. "Sudan: FAO Issues Stark Warning over "Deeply Concerning" Scale of Hunger." Press release. March 20. https://www.fao.org/newsroom/detail/sudan-fao-issues-stark-warning-over-deeply-concerning-scale-of-hunger/en?utm_source=chatgpt.com

Fernandes, G. , P. Teixeira, and T.A. Santos. 2023. "The Impact of the Ukraine Conflict in Internal and External Grain Transport Costs." *Transportation Research Interdisciplinary Perspectives* 19:100803. https://doi.org/10.1016/j.trip.2023.100803

Freeman, R., M. Larch, A. Theodorakopoulos, and Y.V. Yotov. 2025. "Unlocking New Methods to Estimate Country-Specific Effects and Trade Elasticities with the Structural Gravity Model." *Journal of Applied Econometrics* 40 (6):669–684. https://doi.org/10.1002/jae.3133

Fuchs, A., and N.-H. Klann. 2013. "Paying a Visit: The Dalai Lama Effect on International Trade." *Journal of International Economics* 91 (1):164–177. https://doi.org/10.1016/j.jinteco.2013.04.007

Gaulier, G., and S. Zignago. 2010. "BACI: International Trade Database at the Product-Level. The 1994-2007 Version." CEPII Working Paper No. 2010–23. CEPII (Centre for Prospective Studies and International Information). https://www.cepii.fr/CEPII/fr/publications/wp/abstract.asp?NoDoc=2726

Gutmann, J., M. Neuenkirch, and F. Neumeier. 2023. "The Economic Effects of International Sanctions: An Event Study." *Journal of Comparative Economics* 51 (4):1214–1231. https://doi.org/10.1016/j.jce.2023.05.005

HDX (Humanitarian Data Exchange). 2024. "The Humanitarian Data Exchange." Accessed December 9, 2024. https://data.humdata.org/

Heilmann, K. 2016. "Does Political Conflict Hurt Trade? Evidence from Consumer Boycotts." *Journal of International Economics* 99:179–191. https://doi.org/10.1016/j.jinteco.2015.11.008

HRW (Human Rights Watch). 2024. "Sudan: Abusive Warring Parties Acquire New Weapons." *Human Rights Watch News* (blog), September 9. https://www.hrw.org/news/2024/09/09/sudan-abusive-warring-parties-acquire-new-weapons

IFPRI. 2024. "Global Spatially-Disaggregated Crop Production Statistics Data for 2020 Version 2.0." Harvard Dataverse. Accessed December 9, 2024. https://dataverse.harvard.edu/dataset.xhtml?persistentId=doi:10.7910/DVN/SWPENT

Karam, F., and C. Zaki. 2016. "How Did Wars Dampen Trade in the MENA Region?" *Applied Economics* 48 (60):5909–5930. https://doi.org/10.1080/00036846.2016.1186799

Khalifa, A. 2020. "Sudan's Transition: Challenges and Opportunities." *TWI Policy Analysis* (blog), June 1. https://www.washingtoninstitute.org/policy-analysis/sudans-transition-challenges-and-opportunities?utm_source=chatgpt.com

Kirui, O.K., K. Siddig, H. Abushama, and A.S. Taffesse. 2023. "Armed Conflict and Business Operations in Sudan: Survey Evidence from Agri-Food Processing Firms." Sudan SSP Working Paper 11. IFPRI. https://hdl.handle.net/10568/140193

Klomegah, K.K. 2024. "Weapon Supplies from China, Russia, Turkey, and United Arab Emirates Fuelling Sudanese War." *Modern Diplomacy*, July 28. https://moderndiplomacy.eu/2024/07/28/weapon-supplies-from-china-russia-turkey-and-united-arab-emirates-fuelling-sudanese-war/

Kornher, L., and M. Kalkuhl. 2019. "The Gains of Coordination – When Does Regional Cooperation for Food Security Make Sense?" Global Food Security 22:37–45. https://doi.org/10.1016/j.gfs.2019.09.004

Koubi, V. 2017. "War and Economic Growth." In *Peace and Conflict 2012*, ed. J.J. Hewitt, chapter 10. First ed. Routledge. https://doi.org/10.4324/9781315089997-11

Larch, M., J. Luckstead, and Y.V. Yotov. 2024. "Economic Sanctions and Agricultural Trade." *American Journal of Agricultural Economics* 106 (4):1477–1517. https://doi.org/10.1111/ajae.12473

Le Billon, P. 2001. "The Political Ecology of War: Natural Resources and Armed Conflicts." *Political Geography* 20 (5):561–584. https://doi.org/10.1016/S0962-6298(01)00015-4

Lewis, D., G. Kebede, A. Brown, and P. Mackie. 2019. *Surviving, Managing, Thriving: The Informal Economy in Post-Conflict Cities*. UN-Habitat (United Nations Human Settlements Programme). https://unhabitat.org/sites/default/files/2020/02/1-post-conflict_cities.pdf

Li, Y., Z. Jian, W. Tian, and L. Zhao. 2021. "How Political Conflicts Distort Bilateral Trade: Firm-Level Evidence from China." *Journal of Economic Behavior & Organization* 183:233–249. https://doi.org/10.1016/j.jebo.2021.01.003

Lin, F., C. Hu, and A. Fuchs. 2019. "How Do Firms Respond to Political Tensions? The Heterogeneity of the Dalai Lama Effect on Trade." *China Economic Review* 54:73–93. https://doi.org/10.1016/j.chieco.2018.10.009

Marano, V., A. Cuervo-Cazurra, and C.C.Y. Kwok. 2013. "The Impact of Conflict Types and Location on Trade." *The International Trade Journal* 27 (3):197–224. https://doi.org/10.1080/08853908.2013.796835

Mwendia, S., B. Dey, M.I. Mohammed, H. Makkar, A. Notenbaert, and M. Peters. 2023. *Role of Cultivated Forages in Sudan 2 Activity Title: Feed the Future Global Supporting Seed Systems for Development Activity*. USAID and CRS (Catholic Relief Services). https://www.researchgate.net/publication/382676529_Role_of_Cultivated_Forages_in_Sudan_2_Activity_Title_Feed_the_Future_Global_Supporting_Seed_Systems_for_Development_Activity

Nguyen, T.T., and M.H. Do. 2021. "Impact of Economic Sanctions and Counter-Sanctions on the Russian Federation's Trade." *Economic Analysis and Policy* 71:267–278. https://doi.org/10.1016/j.eap.2021.05.004

Nougud, S. 2024. "Sudan's Livestock: $879m Exports Resilience during War." *Atar*, July 8. https://atarnetwork.com/wp-content/uploads/2024/07/ATAR-English-Issue-8-Sudans-livestock-879m-exports-resilience-during-war.pdf

Osman, M., U. Schulthess, B. Ahmad et al. 2025. *Sorghum Production in Selected States of Sudan during the 2024/25 Growing Season*. CIMMYT (International Maize and Wheat Improvement Center). https://hdl.handle.net/10883/35569

Qureshi, M.S. 2013. "Trade and Thy Neighbor's War." *Journal of Development Economics* 105:178–195. https://doi.org/10.1016/j.jdeveco.2013.07.009

Rauschendorfer, J., and B. Shepherd. 2020. "Regional Economic Spillovers from the South Sudanese Civil War: Evidence from Formal and Informal Cross Border Trade." IGC Working Paper. IGC (International Growth Centre). https://www.theigc.org/collections/regional-economic-spillovers-south-sudanese-civil-war-evidence-formal-and-informal

Resnick, D., H. Abushama, M. Ahmed, O. Kirui, and K. Siddig. 2026. "Under the Gun: Military and Paramilitary Actors in Sudan's Agrifood System." *The Journal of Development Studies*, 1–22. https://doi.org/10.1080/00220388.2025.2601585

Sakyi, D., and S.K. Afesorgbor. 2019. "The Effects of Trade Facilitation on Trade Performance in Africa." *Journal of African Trade* 6 (1):1–15. https://doi.org/10.2991/jat.k.191129.001

Sakyi, D., I. Bonuedi, and E.E. Osei Opoku. 2018. "Trade Facilitation and Social Welfare in Africa." *Journal of African Trade* 5 (1-2):35–53. https://doi.org/10.1016/j.joat.2018.08.001

Santos Silva, J.M.C., and S. Tenreyro. 2006. "The Log of Gravity." *The Review of Economics and Statistics* 88 (4):641–658. https://doi.org/10.1162/rest.88.4.641

Seid, E.H., H. Kebret, and A.I. Abdi. 2021. "The State of the Political Instability and Its Impact on Trade in South Sudan: A Critical Assessment." Financial Working Paper FW-004. AERC (African Economic Research Consortium). https://publication.aercafricalibrary.org/handle/123456789/2025

Siddig, K., M. Raouf, and M.O.M. Ahmed. 2023. "The Economy-Wide Impact of Sudan's Ongoing Conflict: Implications on Economic Activity, Agrifood System and Poverty." Sudan SSP Working Paper 12. IFPRI. https://hdl.handle.net/10568/140293

SPARC (SPARC-Knowledge Supporting Pastoralism and Agriculture.) 2025. *The War Economy in Darfur: Distorting Trade and Fuelling Conflict*. SPARC. https://www.sparc-knowledge.org/publications-resources/war-economy-darfur-trade-conflict

Spittaels, S., and Y. Weyns. 2014. *Mapping Conflict Motives: The Sudan – South Sudan Border*. IPIS (International Peace Information Service). https://ipisresearch.be/fr/publication/mapping-conflict-motives-sudan-south-sudan-border/.

Sudan, Ministry of Livestock. 2021. *Livestock Statistical Bulletin, Issue No. 29-30*. Ministry of Livestock.

Taralashvili, T. 2024. "The Impact of Interstate Soft Conflicts on Bilateral Trade Flows Using Structural Gravity Model." *The World Economy* 47 (5):1943–1977. https://doi.org/10.1111/twec.13519

UNCTAD (United Nations Conference on Trade and Development). 2024. "General Profile: Sudan." UNCTADstat. Last updated December 2, 2025. https://unctadstat.unctad.org/CountryProfile/GeneralProfile/en-GB/729/index.html

UNOPS (United Nations Office for Project Services). 2024. "Rehabilitating East Darfur's Gum Arabic Belt." *UNOPS News* (blog). https://www.unops.org/news-and-stories/stories/rehabilitating-east-darfurs-gum-arabic-belt

Wahlstedt, E., and H.M. Sulieman. 2024. *Supporting Conflict-Resilient Food Systems in Sudan*. CSF (Conflict Sensitivity Facility). https://csf-sudan.org/library/supporting-conflict-resilient-food-systems-in-sudan/

World Bank. 2024a. "Data on Doing Business Indicators, Logistic Performance Indicators, and Tariff Rate." World Development Indicators. Accessed December 9, 2024. https://databank.worldbank.org/source/world-development-indicators

World Bank. 2024b. "World Integrated Trade Solution (WITS)." Accessed December 9, 2024. https://wits.worldbank.org/

Yotov, Y.V., R. Piermartini, J.-A. Monteiro, and M. Larch. 2018. *An Advanced Guide to Trade Policy Analysis: The Structural Gravity Model*. WTO (World Trade Organization) and UNCTAD. https://www.wto.org/english/res_e/publications_e/advancedguide2016_e.htm

Chapter 6 Appendix

TABLE 6.A1 Average logistic performance indicators (2007–2022)

	ATTC		CQLS		EACPS		ECCP		FSRCE		QTTRI		OVERALL	
	Mean	%Δ	Mean	%Δ	Mean	%Δ	Mean	%Δ	Mean	%Δ	Mean	%Δ	Mean	%Δ
Conflict countries	2.63	11.75	2.58	12.90	2.62	2.90	2.39	4.13	3.04	2.42	2.44	14.23	2.62	7.72
Nonconflict countries	2.99	17.84	2.92	17.42	2.92	13.11	2.78	14.51	3.35	6.49	2.85	19.35	2.97	14.22
All countries	2.89	17.43	2.82	16.16	2.84	11.97	2.67	13.27	3.26	5.47	2.73	19.38	2.87	13.31

Note: Δ denote the percentage of over the sample period; ATTC, CQLS, EACPS, ECCP, FSRCE, QTTRI, and OVERALL represent, respectively, the ability to track and trace consignments, competence and quality of logistics services, ease of arranging competitively priced shipments, efficiency of the customs clearance process, frequency with which shipments reach consignee within the scheduled or expected time, quality of trade and transport-related infrastructure, and overall logistic performance indicators index.

Source: Authors, based on data from World Bank (2024a).

TABLE 6.A2 Average border and transport efficiency indicators (2005–2014) and tariff rate (2014–2021)

	DE		TE		CE		DM		TM		CM		TFR	
	Number	%Δ	Days	%Δ	Cost	%Δ	Number	%Δ	Days	%Δ	Cost	%Δ	Mean	%Δ
Conflict countries	7.18	11.67	32.02	14.83	2774.28	−9.97	8.99	5.95	39.35	26.16	3434.82	2.20	10.27	10.64
Nonconflict countries	6.09	5.36	21.47	−0.81	1675.06	−8.58	7.01	3.75	23.15	4.75	1963.00	−3.02	8.31	61.47
All countries	6.33	4.29	23.82	−3.61	1920.39	−8.38	7.45	2.47	26.76	−1.06	2291.49	−6.58	8.71	131.61

Note: Δ denote the percentage of over the sample period; DE (DM), TE(TM), CE (CM), and TFR refer to the document to export (import), time to export (import), cost to export (import), and tariff rate, respectively.

Source: Authors, based on data from World Bank (2024a).

TABLE 6.A3 State-level production/livestock ownership and classification into products produced in SAF- and RSF-controlled areas

Product		RSF							Disputed			
		North Darfur	South Darfur	West Darfur	Central Darfur	East Darfur	North Kordofan	Per capita production	Khartoum	West Kordofan	South Kordofan	Per capita production
Population		3,461,818	3,895,007	618,178	943,721	2,390,080	3,444,769	14,753,573	5,941,286	2,612,654	1,156,469	9,710,409
10229 10290		0.74	2.5	2.4	1.96	2.05	0.79	0.70	0.26	3.56	4.65	0.87
10410	RSF	3.94	2.21	2.25	1.85	1.81	4.22	1.10	0.46	4.37	2.21	0.72
10613	RSF	0.62	0.09	0.24	0.2	0.07	0.94	0.14	0.01	0.64	0.25	0.09
20110 20120		0.74	2.5	2.4	1.96	2.05	0.79	0.70	0.26	3.56	4.65	0.87
20410 20421	RSF	3.94	2.21	2.25	1.85	1.81	4.22	1.10	0.46	4.37	2.21	0.72
71320 71360		34,520	27.1	526.5	n/a	n/a	n/a	2,377	122.6	n/a	n/a	12.62
100790	RSF	60,068	180,696.5	35,804.6	n/a	n/a	1,993.5	18,881	8,295.7	n/a	182,845.1	19,684
120242	SAF	33,799.1	225,803.6	32,429.2	n/a	n/a	343,341.4	43,065	n/a	n/a	93,407.3	9,619
120740	SAF	6,400.9	4,567.3	17,737.8	n/a	n/a	306,213.3	22,700	835.3	n/a	224,306.9	23,185
120770	SAF	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
121410	SAF	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
121490		n/a	n/a	n/a	n/a	n/a	n/a	n/a	Production mainly Khartoum			n/a
130120		25% of production in Darfur					n/a	n/a	n/a	n/a	n/a	n/a
150810	SAF	33,799.1	225,803.6	32,429.2	n/a	n/a	343,341.4	43,065.7	n/a	n/a	93,407.3	9,619
230230		Production in both RSF and SAF areas										n/a
520100	SAF	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Product		SAF									
		Kassala	Northern	While Nile	River Nile	Red Sea	Aj Jazirah	Sennar	Gedaref	Blue Nile	Per capita production
Population		2,718,540	1,446,861	3,392,274	1,862,303	2,035,582	5,124,749	2,532,326	3,091,393	813,930	23,017,958
10229 10290		0.91	0.27	3.77	0.11	0.15	2.67	1.7	1.12	2.17	0.55
10410	RSF	2.12	1.03	2.67	1.08	0.44	2.59	1.44	2.24	4.09	0.76
10613	RSF	0.72	0.05	0.04	0.12	0.3	0.13	0.12	0.36	0.01	0.08
20110 20120		0.91	0.27	3.77	0.11	0.15	2.67	1.7	1.12	2.17	0.55
20410 20421	RSF	2.12	1.03	2.67	1.08	0.44	2.59	1.44	2.24	4.09	0.76
71320 71360		8,868.6	61.8	7,142	8	972	23,564.6	7,217	1,954.2	n/a	2,163
100790	RSF	160,217.2	143,323.1	148,908	136,185.9	41,193.9	110,545.2	23,473	80,634.4	171,495.2	12,806
120242	SAF	55,297.1	99485	67,692.6	n/a	n/a	1,441,842	23,561	231,634.5	3,734.2	83,554
120740	SAF	4,937.2	1970.6	166,638.8	1894.4	n/a	3,504	140,217	309,528.4	95,950.7	31,481
120770	SAF	232,180.7	n/a	199,953.6	n/a	2,529.5	719,681.4	206,215	16,624.8	n/a	59,830
121410	SAF	Most production in Central regions and Nile states									n/a
121490		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
130120		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
150810	SAF	55,297.1	99,485	67,692.6	n/a	n/a	1,441,842	23,561.9	231,634.5	3,734.2	83,554
230230		Production in both RSF and SAF areas									n/a
520100	SAF	437,47.6	37,452.9	11,509.1	n/a	10,357.1	142,678	29,347.4	431,78.8	n/a	13,827

Note: n/a = no data were available for these states. For rows with text, no data were available for any state.

Source: Authors, based on data sources reported in Table 6.4