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Food Aid, External Trade and Domestic Markets: Implications for Food Security in Darfur*

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Abstract: In the last decade, internal conflict has greatly hindered market transactions across regions of Sudan, especially transactions between Darfur and the Rest of Sudan. Food aid has helped to offset not only the absence of commercial inflows of grain, but also reductions in Darfur's cereal production. This paper explores the determinants of cereal prices in Sudan utilizing a simple partial equilibrium framework for wheat and sorghum, the country's two main food staples. We also present econometric evidence on the lack of integration of sorghum markets between Darfur and central Sudan, along with quantitative estimates of the impacts of food aid on market prices in the region. The paper concludes with a discussion of national food policy and the paradox of simultaneous commercial exports and large-scale food aid imports of sorghum.

Key Words: Food Security, Food Policy, Trade

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I. Introduction

Food availability and access vary sharply across Sudan, the largest country in terms of area in Africa. Large irrigated and dry land mechanized farms along the Nile basin in northeastern and central Sudan produce sizeable marketed surpluses, but vast distances, internal conflict and poor infrastructure greatly limit commercial flows of food staples to deficit areas in southern Sudan and Darfur (in western Sudan). Moreover, these latter two land-locked areas are generally isolated from international commercial food markets, except for large scale inflows of food aid. Thus, the economic forces that drive food prices and market flows in southern Sudan and Darfur generally differ from the rest of Sudan, as do household food security outcomes.

Historically, there were substantial commercial grain flows from central Sudan to Darfur (De Waal, 1989; Teklu et al., 1991). In the last decade, however, internal conflict has greatly hindered these market transactions. With massive out-migration from rural areas to the relative safety of cities, agricultural production in Darfur has fallen dramatically, as well. Large inflows of food aid have helped to offset not only the absence of commercial inflows of grain, but also the reductions in regional production. Local markets, supplied by both local production and sales of food aid thus remain important as a source of food for almost all households in the region. Almost all of this food aid is imported, though in 2008, one-fourth of the sorghum delivered as food aid to Darfur was procured in eastern Sudan. Imported food aid sorghum in 2008 totaled about 300 thousand tons, approximately equivalent in volume to Sudan's private sector sorghum exports to the Middle East (used mainly for animal feed) in the same year.

This paper explores the complex interactions between food aid inflows, national food policy, market prices and household food security in Darfur. Section two presents an overview of food production, commercial trade, food aid imports and net availability in various regions of Sudan. Section three discusses determinants of cereal prices in Sudan utilizing a simple partial equilibrium framework for wheat and sorghum, the country's two

main food staples. Section four focuses on food aid inflows and price determination in Darfur, presenting econometric evidence on the lack of integration of sorghum markets between Darfur, southern Sudan and central Sudan, along with quantitative estimates of the impacts of food aid on market prices in Darfur. Section five concludes with a discussion of national food policy and the paradox of simultaneous commercial exports and large-scale food aid imports of sorghum.

II. Sudan: Cereal Production and Supply

Less than ten percent of the land in Sudan is arable, and water availability is generally the key constraint on agricultural production. The most productive areas are the large-scale irrigated farms in the Nile basin in eastern Sudan which grow a wide variety of crops, including wheat and vegetables. Semi-mechanized non-irrigated farms in eastern Sudan, for which land preparation is done using tractors, are the major surplus producers of sorghum. Most of the farms in the country, however, have neither irrigation nor mechanized land preparation, and produce drought-tolerant sorghum and millet. In higher rainfall areas of southern Sudan, maize is also a major staple food crop.[1]

Sorghum is by far the major food crop, accounting for three-quarters of national cereal production in 2007 (Table 1). Crop production patterns nonetheless vary across the three major regions of Sudan. In Darfur (western Sudan), low levels of rainfall and lack of irrigation greatly limit crop choice and productivity. Overall cereal production, split almost evenly between millet and sorghum, was only about 590 thousand tons (85 kgs/capita), far below consumption needs. Sorghum dominates cereal production in Southern Sudan, where it accounts for about 90 percent of nearly 1.0 million tons (174 kgs/capita) of cereal produced. Wheat is grown only along the Nile River in the Rest of Sudan, where it accounts for nearly 15 percent of total cereal production of 4.9 million tons (203 kgs/capita).

Net cereal imports (215 thousand tons of sorghum and 1,140 thousand tons of wheat) accounted for 19 percent of the 7.1 million tons (194 kgs/capita) of national total cereal

[1] See World Bank (1990) for a detailed, though dated, overview of agriculture in Sudan. Keen and Lee (2007) provide a more recent summary of agriculture and food security in Sudan.

availability in 2007. For Darfur, food aid sorghum supplied about 55 percent of total sorghum and accounted for 36 percent of total availability of cereals. Wheat imports accounted for nearly two-thirds of net domestic wheat availability. As discussed below, high world prices of cereals in 2007 and 2008 made sorghum exports from Sudan to the Middle East profitable, so that in 2008, Sudan exported 300 to 400 thousand tons of sorghum, while receiving about 300 thousand tons of imported food aid sorghum.

III. Market Price Determination in Central Sudan

Although sharp rises in international cereal prices have caused great concern in many developing countries, the recent food price increases in Sudan have been small relative to earlier domestic price surges related to droughts. Of Sudan's three major staples, wheat, sorghum and millet, only wheat has consistently been a tradable good in the past decade. In most years, sorghum has been a non-tradable good, with a domestic price well above the export parity price, but well below the import parity price. Millet has consistently been a non-tradable commodity.

Domestic wheat prices in Sudan have largely been determined by import parity prices. The exception to this general pattern was 2005, a year when drought led to a 1.7 million ton (39 percent) fall in production of sorghum. Although commercial wheat imports rose by 460 thousand tons from 1.07 to 1.53 million tons, the volume of imports was insufficient to keep domestic prices from rising above import parity. In 2007 and early 2008, domestic wheat prices rose by almost 80 percent along with import parity levels (which nearly doubled). Real domestic wheat prices rose by only 50 percent over this period, though, because appreciation of the real exchange rate of the Sudanese pound relative to major trading partners helped offset the rise in international wheat prices (Table 2).

From 2000 to 2007, domestic sorghum prices fluctuated inversely with the level of rainfall and the size of the domestic harvest. Private sector commercial exports or imports of sorghum were not profitable (except perhaps for occasional small-scale cross-border informal trade). The sharp rise in world sorghum prices in 2007 and 2008 that closely tracked the rise in world prices of maize (a close substitute for animal feed), however, made commercial

exports of sorghum profitable, even though the harvest in that year was 22 percent below that of 2006/07 (Figure 1).

Interviews with traders in Gedaref in 2008, the major wholesale market for sorghum in Sudan, suggest that the quantities of sorghum exports were determined at least in part by government policy and not solely by market forces. Nevertheless, domestic sorghum prices closely followed estimated export parity prices in 2007 and 2008, rising by 42 percent in nominal terms and 21 percent in real terms.[2]

Model Simulations of Market Prices

To analyze the impacts of production shocks, changes in world prices and changes in food aid net inflows, we utilize a simple partial equilibrium model of the sorghum and wheat markets. The model assumes that domestic wheat prices are determined by import parity prices (and are thus exogenous in these simulations), but that sorghum prices are determined by domestic demand and net domestic supply which in some scenarios is reduced by private sector commercial exports. In the main simulations, we assume an own-price elasticity of demand of sorghum of -0.8 (and -0.5 in the sensitivity analysis).

Model simulations suggest that in the absence of exports or any changes to food aid inflows, the 22 percent decline in domestic production in 2008 would have led to an estimated 18 to 27 percent increase in real sorghum prices (Table 3). These figures assume an integrated national market. Assuming that sorghum and wheat markets in Darfur and southern Sudan were effectively isolated from markets in the rest of Sudan (as suggested by the econometric evidence presented below), the estimated effect of the 26 percent production decline in the Rest of Sudan is 21 to 32 percent.

Exports of 300 thousand tons of sorghum in 2008 which reduced net domestic supply raised real domestic sorghum prices by an estimated 7 to 10 percent, assuming an integrated national market, and by 9 to 14 percent, assuming a smaller core national market in the Rest

[2] Percentage changes are calculated using average wholesale prices in Khartoum from January-May in 2007 and 2008, respectively.

of Sudan. In either case, consumers suffered while producers (and traders) benefited from the opportunity to export sorghum in 2007/08.

The World Food Programme also procured about 100 thousand tons of sorghum domestically in 2007/08, a figure only about one-third the level of commercial exports. Assuming that the cereal markets in the Rest of Sudan are not integrated with the Darfur and Southern Sudan, the combined effect of commercial exports and the domestic procurement was to raise prices from 13 to 18 percent relative to Simulation 1 (Production Shock Only). Relative to a scenario of a production shortfall with commercial exports (Simulation 2), the effect of domestic procurement was minimal, raising sorghum prices by only about 4 percent.[3] Thus, domestic procurement of food aid in 2008 played only a minor role in domestic sorghum price increases, especially as compared to the effects of the production shortfall and commercial exports.

IV. Food Aid and Market Prices in Darfur

Food aid has been critical for overall food supply and household food security of the approximately six million people in Darfur since the onset of major conflict in 2003. From 2003 through 2008, food aid (wheat and sorghum) accounted for an average of 39 percent of annual cereal availability. Overall, wheat accounted for about one-third of the cereal food aid in this period, though there was almost no wheat food aid in 2007 or 2008 (Table 4).

Calculations of simple price correlations across Sudan indicate (i) substantial co-movement of prices of sorghum between El Obeid, largest cereal hub in central Sudan, and Gedaref, main cereal markets in the production area; (ii) significant co-movement between the Darfurs (apart from El Geneina) and El Obeid, largest nearby wholesale cereal market; and (iii) very low correlation between southern Sudan (Juba) and the rest of the markets in Sudan. Nonetheless, in most years, there is reportedly little trade, especially between Darfur and El Obeid. This suggests that the high price correlations may be due mainly to shared

[3] For the Darfur region alone, a 20 percent reduction in sorghum production, along with the marginal decline in food aid sorghum (292 to 286 thousand tons) is estimated to lead to an increase in sorghum prices by 17 to 27 percent. This calculation assumes that the Darfur cereal markets are isolated from those in other parts of Sudan and that own-price elasticity of demand for sorghum of -0.5 to -0.8.

weather conditions and thus common production shocks across Darfur and central Sudan. For example, the 2005 drought significantly reduced production in both Darfur and much of the rest of Sudan, contributing to high cereal prices throughout the region.

Co-integration analysis likewise suggests that the co-movement of prices evidenced in the price correlations do not reflect market integration. Sorghum prices in El Fasher and Nyala, both in Darfur, Gedaref and El Obeid, as well as Juba all proved to be non-stationary by both Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) unit root tests (p-value ranging from 0.15 to 0.52)[4]. Using a constant in the cointegrating equation and no deterministic trend, however, Johansen trace test (Johansen and Juselius, 1990) showed no long-term price linkages between El Obeid, El Fasher and Nyala or between El Obeid, Gedaref and Juba[5]. However, prices in El Obeid and Gedaref, both in the Rest of Sudan, are co-integrated (Table 5). These econometric results corroborate the existence of three separate markets for analysis: Darfur, southern Sudan and the Rest of Sudan.

These results are, in general, corroborated by trader interviews that describe little actual trade flows in most years, especially between Darfur and the rest of Sudan (WFP, 2007). The major exception to this general pattern is the reported backhauling of food aid wheat from Darfur to central Sudan and even Khartoum in the 2005 drought year. (As a result of these reverse flows, WFP changed the composition of its food aid, replacing nearly all of the wheat food aid with sorghum, the preferred staple in Darfur.) More recently, trade flows across markets within Darfur have increased somewhat, though these remain hindered by poor security conditions in many places (Buchanan-Smith and Jaspars, 2007; WFP, 2007).

Impact of Food Aid Flows on Sorghum Prices in Darfur

In order to estimate the impact of food aid on market prices in Darfur, we estimate a reduced form equation including wholesale prices and quantities of food aid distributed. Since reliable data on cereal production in Darfur is not available, we attempt to capture the effects of weather-related production shocks in Darfur by using the relative price of sorghum in

[4] The El Geneina data series was considered stationary with both statistical routines (at 1 percent). Nevertheless, since this series was constructed from a different data source and had many missing values, it was not included in the subsequent analysis.
[5] The Juba data series starts only in 2006 and is thus too short to permit conclusive estimates of the presence or absence of co-integration.

Darfur to the price of sorghum in El Obeid. Assuming similar production shocks affecting both Darfur and El Obeid (and central Sudan), relative prices of sorghum between these markets will largely be determined by food aid flows into Darfur.

As shown in Figure 2, wholesale sorghum prices were typically above those in El Obeid before the conflict (i.e. in 2002), and below those in El Obeid after the conflict started. Periods of high food aid inflows tend to correspond with low price ratios (i.e. prices in Darfur below those in El Obeid). Note also, that food aid inflows into Darfur have followed a seasonal pattern in recent years with food aid flows higher in the lean season (June to November).

Both ADF and PP routines indicate that food aid deliveries and price ratios for Nyala and El Fasher are non-stationary (both in levels and logarithms), at a significance level of 6 percent on average. Note, though, that the power of this test is weakened by the presence of a structural break - for the onset of the Darfur crisis in 2003, see Perron, 1989. Thus, we proceed with Engle-Granger procedure for univariate cointegration models (Engle and Granger, 1987) that consists in an Ordinary Least Squares (OLS) regression including the price ratio and food aid deliveries to Darfur (Table 6). For both Nyala and El Fasher, increases in food flows result in a statistically significant decrease in market prices relative to those in El Obeid. Cointegration relationships were validated by the stationarity of the estimated residuals. Note that specific tables for testing the significance of the super consistent estimators and stationarity of the estimated residuals (Cointegration-ADF) were used (see MacKinnon, 1990). However, the high degree of auto-correlation of the residuals of these equations suggest that the coefficients could overstate the impact of food aid on market prices, so further analysis is needed.[6]

The regression results suggest that food aid flows of sorghum into Darfur which average approximately 520,000 tons per year (43,000 tons per month) lower prices in El Fasher relative to El Obeid by about 50 percentage points (about 35 percentage points for the

[6] Similar results were obtained when using the logarithms of the variables, and bimonthly data. Durbin-Watson tests for (first order) auto-correlation of residuals are systematically rejected.

Nyala price relative to El Obeid)[7]. By comparison, using the simple multi-market model outlined above for Darfur region only, a 10,000 ton/month increase in food aid would result in a 22 percent decline in the real price of sorghum.

By lowering this market price, food aid increases food access for all net-purchaser poor households, not only those who are direct recipients of food aid. This is particularly crucial in drought years as in 2005 when the rest of Sudan was affected by high food prices but Darfur prices remained low.

V. Conclusions and Policy Implications

Food aid policy in Sudan has adapted over time in response to problems encountered and changing market conditions. After initial distribution of large volumes of wheat led to substantial sales by recipient households and backflow of wheat from Darfur to central Sudan, WFP replaced its wheat food aid with sorghum. Moreover, flows have been sufficient to substantially increase food supply in Darfur and even reduce prices below those in central Sudan, although the price reduction has not been so steep as to make sorghum trade from Darfur to central Sudan profitable. Thus, from a regional perspective, the policy is functioning well, reducing prices for food insecure net purchaser households in Darfur while avoiding adverse impacts on producer incentives in the Rest of Sudan.

From a national perspective, however, simultaneous private sector exports, domestic procurement and food aid imports is socially wasteful though logical for each of the major actors given their individual objectives and constraints. Major food aid donors such as the United States still prefer to give donations in kind, in large part because this aid has the support of producers, shippers and even NGOs based in the donor country (Barrett and Maxwell, 2005). The World Food Programme, constrained in the amount of cash donations it receives, has insufficient funds to procure more locally and in any case would find it difficult in the short-run to massively escalate local procurement. Sudan's national government benefits from the food aid donations (which fund relief efforts) and from foreign exchange

[7] Assuming an income elasticity of sorghum demand of 0.8 and that sorghum expenditures accounting for a 40 percent budget share, the implicit average own-price elasticity of sorghum in Darfur is -0.6 using the estimated parameter for Nyala (and about -0.45 using the estimated parameter for El Fasher).

earnings from sorghum exports. Private commercial traders simply sell to buyers at the market price.

Ultimately, the social cost of this policy is shared by the donor countries (who pay too much for the delivery of sorghum to intended recipients) and Darfur's poor (who perhaps could have received more resources if the same amount of donor resources were spent on lower cost locally purchased sorghum). Note that in this case, where food aid volumes have been large enough to make private imports of food into Darfur unprofitable, cash transfers would not lead to similarly large increases in food supply nor low prices for poor households purchasing from the local market.

Of course, the most important measure to increase food security and welfare of the people of Darfur is to end the conflict and restore peace. When peace is restored, in-kind food aid inflows to the region will need to decrease to avoid price disincentives on local production. In the mean time, substantial volumes of food aid benefits poor net consumers in Darfur both through the direct transfer of resources and by lowering market prices in Darfur. In any case, a greater reliance on local procurement of food aid sorghum (from other parts of Sudan, or perhaps in the long run, from rural Darfur itself) would free up additional resources for needed development and poverty alleviation welfare programs.

References

Barrett, Christopher B. and Daniel G. Maxell (2005). Food Aid After Fifty Years: Recasting Its Role. Routledge: New York.

Buchanan-Smith, Margie and Susanne Jaspars (2007). "Conflict, Camps and Coercion: The Ongoing Livelihoods Crisis in Darfur", *Disasters* (31 (supplement 1): s57-s76.

De Waal, Alex (1989). Famine that Kills: Darfur, Sudan. Oxford University Press: Oxford.

Engle, Robert and Clive Granger (1987). "Cointegration and error-correction representation, estimation and testing". *Econometrica* **55** (1987), pp. 251–276.

Johansen, Søren and Katarina Juselius (1990). "Maximum likelihood estimation and inference on cointegration: With application to the demand for money". *Oxford Bulletin of Economics and Statistics* **52** (1990), pp. 169–210.

Keen, David and Vivian Lee (2007). "Conflict, Trade and the Medium-Term Future of Food Security in Sudan", *Disasters* 31 (supplement 1): s9-s24.

MacKinnon, James (1990). "Critical Values for cointegration tests". In *Long-Run Economic Relationships*: Reading in Cointegration. Edited by R.F. Engle and C.W.J. Granger, 267-76: Oxford University Press.

Perron, Pierre (1989). "The Great Crash, the Oil Shock and the Unit Root Hypothesis", *Econometrica* 57(6): 1361-1402.

Teklu, Tesfaye, Joachim von Braun and E. Zaki (1991). Drought and Famine Relationships in Sudan: Policy Implications. Research Report No. 88. Washington, D.C., USA: International Food Policy Research Institute (IFPRI).

World Bank (1990). Sudan: Towards an Action Plan for Food Security. Stimulating Growth and Targeting Interventions. Report No. 8167-SU. World Bank: Washington, D.C.

World Food Programme (WFP), (2008). Food Security and Nutrition Assessment of the Conflict-Affected Population in Darfur, Sudan 2007. Final Report. World Food Programme, FAO, and UNICEF.

Table 1: Sudan: Population, Production and Availability of Cereals, 2007

	Darfur	Southern Sudan	Rest of Sudan	Total Sudan
Population 2003	6.4	5.3	22.0	33.6
Rural	5.2	4.2	12.7	22.2
Urban	1.1	1.1	9.3	11.5
Urban (percent)	17%	20%	42%	34%
Production				
Sorghum	0.276	0.901	3.812	4.989
Wheat	0.001	0	0.667	0.668
Millet	0.312	0.098	0.386	0.796
Maize				
Total	0.589	0.999	4.865	6.453
Total per capita 2007	85	174	203	176
Availability per capita				
Sorghum	79	150	134	126
Wheat	0	0	73	48
Millet	41	15	15	20
Maize	0	0	0	0
Total	120	165	221	194

Notes: Per capita production and availability are estimated using a projection of 2007 population based on 2003 population estimates and a 2.1 percent population growth rate in all regions.
Darfur rural-urban breakdown based on pre-conflict urbanization figures and likely greatly understate current urbanization rates.
Maize figures are not yet included in this table.

Table 2: Sudan: Food Aid, Production and Real Prices, 2003-08

	Food Aid Sorghum (mn tons)	Food Aid Wheat (mn tons)	Production Sorghum (mn tons)	Production Other Cereals (mn tons)	Real Price Sorghum ('2003 SDP per ton)	Real Price Wheat ('2003 SDP per ton)	Ratio P Sorghum / P Wheat
2003	0.135	0.072	2.825	0.915	474	789	0.61
2004	0.219	0.063	4.691	1.166	421	788	0.53
2005	0.196	0.445	2.678	0.947	783	875	0.90
2006	0.330	0.153	4.327	1.090	461	562	0.82
2007	0.364	0.021	4.989	1.464	307	616	0.51
2008*	0.381	0.000	3.906	1.546	384	919	0.42
Average 2003-08*	0.271	0.125	3.903	1.188	472	758	0.63

* 2008 data is for January through May, 2008.
Note: Real prices are calculated using wholesale prices in Khartoum deflated by the middle-income CPI.
Source: Calculated from WFP and Sudan Ministry of Agriculture data.

Table 3: Simulated Effects of Production and Trade Shocks in Sudan, 2008

	Sim 1: Prod shock only		Sim 2 w/ Exports		Sim 3 w/ WFP Proc	
	2008 ROSudan	2008 Total	2008 ROSudan	2008 Total	2008 ROSudan	2008 Total
Production	2.807	3.906	2.807	3.906	2.807	3.906
(absolute change)	-1.005	-1.083	-1.005	-1.083	-1.005	-1.083
(percent change)	-26.4%	-21.7%	-26.4%	-21.7%	-26.4%	-21.7%
Net Supply	2.762	4.097	2.462	3.797	2.362	3.697
(absolute change)	-0.431	-0.503	-0.731	-0.803	-0.831	-0.903
(percent change)	-13.5%	-10.9%	-22.9%	-17.5%	-26.0%	-19.6%
Real Price Change						
(percent change)	20.6%	17.5%	32.0%	25.4%	35.7%	28.0%
(relative to Sim 1)	0%	0%	9%	7%	13%	9%
Alternative Elasticities						
Real Price Change						
(percent change)	32.2%	27.2%	50.4%	39.8%	56.5%	44.1%
(relative to Sim 1)	0%	0%	14%	10%	18%	13%

Source: Model simulations.

Table 4: Food Aid and Cereal Prices in Darfur: 2003-08

	2003	2004	2005	2006	2007	2008	2003-08
Food Aid (mn tons)							
Sorghum	0.135	0.219	0.196	0.330	0.296	0.282	0.243
Wheat	0.072	0.063	0.445	0.153	0.000	0.000	0.122
Net Availability (mn tons)							
Sorghum	0.352	0.464	0.294	0.530	0.544	0.481	0.444
Total Cereals	0.767	0.968	1.112	1.018	0.826	0.707	0.900
Food Aid / Net Availability							
Sorghum	38%	47%	67%	62%	54%	59%	55%
All Cereals	27%	29%	58%	47%	36%	40%	39%
Wholesale Prices (SP/ton)							
Sorghum (Darfur)	383	404	602	473	413	525	467
Sorghum (El Obeid)	492	461	943	599	395	613	584
Ratio (Darfur / El Obeid)	0.78	0.88	0.64	0.79	1.05	0.86	0.83
Sorghum (Khartoum)	487	471	952	591	430	593	587
Ratio (Khartoum/El Obeid)	0.99	1.02	1.01	0.99	1.09	0.97	1.01

Notes: Food aid totals are for all Sudan, almost all of which was distributed in Darfur.
The Darfur wholesale price is the average of prices in El Fasher, Geneina and Nyala.

Table 5: Co-integration Regression for Sorghum Prices in the Rest of Sudan

Dependent Variable	Sorghum Price Gedaref
Constant	-37.954 0.05**
El Obeid	0.939 0.000***
Observations	77
R-squared	0.958
AIC	788.441
Residuals	
Durbin-Watson	1.2
C-ADF (pvalue)	0.5

Notes: Robust p-values for super consistent estimators below coefficients.

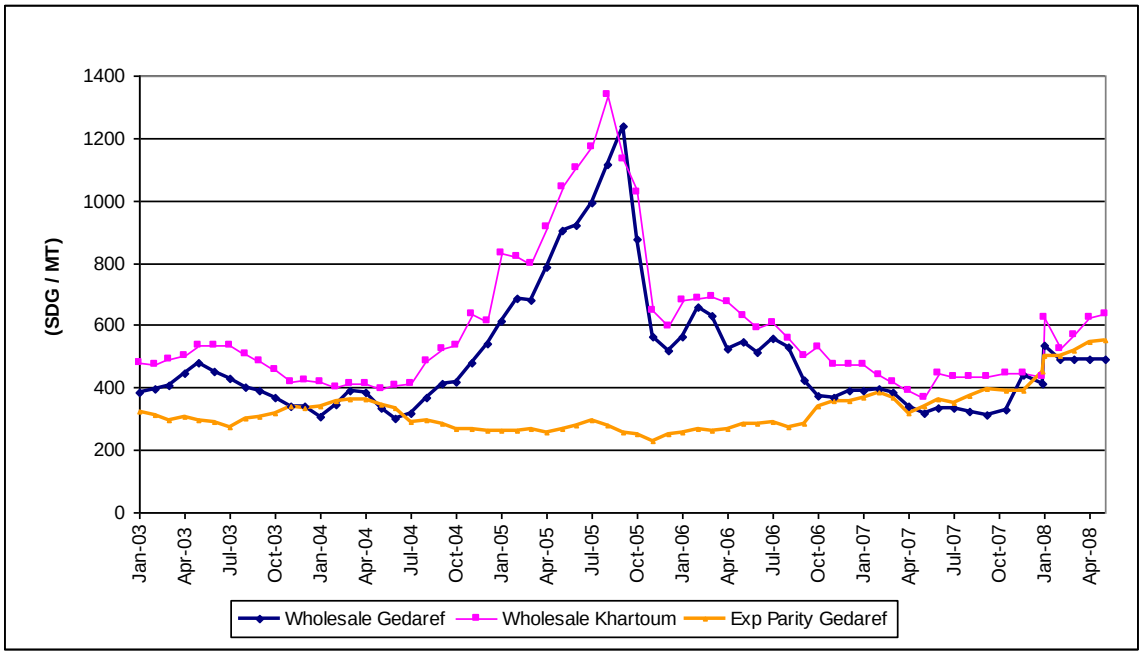
*significant at 10%; ** significant at 5%; *** significant at 1%
Source: Authors' calculations.

Table 6: Food Aid and Sorghum Market Price Ratios in Darfur

Dependent Variable	Sorghum Price Ratio Nyala/El Obeid	Sorghum Price Ratio Fasher/El Obeid
Constant	0.922	1.025
	0.000***	0.000***
Food aid	-0.012	-0.021
	.076*	0.001***
Observations	77	77
R-squared	0.048	0.133
AIC	-20.3	-16.8
Residuals		
Durbin-Watson	0.7	1.2
C-ADF (pvalue)	0.3	0.5

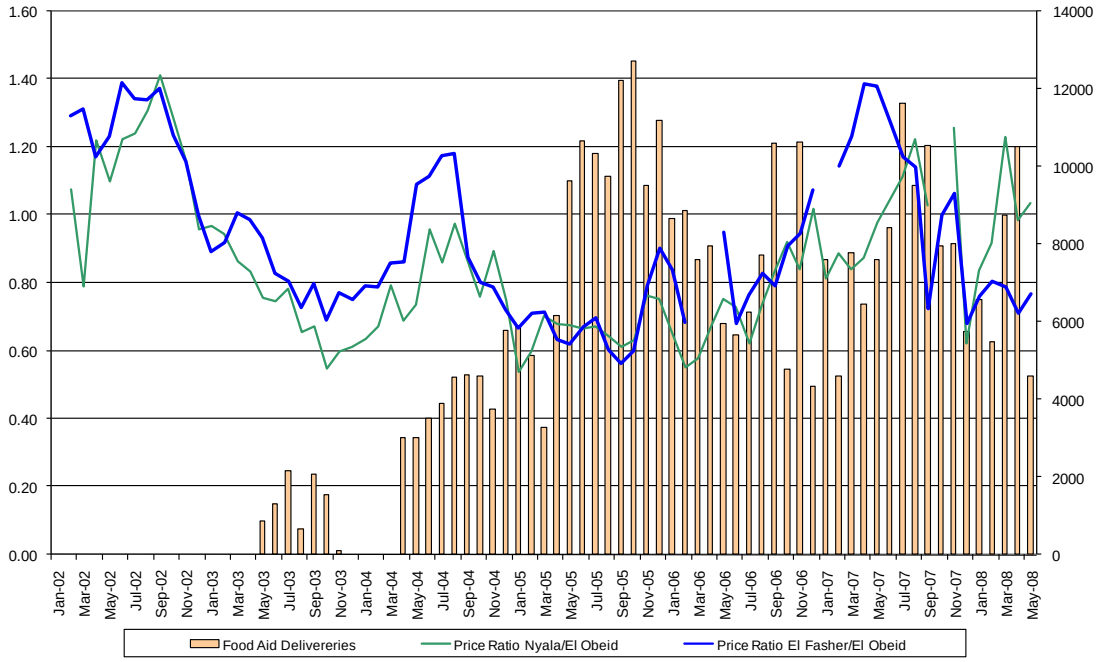
Notes: Robust p-values for super consistent estimators below coefficients.
*significant at 10%; ** significant at 5%; *** significant at 1%
Source: Authors' calculations.

Figure 1: Sudan: Domestic and Export Parity Prices of Sorghum, 2003-08



Source: Authors' estimates; FAO and SRCO price data.

Figure 2: Sorghum price ratios (Darfur/El Obeid) and Food Aid Deliveries (in metric tons)



Source: SRCO for sorghum prices, WFP for food aid deliveries.
Note: Food aid deliveries are aggregated for all Darfur.