

Online Appendix:

“Spatial Spillovers of Conflict in Somalia”

Marco Alfano & Thomas Cornelissen

Contents

A	Additional tables and figures	2
B	Robustness	21
C	Identification checks	23
D	Event-driven changes in conflict	25
E	Computation of the risk of violence	27
F	Detail on SHFS analysis	28
G	Context on distance and transport cost	29
H	Data sources	31
I	Detail on Nightlight data preparation	32
	References	34

Appendix A Additional tables and figures

Table A.1: Further summary statistics

A: Terrorist attacks (GTD)					
Type of incidence	All	Aimed at Military	Aimed at transport	Aimed at other	Involving barricades
Nr of incidents	4,496	1,890	37	2,569	12
% of total		42.0%	0.8%	57.2%	0.3%
B: Terrorist attacks along transportation routes (GTD)					
Type of incidence	All	Aimed at Military	Aimed at transport	Aimed at other	Involving barricades
Nr of incidents	180	114	4	62	0
% of total		63.3%	2.2%	34.4%	0%

Notes: Table reports summary statistics on conflict and characteristics of households in Somalia. Panel A: reports terrorist attacks in Somalia by target (based on GTD); Panel B: reports terrorist attacks within 5 kilometres either side of transportation routes by target (based on GTD); **Data sources:** GTD, [The World Bank \(2017\)](#).

Table A.2: Types of violence

	(1)	(2)	(3)	(4)	(5)
Dependent variable: Log price of maize					
Type of conflict	Battle	Against Civilians	Remote	Strategic	Riots
Panel A: number of conflict events					
Mean of conflict/month	1.29	0.34	0.33	0.16	0.02
Conflict en route (z-score)	0.0108 (0.0026)	0.0166 (0.0039)	-0.0008 (0.0029)	-0.0003 (0.0059)	-0.0019 (0.0026)
Panel B: = 1 if conflict lasts at least 4 months					
Mean of conflict/month	0.17	0.02	0.02	0.00	0.00
Conflict en route	0.0601 (0.0185)	0.0607 (0.0379)	0.0808 (0.0300)	n.a	n.a
Observations	2,085	2,085	2,085	2,085	2,085
R^2	0.925	0.926	0.925	0.925	0.925

Notes: Table shows effect of conflict along transit route by type of conflict. Panel A: *Battle* includes Armed clash, Non-state actor overtakes territory, Government regains territory; *Against civilians* includes Abduction/forced disappearance, Attack, Sexual violence; *Remote* includes Grenade, Remote explosive/landmine/IED, Shelling/artillery/missile attack, Suicide bomb, Air/drone strike, Chemical weapon; *Strategic* includes Agreement, Arrests, Change to group/activity, Disrupted weapons use, Headquarters or base established, Looting/property destruction, Non-violent transfer of territory; *Riots* includes Mob violence, Violent demonstration, Peaceful protest, Protest with intervention, Excessive force against protesters. All estimates are based on z-scores. Panel B: explanatory variables take value = 1 if respective type of conflict lasted at least 4 months. Incidents of strategic violence and riots in columns (4) and (5) are too low (0.003 and 0.000, respectively) for meaningful estimates. **Data sources:** ACLED, FAO.

Table A.3: Alternative measurements

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
	Dependent variable: Log price of maize													
Conflict en route 1km corridor	0.0043 (0.0015)				0.0037 (0.0016)									
Conflict en route 2.5km corridor		0.0031 (0.0014)		0.0025 (0.0015)										
Conflict en route 2.5-5km corridor			0.0062 (0.0032)	0.0057 (0.0034)	0.0057 (0.0033)									
Conflict en route						0.0038 (0.0012)	0.0034 (0.0009)	0.0139 (0.0053)	0.0187 (0.0057)	0.0145 (0.0056)	0.0139 (0.0053)	0.0095 (0.0034)	0.0026 (0.0058)	0.0004 (0.0250)
Rainfall (z-score)								-0.0900 (0.0359)						
SPEI (z-score)									-0.0319 (0.0076)					
Log maize prod. (z-score)										-0.0710 (0.0194)				
Observations	2,085	2,085	2,085	2,085	2,085	2,085	2,085	2,085	2,085	2,085	2,085	2,085	2,085	2,085
R^2	0.925	0.925	0.925	0.925	0.925	0.925	0.925	0.925	0.923	0.923	0.925	0.925	0.925	0.925
Geogr precise						yes								
Not own admin							yes							
GTD												yes		
z-score								yes	yes	yes	yes	yes		
Destruction related													yes	
Tax related														yes

Notes: Table reports spillover effects of conflict on maize prices using different measurements. Dependent variable is log of maize price. *Conflict en route 1km corridor*, *Conflict en route 2.5km corridor*, *Conflict en route 2.5-5km corridor* counts number of violent incidents occurring within along the shortest route between maize growing area and market per month for a corridor of 1km, 2.5km, and between 2.5 and 5km, respectively. *Rainfall (z-score)* denotes the z-score of rainfall in the growing season prior to month m . *SPEI (z-score)* denotes the z-score of the Standardised Precipitation-Evapotranspiration Index in the growing season prior to month m . *Log maize prod (z-score)* denotes the z-score of the log production of maize (in metric tonnes) in the growing season prior to month m , which we obtained from the FSNAU and match to each market. Explanatory variable in column (6) excludes any conflict occurring in the same administrative region as m . Explanatory variable in column (7) only uses violent incidents classified as 'geographically precise' by ACLED. Columns (8) to (12) use the z-score of *Conflict en route*. Column (12) defines *Conflict en route* as terrorist attacks taken from the GTD. Column (13) uses description in ACLED data and selects only incidents described with words 'destroy', 'explode', 'roadblock', 'checkpoint', and 'barricade'. Column (14) uses description in ACLED data and selects only incidents described with word 'tax'. Standard errors clustered at market level are reported in parentheses. **Data sources:** ACLED, FAO, FSNAU.

Table A.4: Alternative specifications and samples

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Dependent variable:									
	Log price of maize							Conflict en route		
Conflict en route	0.0039 (0.0012)	0.0048 (0.0019)	0.0050 (0.0017)	0.0038 (0.0014)	0.0034 (0.0014)	0.0050 (0.0017)	0.0046 (0.0012)	0.0070 (0.0036)		
Conflict en route × log border dist	0.0019 (0.011)									
Conflict en route × informal imports		−0.0004 (0.0015)								
Conflict en route × formal imports			0.0050 (0.0033)							
Battle of Bel. Weyn									3.6308 (0.8330)	
Galkayo ceasefire										−3.3406 (0.2658)
Observations	2,085	1,182	2,085	1,708	1,733	1,671	1,312	250	238	393
R ²	0.925	0.924	0.926	0.916	0.935	0.922	0.923	0.958	0.497	0.564
Sample	All	2010-18	All	No Somali- land	Not next to Kenya	Not next to Ethiopia	2009-18	Feb 2016 to Dec 2017	Mar, Qor, BW, Gal 2006-10 yes	All 2015-17 yes
Market, Year, Month FE										

Notes: Table reports effect of incidents of conflict along maize transportation route on the price of maize using different samples and specifications. Dependent variable is the log of the price of maize in columns (1) to (8) and conflict along transportation routes in columns (9) and (10). *Conflict en route* counts number of violent incidents occurring within a 5km radius either side of the shortest route between maize growing area and market per month, *log border dist* is the logarithm of the aerial distance between market i and the closest point on the Somali border (transformed to z-score), *informal imports* is the number of informal maize imports into Somalia as reported by FSNAU (transformed to z-score), *formal imports* is the number of formal maize imports into Somalia as reported by UNCTAD (transformed to z-score). Column (4) drops markets located in Somaliland (Borama and Hargeisa), column (5) drops markets located close to Kenya (Buale and Kismayo), column (6) drops markets located close to the Ethiopian border (Belet Weyne and Hudur), column (7) uses only years 2009 to 2018, column (8) uses only observations between February 2016 and December 2017 **Battle of Bel. Weyn** = 1 in column (9) for June and July 2008 for markets of Belet Weyne and Galkayo, sample consists of markets of Marka, Qorioley, Belet Weyne, and Galkayo from 2006 to 2010. **Galkayo ceasefire** = 1 in column (10) for December 2015 to September 2016 for Galkayo, sample consist of all markets from 2015 to 2016. **Data sources:** ACLED, FAO.

Table A.5: Robustness to exclusion of markets

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
	Dependent variable: Log price of maize										
Conflict en route	0.0041 (0.0016)	0.0043 (0.0015)	0.0037 (0.0014)	0.0034 (0.0014)	0.0038 (0.0014)	0.0042 (0.0016)	0.0036 (0.0019)	0.0038 (0.0015)	0.0033 (0.0014)	0.0038 (0.0016)	0.0028 (0.0010)
Observations	1,880	1,876	1,906	1,892	1,887	1,880	1,883	1,926	1,877	1,965	1,878
R^2	0.930	0.924	0.923	0.932	0.921	0.923	0.916	0.928	0.926	0.926	0.927
Excluded market	Baidoa	BeletW	Borama	Buale	Hargeisa	Hudur	Galkayo	Kismayo	Marka	Mogadishu	Qorioley

Notes: Table reports effect of incidents of conflict along maize transportation route on the price of maize using different samples. *Conflict en route* counts number of violent incidents occurring within a 5km radius either side of the shortest route between maize growing area and market per month. Dependent variable is the log of the price of maize. Columns (1) to (11) sequentially drop the following markets respectively Baidoa, Belet Weyne, Borama, Buale, Hargeisa, Hudur, Galkayo, Kismayo, Marka, Mogadishu, and Qorioley. **Data sources:** ACLED, FAO.

Table A.6: Additional specifications

	(1)	(2)	(3)	(4)	(5)	(6)
	Dependent variable: Log price of maize					
Conflict en route	0.0042 (0.0021)	0.0037 (0.0014)				
Main roads (J&S)			0.0030 (0.0011)	0.0027 (0.0010)		
Secondary roads (J&S)				0.0011 (0.0020)		
Attack risk (z-score)					0.0603 (0.0164)	0.0417 (0.0172)
Conflict en route (0-6 lags, z-score)						0.0492 (0.0264)
Observations	2,085	2,059	2,085	2,085	2,085	2,085
R²	0.951	0.927	0.925	0.925	0.926	0.926
year-by-month FE	yes					
3 lags and leads		yes				

Notes: Dependent variable is the log of the price of maize. *Conflict en route* counts number of violent incidents occurring within a 5km radius either side of the shortest route between maize growing area and market per month. *Main roads (J&S)* and *Secondary roads (J&S)* counts number of violent incidents occurring within a 5km radius either side of main and secondary roads on the road network used by [Jedwab and Storeygard \(2022\)](#) per month. *Attack risk* uses the method proposed by [Tapsoba \(2023\)](#) to capture attack risk in a given month by aggregating the estimated density of the occurrence of attacks along a corridor 5 kilometres either side of the transportation route supplying maize to each market, excluding attacks within a 15km radius of market (transformed to z-score)—see Section 4.3 and Appendix E for detail, *Conflict en route (0-6 lags)* is the average of *Conflict en route* over the current and the past 6 months (transformed to z-score). Column (1) also controls for year-by-month fixed effects. Column (2) also controls for 3 months leads and lags of *Conflict en route*. **Data sources:** ACLED, FAO.

Table A.7: Effect of conflict along transportation route on price of maize —Identification

	(1)	(2)	(3)	(4)	(5)
Dependent variable	Log price of maize	Placebo price index	Log price of maize	Log price of maize	Log price of maize
Conflict en route	0.0035 (0.0015)	−0.0010 (0.0008)	0.0111 (0.0039)	0.0158 (0.0051)	0.0111 (0.0039)
Conflict 15km around market	0.0004 (0.0010)	0.0006 (0.0008)	−0.0004 (0.0013)	−0.0004 (0.0010)	−0.0005 (0.0013)
Conflict betw. growing area and market	0.0006 (0.0004)				
Observations	2,085	2,128	2,085	701	2,085
R^2	0.925	0.977	0.925	0.908	0.925
Conflict	ACLED	ACLED	GTD	GTD	GTD
Terrorist attacks			All	Successful	No food

Notes: Table includes identification checks for effect of conflict along transportation routes on price of maize. Estimation is based on equation (2). Dependent variable is log price of maize in columns (1), (3), (4), and (5) and average of log prices of charcoal, diesel, petrol, potable water, goats, sheep, and camels in column (2). *Conflict en route* counts incidents of conflict per month occurring 5 kilometres either side of the transportation route supplying maize to each market, excluding attacks within a 15km radius of market; *Conflict 15km around market* denotes incidents of conflict occurring within a 15km radius of each market; *Conflict betw. growing area and market* denotes incidents of conflict occurring in any administrative region located between each market and its growing area *excluding* any incidents within 5 kilometres of the transportation route to that market; all regressions control for rainfall (in mm) during previous growing season; Standard errors are clustered at the market level and reported in parentheses. **Data sources:** ACLED, FAO, FEWS NET.

Table A.8: Lagged conflict

	(1)	(2)	(3)	(4)	(5)
	Dependent variable: Log price of maize				
Conflict en route	0.0062 (0.0015)	0.0038 (0.0014)	0.0039 (0.0014)		
Conflict en route (lagged 1 month)	0.0038 (0.0020)		0.0029 (0.0018)		
Conflict en route (lagged 2 months)	0.0035 (0.0024)		0.0027 (0.0019)		
Conflict en route (lagged 3 months)	0.0037 (0.0026)		0.0046 (0.0022)		
Conflict en route (lagged 4 months)	0.0032 (0.0025)		0.0030 (0.0015)		
Conflict en route (lagged 5 months)	0.0031 (0.0015)		0.0023 (0.0008)		
Conflict en route (lagged 6 months)	0.0012 (0.0023)		0.0020 (0.0019)		
Conflict en route (1-6 lags)		0.0034 (0.0015)			
Conflict en route (7-12 lags)		0.0013 (0.0013)			
Conflict en route (13-18 lags)		0.0009 (0.0012)			
Average monthly conflict en route over past half year				0.0214 (0.0077)	0.0260 (.0214)
Observations	2,079	2,085	2,079	2,085	2,085
R^2	0.926	0.926	0.926	0.926	0.931
In growing region	yes				
Growing region-by-year and-month fixed effects					yes

Notes: Dependent variable is the log of the price of maize. *Conflict en route* counts number of violent incidents occurring within a 5km radius either side of the shortest route between maize growing area and market per month. *Conflict en route (lagged x months)* refers to respective lags of *Conflict en route*. *Conflict en route 1-6 lags*, *Conflict en route 7-12 lags*, and *Conflict en route 13-18 lags* refer to the sums of *Conflict en route* for 1 to 6, 7 to 12, and 13 to 18 months, respectively. *Average monthly conflict en route over past half year*, refers to the average of monthly *Conflict en route* over the current and the past 6 months, as a way of aggregating up the persistent effects of past conflict. *Conflict en route* in column (1) relates to conflict on roads in growing areas only. Column (5) modifies the baseline specification by controlling for growing-region by year-and-month fixed effects and market fixed effects, instead of market-by-year and market-by-month fixed effects. **Data sources:** ACLED, FAO.

Table A.9: Placebo regressions

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Imports			Exports			
Log price of	Diesel	Petrol	Water	Char-coal	Goats (for export)	Sheep (for export)	Camels
Panel A: All markets							
Conflict along maize route	0.0012 (0.0009)	-0.0011 (0.0009)	-0.0009 (0.0010)	-0.0004 (0.0008)	0.0001 (0.0011)	-0.0000 (0.0007)	-0.0022 (0.0016)
Observations	2,126	2,126	1,789	2,073	2,124	1,944	2,052
R^2	0.982	0.975	0.944	0.973	0.954	0.970	0.969
Panel B: markets close to and far away from the coast							
Conflict along maize route	0.0007 (0.0013)	-0.0003 (0.0011)	-0.0012 (0.0006)	-0.0015 (0.0016)	-0.0021 (0.0017)	-0.0006 (0.0007)	0.0010 (0.0018)
Sample	Far away from coast			Close to coast			
Observations	1,418	1,418	1,128	708	707	577	636
R^2	0.984	0.981	0.957	0.939	0.871	0.949	0.952

Notes: Table reports effect of incidents of conflict along maize transportation route on the price of *other* goods traded along different roads. *Conflict en route* counts number of violent incidents occurring within a 5km radius either side of the shortest route between maize growing area and market per month. Dependent variables are the log prices of three common imports into and four common exports out of Somalia: diesel (column 1), petrol (column 2), water (column 3), charcoal (column 4), goats of export quality (column 5), sheep of export quality (column 6), and camels (column 7). Sample in panel A consists of all 11 markets. Prices of export goods measured in markets located far away from the coast may not include the transport cost to the export port. Likewise, prices of import goods measured in markets located at the coast may not include the transport cost to the final destination market. In Panel B, we therefore use import prices in columns (1) to (3) only for markets located far away from the coast (Baidoa, Belet Weyne, Borama, Buale, Galkayo, Hargeisa, and Hudur), and export prices in columns (4) to (7) only for markets close to the coast (Kismayo, Marka, Mogadishu, and Kismayo). Data are drawn from FSNAU available under <https://fsnau.org/ids/index.php>, accessed September 2024. **Data sources:** ACLED, FSNAU.

Table A.10: Additional household outcomes

	(1)	(2)	(3)	(4)	(5)
	<u>In the past 2 months child (aged < 10) suffered from . . .</u>				
	Non-infectuous illness	Gastro- enteritis	Malaria	Typhoid fever	Chest infection
Conflict en route (excl. same region)	0.0007 (0.0004)	0.002* (0.001)	0.004*** (0.001)	0.0002*** (3.1E-05)	0.0001* (3.4E-05)
Observations	8180	8180	8180	8180	8180
R2	0.00	0.05	0.03	0.004	0.003
Mean Dep. Variable:	0.02	0.08	0.04	0.002	0.003

Notes: Regressions control for region effects, attacks in own area, household size, proportion literate in household, gender of household head, household below poverty line, and child age dummies. The health outcomes were asked only in 2016 and exploit cross-sectional variation only. The time horizon of the definition of *Conflict en route* is adjusted to the time horizon of the respective survey questions—see Appendix F for more detail. Robust standard errors clustered at the region level are in parentheses.

Data sources: SHFS, ACLED.

Table A.11: Robustness against excluding migrant households

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	High prices affecting food	<u>Log quantity consumed</u> Maize Sorghum		Household spent savings	Index of non-food spending	<u>Child suffered from</u> Any Infectuous illness illness		Not enrolled in school (aged 6-14)
Conflict en route (excl. same region)	0.003 (0.002)	-0.019 (0.027)	0.04 (0.023)	0.006 (0.002)	-0.278 (0.07)	0.003 (0.002)	0.004 (0.001)	0.0053 (0.0015)
Observations	3,644	5,562	5,534	1,889	3,880	7,452	7,452	6,172

Notes: The table replicates the effects of violent incidents along maize transportation routes on the outcomes from Table 4 using the same regression specifications but excluding migrant households. Migration household are defined by the household head living in a different region of Somalia than where they were born (information available in both the 2016 and 2017 waves), or by the number of years that any of the household members has lived in the current district being smaller than their age (available in the 2016 wave), or by the household falling under the UNHCR Internally Displaced People definition (available in the 2017 wave) of having ever left their usual place of residence due to conflict, violence, human rights violations or disasters. Robust standard errors clustered at the region level are in parentheses. **Data sources:** SHFS.

Table A.12: Descriptives - Alternative Routes

	(1)	(2)
	All markets	Distant markets
Panel A: Travel time		
<i>Travel time (speed-weighted distance) of shortest route (hours)</i>		
Mean	6.3	9.0
Standard deviation	3.7	3.0
Minimum	1.5	6.3
Maximum	13.9	13.9
<i>Travel time on alternative routes relative to shortest route (ratio)</i>		
2nd route	1.4	1.4
3rd route	1.4	1.4
4th route	4.1	4.1
5th - 9th route (average)	4.2	4.2
Panel B: Attacks on routes		
<i>Attacks on shortest route</i>		
Whole sample period	1.5	3.1
After 2016	4.1	8.9
<i>Attacks on alternative routes relative to shortest route (ratio)</i>		
2nd route	1.5	1.6
3rd route	1.7	1.7
4th route	1.5	1.5
<i>Correlation with attacks on shortest route</i>		
2nd route	0.92	0.95
3rd route	0.93	0.93
4th route	0.86	0.86
Observations	2,085	821

Notes: Not all 11 markets have alternative routes; 5 have only one route, 2 have two routes, 1 has 4 routes and 3 have 9 routes. The 'distant markets' are Belet Weyne, Hudur, Galkayo, and Baidoa. **Data sources:** ACLED, FAO.

Table A.13: Estimation of γ

	(1)	(2)	(3)	(4)
Log travel time on least-cost route	0.464 (0.098)	0.427 (0.153)	0.404 (0.066)	0.503 (0.077)
N	89	82	2,085	2,085
Sample years	2001	2001	2001-2018	2001-2018
Population size	Yes	Yes	Yes	Yes
Year-month effects	Yes		Yes	Yes
Growing region-year-month effects		Yes		
Attacks linear			Yes	
Attacks flexible				Yes

Notes: The table reports results from regressing the log maize price on log travel time on the least-cost route to get an estimate for γ in equation (6) using between-market variation. Columns (1) and (2) keep attacks along transportation routes constant by focusing on the period of 2001, a period before the onset of the al-Shabab insurgency in which attacks were close to zero. The remaining columns instead focus on the full sample period but control for attacks along transportation routes and local attacks linearly (column 3) or flexibly (column 4). For the flexible specification in column (4) we create dummies indicating the 10 decile bins of violence along the route and of local violence, and include interactions of these dummies with each other and with year dummies. Standard errors clustered at the market level in parentheses. **Data sources:** ACLED, FSNAU.

Table A.14: Descriptive statistics - market access

Panel A: Market information		
	Population	Log market access at zero attacks
Kismayo	243,043	0.00
Buale	121,894	0.73
Galkayo	501,542	3.29
BeletWeyne	278,118	4.67
Mogadishu	2,330,708	6.23
Hudur	123,442	7.07
Baidoa	546,957	7.34
Hargeisa	1,346,651	7.67
Qorioley	286,402	8.30
Borama	597,842	8.48
Marka	199,872	8.61
Panel B: Variation		
<i>Log market access at zero attacks</i>		
Between-market std. dev.		3.09
Within-market std. dev.		0.00
<i>Log market access at observed attacks</i>		
Between-market std. dev.		3.30
Within-market std. dev.		0.29

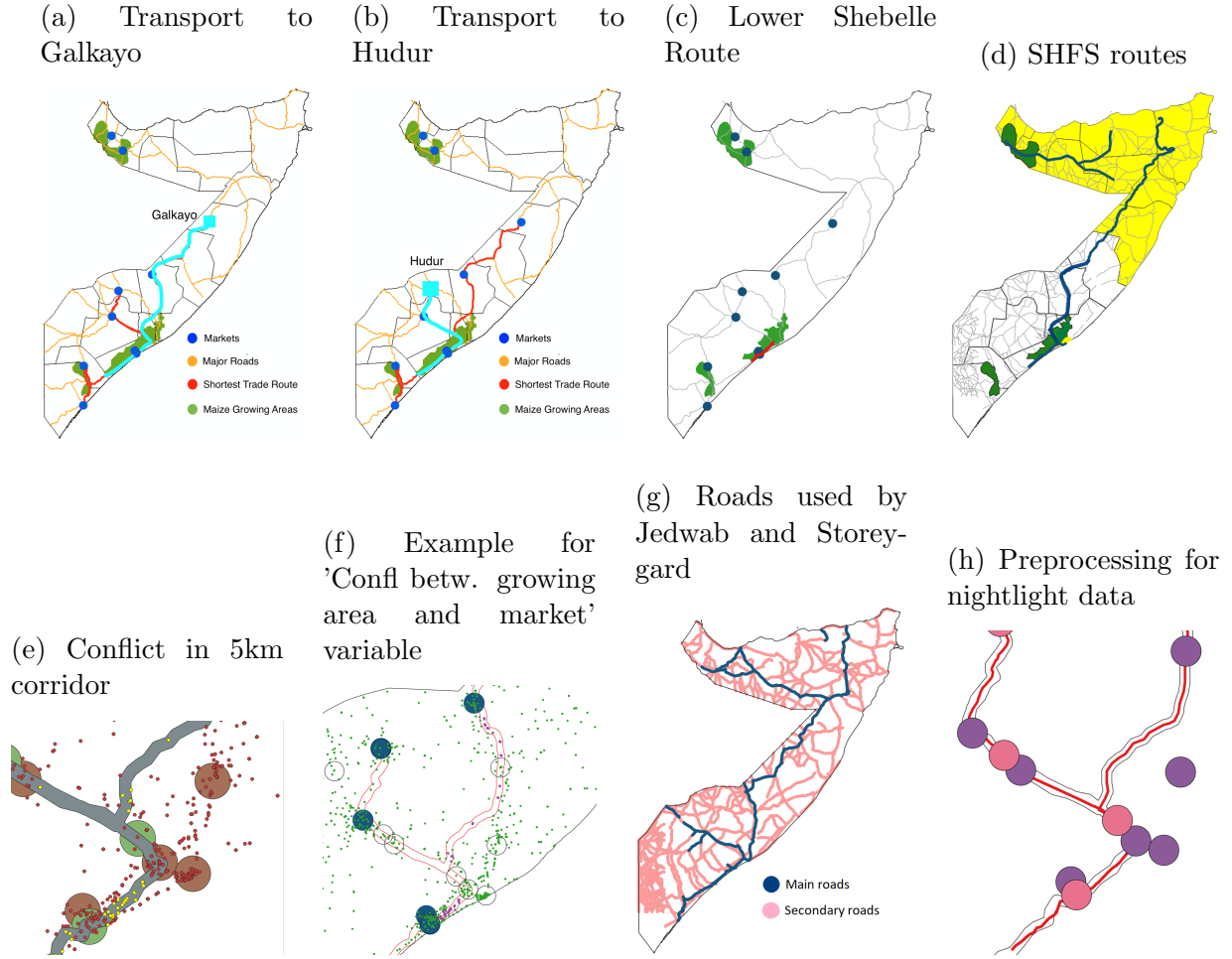
Notes: The table reports descriptive statistics for the market access measure computed according to equations (7) and (8) in the main text. Log market access at zero attacks is computed by setting the number of violent attacks to zero, which eliminates time variation in market access and reflects only the cross-market variation. The measure is normalized to 0 for the market with the lowest market access. Log market access at observed attacks includes time variation from the occurrence of attacks and is the measure used for the analysis in Table (6) of the main text. **Data sources:** ACLED.

Table A.15: Robustness check of varying θ for market access computation

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Market access	Effect of			Total	Effect of attacks when	
	range	market	access	on food prices	effect	added to regression	
θ	(2001-2018)	b	se	t	(2) $\times$ (3)	b	se
1	-0.30	-0.50	0.17	-2.97	15.1%	-0.0003	0.0009
2.74	-0.57	-0.23	0.07	-3.18	13.3%	-0.0001	0.0008
3.8	-0.69	-0.17	0.05	-3.22	11.4%	0.0001	0.0007
5.4	-0.87	-0.11	0.03	-3.32	9.4%	0.0003	0.0007
8.22	-1.21	-0.07	0.02	-3.16	8.1%	0.0003	0.0007

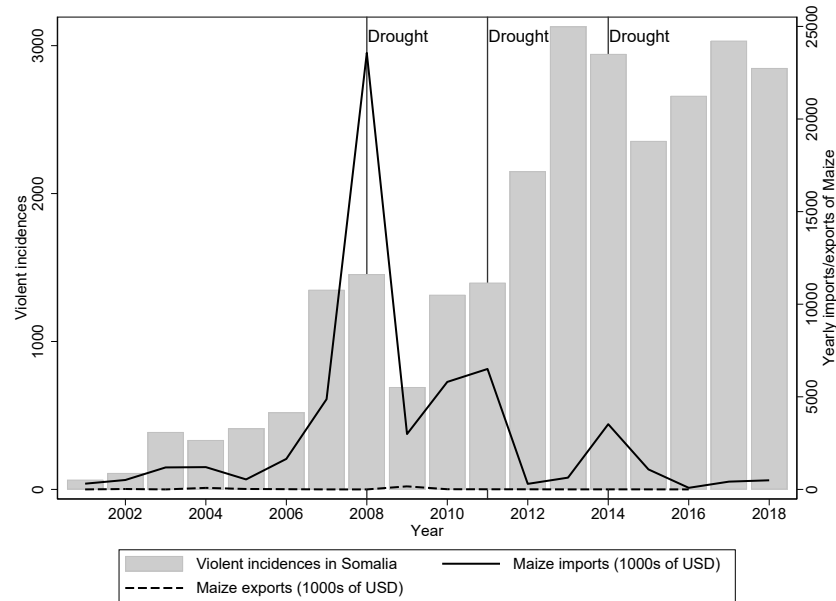
Notes: The table reports robustness checks for the effect of market access on the food price index. The baseline results using $\theta = 3.8$ are in column (1), Panel A, of Table . The present table shows how the results change when market access (see equations) is computed at varying levels of θ , ranging from 1 to 8.22. **Data sources:** ACLED, FSNAU.

Figure A.1: Additional maps



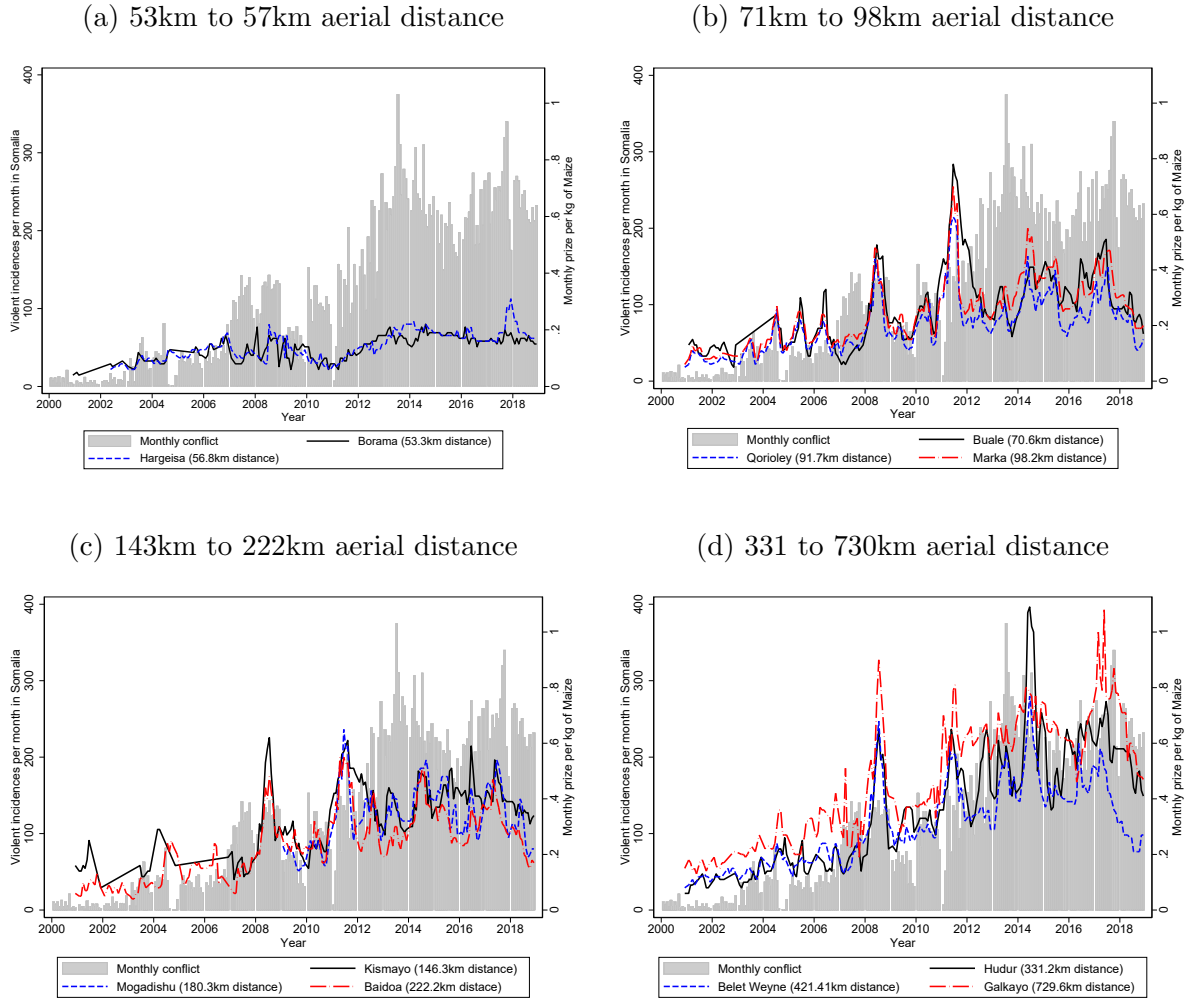
Notes: Map a: shows transportation route used to supply market of Galkayo with maize; Map b: shows transportation route used to supply market of Hudur with maize; Map c: shows main transportation road in Lower Shebelle in red; Map d: shows the shortest maize trading routes to areas covered by the SHFS implemented by the World Bank (Awdal, Banaadir, Bari, Mudug, Nugal, Sanaag, Sool, Togdheer, and Woqooyi Galbeed). Map e: shows geographical location of roads (grey), towns (maroon) and cities (green), incidents of conflict falling within 5 kilometres of transportation routes are denoted as yellow dots and incidents falling outside of the corridor as red dots; Map f: shows attacks captured by variable *Conflict en route* in purple and attacks captured by variable *Confl betw. growing area and market* in green, transportation routes are shown in red, market towns in blue and other towns in black; Map g: shows primary and secondary roads used by [Jedwab and Storeygard \(2022\)](#) Map h: shows the 1km corridor we use to extract nightlights in red (excluding any emissions 15km around cities and towns)

Figure A.2: Imports and exports of maize



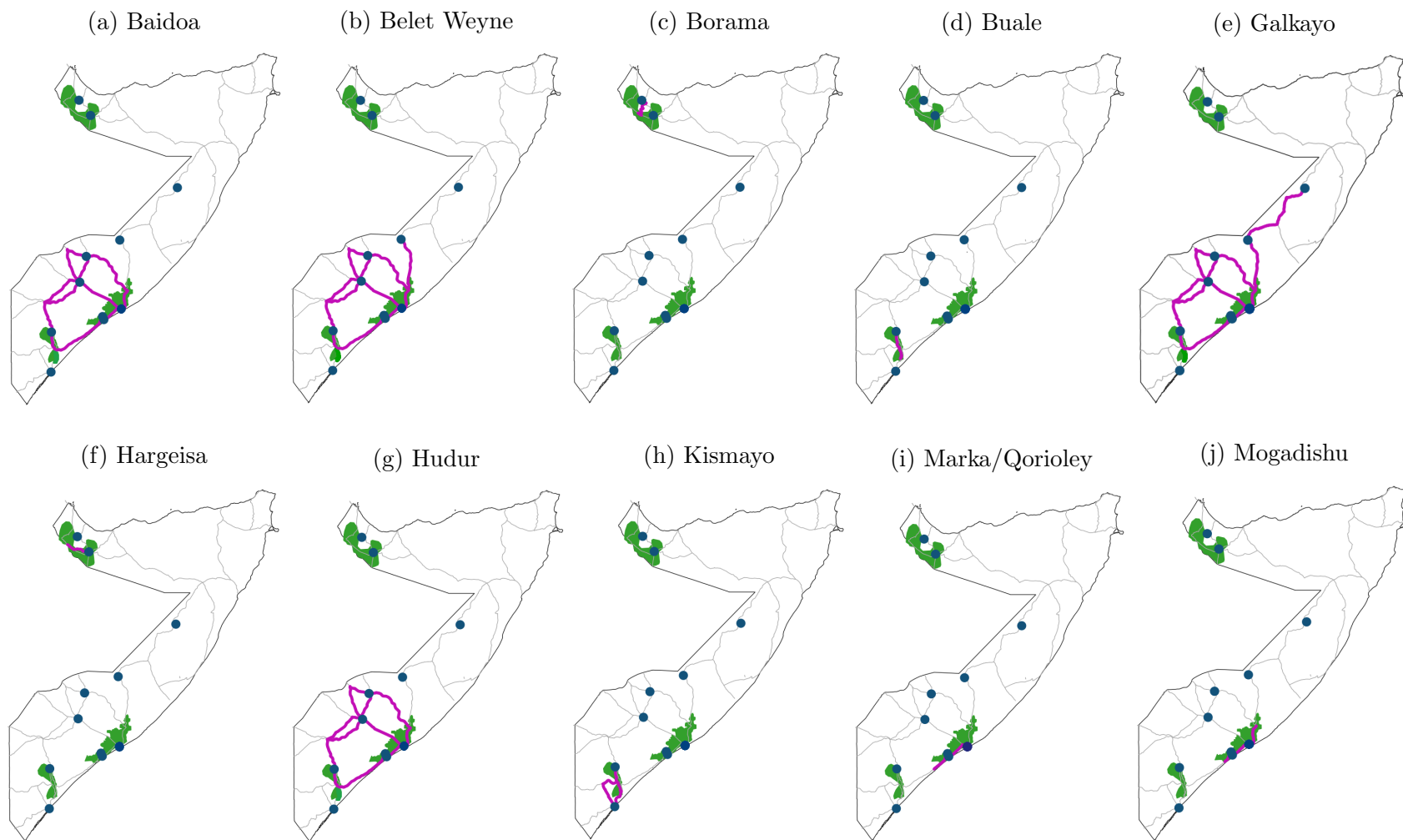
Notes: Figure reports conflict in Somalia along with imports and exports of maize. Bars indicate yearly incidents of violence drawn from ACLED; solid line refers to yearly imports of maize in 1000s USD drawn from United Nations Conference on Trade and Development (UNCTAD); dashed line refers to yearly exports of maize in 1000s USD drawn from United Nations Conference on Trade and Development (UNCTAD); vertical lines denote incidents of droughts. The UNCTAD trade data are freely available at <https://unctadstat.unctad.org/EN/>

Figure A.3: Prices over time for all 11 markets



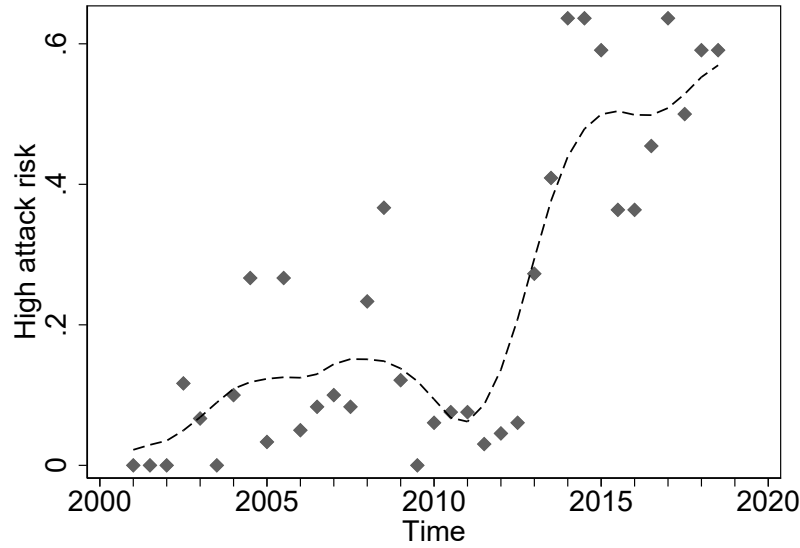
Notes: The figure reports conflict and maize prices over time and by market in Somalia. Lines denote monthly maize prices and bars monthly incidents of conflict. Distances are in kilometres and refer to aerial distances. **Data sources:** ACLED, FAO.

Figure A.4: Alternative transportation routes



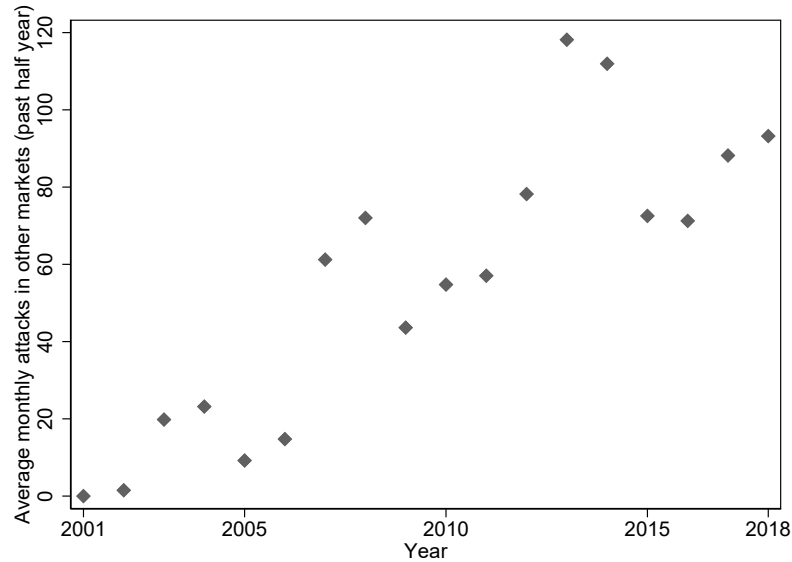
Notes: Figure shows the network of the shortest and of alternative routes from the closest growing area to each market. Shortest and alternative routes have been computed by applying a depth-first search algorithm (Black, 2008) to the road network depicted in Figure 1b to find all simple (non-cyclical) paths between each market and its growing area.

Figure A.5: Evolution of attacks risk and actual attacks over time



Notes: This figure shows the time evolution of the attack risk along transportation routes for maize. For this, the density estimates were aggregated along transportation routes for maize at a monthly level, and transformed into an indicator for the upper quartile of the density (high-attack risk). The figure shows semi-annual average of the high-attack risk indicator. **Data sources:** ACLED.

Figure A.6: Evolution of attacks located within markets



Notes: The figure plots annual averages of attacks located within the cities corresponding to the 11 markets of our analysis. Annual averages are obtained as the year coefficients from regressing average monthly attacks in other markets (varying at the market-month level) on a set of year and market fixed effects. **Data sources:** ACLED.

Appendix B Robustness

Alternative measurements. Our baseline results are robust against a wide battery of alternative specifications. Columns (1) and (2) of Appendix Table A.3 show that our results remain robust to using smaller corridor sizes of 1km and 2.5km to define attacks along roads. In column (3) we only use violent incidents occurring between 2.5km and 5km away from roads (and thus not on the roads themselves). We find a strong positive effect, which tallies with our analysis in section 4.3 suggesting that uncertainty is an important pathway of impact. In column (4) and (5) we control for two corridors contemporaneously: between 0 and 2.5km and between 2.5km and 5km and between 0 and 1km and 2.5km and 5km, respectively. The size of the point estimates remains comparable to our baseline specification and the two effects are not statistically different from each other. In column (6), we re-estimate equation (2) using only incidents of conflict classified as 'geographically precise' by ACLED and find virtually identical results. Column (7), in turn, uses an alternative measure of local conflict (defined as occurring within the same administrative region as market i) and finds very similar results. The next three columns control for productivity in growing regions in three ways: column (8) uses rainfall, column (9) uses the Standardised Precipitation-Evapotranspiration Index (SPEI),¹ a common drought measure, and column (10) the log of maize production in megatons (all as standardized z-scores).² As expected, both measures negatively affect prices and our results remain robust. In columns (11) and (12), we compare the effect of violent incidents drawn from the ACLED and GTD using z-scores and find very similar effect sizes. In column (13), we use the description of each ACLED data point to exclude any incidents related to road blocks, food, or barricades. Finally, in column (14), we use ACLED notes to select violent incidents related to 'tax' and find no effect.

Imports and specific markets. We investigate the importance of differential access to maize imports in columns (1) to (3) of Appendix Table A.4 where we interact violence along transit routes with the z-scores of log distance to the closest border, informal maize imports via Ethiopia, and official maize imports, respectively. The baseline effect of conflict en route remains stable. The interaction terms do not show a clear pattern and are not statistically significant. Moreover, columns (4) to (8) show that our results remain robust to excluding different markets and time periods. More generally, in Appendix Table A.5 we re-estimate equation (2) eleven times, dropping a different market at each iteration. The effects remain robust. Thus, our results are not driven by only a few specific markets.

Alternative specifications. To investigate whether our results remain robust to different specifications, we start by showing that our results do not change when we additionally control for year-by-month fixed effects in column (1) of Appendix Table A.6. Results also remain unchanged when controlling for three lags and leads of attacks along roads in column (2). Column (3) shows that we get very similar results if we compute the shortest route based on the road network used by Jedwab and Storeygard (2022). Column (4) further shows that

¹The data are publicly available under <https://spei.csic.es/>.

²The data are publicly available under <https://crops.fsnao.org/>.

the secondary roads in the [Jedwab and Storeygard \(2022\)](#) road network do not matter for prices in our context.

Appendix C Identification checks

In this appendix we provide additional evidence to rule out a range of potential endogeneity concerns.

Supra-regional omitted variables and correlated conflict shocks. A possible identification concern relates to highly correlated waves of conflict or omitted variables at a supra-regional level, which could introduce a spurious correlation between market prices and conflict, including further away from markets. As an example, the Somali territory is under the control of three separate entities: the Somali government together with its AMISOM allies, al-Shabaab, and Somaliand. Institutions specific to each faction could differ in terms of their efficiency, and inefficient institutions could cause both, high prices (because of less efficient markets) and more violence (because of lack of institutions or enforcement, or in protest to high prices).

By controlling for local violence in market i 's administrative area and for market-specific year and month effects, our specification in equation (2) allows already for changes in general levels of violence at the supra-regional level. To further address this concern, however, we augment equation (2) with an additional covariate including incidents of conflict occurring in any administrative region located between each market and its growing area, but excluding any incidents within 5 kilometres of the transportation route to that market, which are already included in $conflict_{route_{itm}}$. The map in Appendix Figure A.1f) shows these incidents in green whereas attacks captured by $conflict_{route_{itm}}$ are shown in purple. It acts as a further control for generalized conflict and helps us to establish whether the effect is driven by more general incidents of conflict, or specifically by those occurring along transportation routes. As the results in column (1) of Table A.7 show, the effect of violence along the transportation route remains robust, and violence between growing areas and markets away from transportation routes has no effect. This implies that the effect of violence along transportation routes is unlikely to be driven by a spurious correlation induced by supra-regional differences in generalized violence across different parts of the country.

Placebo outcomes. Using data provided by the Food Security and Nutrition Analysis Unit (FSNAU) for Somalia we focus on three imports: petrol, diesel, and drinking water. Moreover, we consider four exports: charcoal, goats of export quality, sheep of export quality, and camels. These imports and exports are transported along very different routes than maize, between the respective markets and the relevant entry points into (and exit points from) Somalia. Column (2) of table A.7 shows a very small and statistically insignificant effect of conflict along the transportation route for maize on the average placebo price index. In Appendix Table A.9 we find the same when looking at each price separately. As an additional check, in panel B, we also distinguish cities close to and far away from the coast and find the same patterns.

Alternative measure of attacks. Next we explore the question whether our results might be affected by ACLED not recording all violent incidents that may be relevant for the price of maize by using information drawn from the GTD and re-defining the variable $conflict_{route_{itm}}$

as *terrorist attacks* occurring 5 kilometres either side of the shortest transportation route. As column (3) in Table A.7 shows, each terrorist attack en route increases the price of maize by around 1.1 percent. Moreover, the standardized effects of attacks defined from the ACLED and GTD databases are very similar (columns 11 and 12 of Appendix Table A.3).

Endogenous targeting of transport routes. We provide two pieces of evidence addressing the possibility that specific transport routes are being targeted by al-Shabaab according to unobserved factors that correlate with prices at exactly the markets served by these routes.

First, using detailed information on success rates of attacks from the GTD, we follow the approach by Jones and Olken (2009) and Brodeur (2018), which exploits the inherent randomness of success of violent incidents. Whilst targeting of a specific area might be selective, whether an attack is successful or not is more likely to be (conditionally) quasi-random. We restrict the sample to only month-market observations that experienced terrorist attacks, thus conditioning on markets in given points of time being targeted. Conditionally on being targeted, we then regress food prices on *successful* attacks. The results in column (4) of table A.7 confirm that each successful terrorist attack (conditional on attempted attacks) increases the price of maize by 1.58 percent, not too different from the 1.1 percent baseline effect in column (3) of the table. Second, we use detailed information contained in the GTD on characteristics of violent incidents and drop all incidents of conflict coded as aimed at food consumption and distribution. Column (5) shows that the results remain stable.

Appendix D Event-driven changes in conflict

To add transparency regarding the sources of variation in conflict and to shed light on the role of specific policies, we estimate the price reaction to sudden changes in conflict driven by three specific events. We exploit the sudden increase in conflict during the Battle of Belet Weyne (2008), the sudden decrease during the Galkayo ceasefire (2015/16), and reduced terrorist activity resulting from US airstrikes aimed at al-Shabaab (2007-18).

The Battle of Belet Weyne. The Battle of Belet Weyne was a sudden increase in fighting from June to July 2008, which affected the two markets of Belet Weyne and Galkayo. In early June 2008, Islamist forces initiated the takeover of the area around Belet Weyne after the Ethiopian garrison withdrew from the area. Fighting drastically escalated in July when Somali opposition fighters ambushed a retreating Ethiopian Army. This fighting caused an estimated 200 casualties. In column (9) of table A.4 we regress conflict along transit routes on a dummy for the battle and find that this event decreased attacks along roads by around 3.6 attacks. Focusing on the years 2006 to 2010, we compare prices in these two affected markets to two other markets on the same transportation route closer to the growing area and thus unaffected by the Battle (Marka and Qorioley—see map in Figure 1). Interacting quarterly dummies with an indicator for the two affected markets, we find a drastic and statistically significant increase in prices in the second quarter of 2008—see Figure D.1a).³

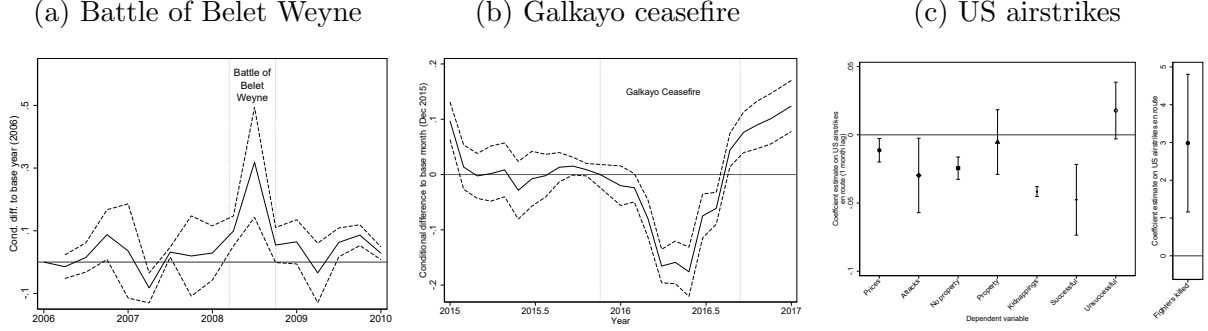
The Galkayo ceasefire. Following a bout of conflict occurring in November 2015 between the markets of Galkayo and Belet Weyne (see map 1b) a peace agreement was brokered on December 2, 2015. Policy reports argue that the ceasefire led to a marked decrease in fighting (PDRC, 2021). This tallies with our own data, which show no terrorist attacks along routes to Galkayo from late 2015 until September 2016, with fighting resuming in October 2016. Column (10) of table A.4 shows that the Galkayo ceasefire decreased attacks along transportation routes by around 3.3 attacks. To evaluate the impact of this ceasefire on maize prices we select the years 2015 and 2016, interact a dummy for the market of Galkayo with month dummies and regress these on maize prices in USD whilst controlling for market, year, and month fixed effects, and using all other markets as the reference group. As figure D.1b) shows, maize prices in Galkayo decrease significantly relative to the comparison markets. After violence re-erupts towards the end of 2016, prices in Galkayo increase once more.

US air strikes. Since 2007, as part of the 'war on terror', the US has been targetting al-Shabaab fighters with airstrikes to decrease terrorist activity and the organization's capacity.⁴ According to the Bureau of Investigative Journalism (BIJ), the US carried out 112 separate airstrikes (of which 44 used drones) in Somalia between 2007 and 2018, killing 850 individuals of which 11 were civilians. By decreasing al-Shabaab's capacity, we would expect US drone strikes to decrease conflict along transportation routes and thus decrease far-away maize prices.

³We also control for market, year, and month fixed effects and for market-specific rainfall.

⁴<https://www.cfr.org/background/al-shabaab> Accessed June 2023.

Figure D.1: Price reactions to event-driven changes in conflict



Notes: Panel a: shows point estimates (solid lines) and 95% confidence intervals (dashed lines) for month dummies interacted with indicator variable for the markets of Belet Weyne and Galkayo - the markets of Marka and Qorioley are the base category (base month is May 2008). The dependent variable is maize prices in USD. Regression controls for market, year, and month fixed effects and market, season-specific rainfall. Panel b: shows point estimates (solid lines) and 95% confidence intervals (dashed lines) for month dummies interacted with indicator variable for the market of Galkayo - the remaining 10 markets are the base category (base month is December 2015). Dependent variable is the log of maize prices in USD. Regression controls for market, year, and month fixed effects and market, season-specific rainfall. Panel c estimates equation (2) to show effect of US airstrikes (1 month lag) on the log maize price, the number of terrorist attacks en route, the number of terrorist attacks by whether they involve property damage or not, the number of terrorist attacks by whether they are successful or not, log of nightlight emissions along transit routes, and fighters killed between market and growing region. **Data sources:** ACLED, FAO, NASA, GTD.

Using data from The Bureau of Investigative Journalism (TBIJ), we define a variable measuring all incidents of US airstrikes occurring between market i and its supplying growing region in the month before m .⁵ Figure D.1c) shows that lagged US airstrikes along transportation routes decrease maize prices. A one standard deviation increase in lagged airstrikes decreases prices by around 1 percent, which is similar in magnitude to the positive, standardized effect of conflict in columns (11) and (12) of table A.3. In line with an incapacitation or deterrence effect, we find that airstrikes between growing areas and markets cause around 3 al-Shabaab casualties per strike and also significantly decrease terrorist attacks along transportation routes one month later, particularly for attacks not causing property damage, successful terrorist attacks and kidnappings, which have a particularly strong effect on prices (see Table 3).

⁵Since there are no exact geo-coordinates of attacks, we exclude attacks in the same administrative region as market i .

Appendix E Computation of the risk of violence

We follow the method developed by [Tapsoba \(2023\)](#) to compute the risk of violence over space and time. We start by creating an evaluation grid of points in space and time at which to evaluate the risk of violence. For this we cover Somalia with a 2-dimensional grid of points spaced 0.018 degrees of longitude and latitude (corresponding to an approximately 2 km spacing in each direction) and create a time grid comprising the 15th of each month from January 2001 to December 2018. We then iterate over these time points t , with the following steps at each iteration:

1. Load ACLED data including all battles and violent attacks against civilians in Somalia from one year before t up to the end of the month comprising t
2. Use this data to estimate the probability density of attacks evaluated at all spatial points of the grid and at time point t using multivariate normal kernel density estimation (using *mvksdensity* in Matlab)

This leaves us with an estimated probability density for the occurrence of an attack at each grid point in time and space. For every month t , and for each of the shortest transport routes to a given market, we then compute a measure of attack risk along the transportation route by adding up the density over all spatial grid points that are within a 2km corridor along the road. To do this, we overlay Somalia with 2km by 2km grid squares, retain those squares that are crossed by any of the shortest routes, and then aggregate the attack density over all grid points that fall into these squares.

Appendix F Detail on SHFS analysis

The regressions in Table 4 are based on the 2016 and 2017 panel waves of the Somali High-Frequency Survey survey (see Appendix H for the source), with the exception of the outcomes in columns (4) and (6)-(7), which were only asked in 2016 and exploit cross-sectional variation only.

Dependent variables: The index in column (5) is the sum of eight dummies indicating any spending in the non-food categories public transport, soaps/toiletries/cosmetics, energy/utilities, donations, domestic help/repair/maintenance, music/entertainment, clothing, and homeware. Infectious illness is an indicator for having suffered from gastroenteritis, malaria, typhoid fever, or chest infection. Non-infectious illness is an indicator for having suffered from dental problem, fracture, wound, mental disorder, asthma, headache, fainting, eye problem, backache, or an unspecified long-term illness.

Conflict en route definition: For outcomes asked for the current month or week, conflict en route is based on violent incidents in the survey month of each respective wave (columns 2-4 in Table 4). For outcomes asked retrospectively over the past year, violent attacks are averaged over the year prior to the survey (columns 1 and 5 in Table 4). The health outcomes in columns 6-7 refer to the past two months, but to allow for a cumulative effect of past conflict, we define conflict en route over the year preceding the past two months (similarly in Table A.10). School enrollment is asked 'currently', and to allow for cumulative effects of past conflict we define conflict en route over the past year.

Sample sizes: Sample sizes vary across columns in Table 4 due to the following reasons. Columns (1)-(5) are at the household level, columns (6)-(7) at the child level covering children aged 0-10, and column (8) at the child level covering children aged 6-14. Outcomes in columns (4) and (6)-(7) were only asked in the 2016 survey wave. Moreover, according to the survey design, not all households have been asked all consumption items, and in 2016 the module on shocks that have affected households (including high food prices, column 1) has not been asked to all households.

Appendix G Context on distance and transport cost

In section 5, τ_{od} represents an iceberg trade cost, linking the price at destination p_d to the price at origin p_o through $p_d = p_o \tau_{od}$. We can think of τ_{od} defined as $\tau_{od} = 1 + t_{od}$, where t_{od} is a tax equivalent trade cost. As argued in [Anderson and Van Wincoop \(2004\)](#), it is reasonable to assume that distance $dist_{od}$ affects trade cost via the tax equivalent trade cost, i.e., t_{od} is a function of distance: $t_{od} = f(dist_{od})$. For the effect of distance on the price at destination, γ , this setup yields:

$$\begin{aligned} \gamma = \frac{d \ln p_d}{d \ln dist_{od}} &= \frac{\partial \ln p_d}{\partial \ln t_{od}} \times \frac{d \ln t_{od}}{d \ln dist_{od}} = \frac{\partial \ln[p_o(1 + t_{od})]}{\partial \ln t_{od}} \times \frac{d \ln t_{od}}{d \ln dist_{od}} \\ &= \frac{\partial \ln(1 + t_{od})}{\partial \ln t_{od}} \times \frac{d \ln t_{od}}{d \ln dist_{od}} = \frac{\partial \ln(1 + t_{od})}{\partial t_{od}} t_{od} \times \frac{d \ln t_{od}}{d \ln dist_{od}} \\ &= \frac{t_{od}}{1 + t_{od}} \times \frac{d \ln t_{od}}{d \ln dist_{od}} \end{aligned} \quad (G.1)$$

The term $\frac{t_{od}}{1+t_{od}}$ is the share of tax equivalent trade costs relative to the total price at destination. Equation (G.1) has two key implications. First, the effect of distance on the price in a log-log model will be larger the higher the share of trade costs in the total price. Second, if we assume that $\frac{d \ln t_{od}}{d \ln dist_{od}} \leq 1$, meaning that the trade cost does not over-proportionately react to changes in distance, then the share of trade costs in the total price provides an upper bound for the price effect of distance.

In our context of the maize market in Somalia in the 2000s, we find $\hat{\gamma} = 0.46$ (Appendix Table A.13). In comparison, [Donaldson \(2018\)](#) reports an effect of 0.169 for the salt market in India in the 1860-1930 period, and [Limao and Venables \(2001\)](#), albeit in the context of international container shipping costs, find elasticities of iceberg transport cost with respect to distance of around 0.25–0.38.

As equation (G.1) demonstrates, an explanation for the relatively larger effect in our context could be a higher share of transportation costs in the total price. Several pieces of evidence suggest this as a plausible explanation. First, the mode of transport in our context is exclusively by road. Notably, railway transport, which is present in [Donaldson \(2018\)](#)'s context (and estimated to be cheaper by a factor of around 2 per unit-distance costs) is absent in our context. Moreover, Somalia's road network and transport infrastructure are poor, a factor that has been shown by [Limao and Venables \(2001\)](#) as an important determinant of high transport costs.

In their literature survey, [Anderson and Van Wincoop \(2004\)](#) cite a tax-equivalent share of direct and indirect transport cost of 21% as their preferred estimate, but also make clear that transport costs can be higher in bulky agricultural products and that developing countries have significantly higher trade costs. Focusing on Sub-Saharan Africa, [Christ and Ferrantino \(2011\)](#) report a wide range of anecdotal evidence about the high costs and time of land-transport in the region, which is a result not only of poor infrastructure, but also of prolonged delays due to slow administrative procedures or frequent road blocks. In addition to monetary and time cost, they also highlight significant uncertainty in land transport

caused by unpredictable and changing road and rail conditions, administrative obstacles, corruption, and informal payment demands. As [Christ and Ferrantino \(2011\)](#) state, 'This uncertainty leads to numerous costs such as scheduling costs, information costs, suboptimal inventory levels, supply chain redundancy, and reduced orders.' For selected commodities destined for export, these authors provide estimates of the total monetary and non-monetary costs for land transport in Sub-Saharan Africa, and find that in many cases these far exceed [Anderson and Van Wincoop \(2004\)](#)'s transport cost estimate of 21% for the US. Focusing specifically on the maize market in East Africa, [The World Bank \(2009\)](#) identify domestic transport cost as one of the most important item (averaging to up to 76%) of total marketing costs of maize, due to various factors, including poor infrastructure, delays and bribes, as well as cost and market structures in the trucking industry. An UNDP/SCALA Report ([FAO, 2024](#)), for instance, interviewed a private company (ADCO) working with maize and sesame farmers in southern Somalia. ADCO reported transportation costs of around USD44 per truck. However, for insecure areas an additional fee of USD50-USD100 per lorry is typically imposed. Moreover, a policy report by the Rift Valley Institute documents the pervasiveness of road checkpoints and bribes in the Somali context, a practice already common before the onset of the al-Shabaab insurgency.⁶ Al-Shabaab's activities have made this problem worse since the organisation frequently uses highways to ambush government forces and to disrupt trade⁷ through, for instance, hijacking and kidnapping.⁸ Given this background of high transport costs, a comparatively high estimate for the effect of distance on prices seems reasonable.

⁶https://riftvalley.net/wp-content/uploads/2023/10/Paying-the-Price_Final-Reduced3-reduced.pdf, accessed December 2024.

⁷https://landinfo.no/asset/3569/1/3569_1.pdf. accessed January 2025.

⁸<https://insecurityinsight.org/wp-content/uploads/2023/02/Somalia-Conflict-Hunger-and-Aid-Security-February-2023.pdf?>. accessed January 2025.

Appendix H Data sources

We use the following data sources in the paper

- Armed Conflict Location & Event Data Project (ACLED) are available at <https://acleddata.com>.
- Global Terrorism Database (GTD) data are available at <https://www.start.umd.edu/gtd/about/>.
- US airstrike data from the Bureau of Investigative Journalism (TBIJ) are available at <https://www.thebureauinvestigates.com/stories/2017-01-01/drone-wars-the-full-data/>.
- FAO maize price data are available at <https://fpma.apps.fao.org/gIEWS/food-prices/tool/public/#/home>
- First round of Somali High Frequency Survey (SHFS) is available at <https://microdata.worldbank.org/index.php/catalog/2738>.
- Second round of Somali High Frequency Survey (SHFS) is available at <https://microdata.worldbank.org/index.php/catalog/3181>.
- Food Security and Nutrition Analysis Unit (FSNAU) data on prices for food and non-food Minimum Expenditure Basket (MEB) prices are available at <https://fsnau.org/ids/index.php>. The data are available only from 2011 to 2018.
- Visible and Infrared Imaging Suite (VIIRS) Day Night Band (DNB) data are available at <https://eogdata.mines.edu/products/vnl/>. The data are available only from April 2012 to December 2018.
- Maize trade maps by FEWS NET are available at <https://fews.net/east-africa/somalia>
- Somali road network as provided by the FAO, depicted on Figure 1b is available at https://spatial.faoswalim.org/layers/geonode:SOM_Primary_Roads_UNOCHA
- SPEI data are available under <https://spei.csic.es/>
- Food Security and Nutrition Analysis Unit (FSNAU) maize production data are available under <https://crops.fsnau.org/>

Appendix I Detail on Nightlight data preparation

In line with the literature, we apply several preprocessing steps:

- We use monthly averaged NASA nightlight data, which reduces noise and atmospheric distortions through temporal averaging techniques (NASA’s Scientific Visualization Studio, 2023; Earth Observation Group, (n.d.; Li et al., 2020).
- To focus on traffic rather than economic activity or population movements, we exclude cities and towns along transit routes (Mellander et al., 2015).
- Following SánchezdeMiguel et al. (2019), who warn against oversaturation in the vicinity of cities, we create 15km buffer zones around these areas.
- QGIS requires a polygon-defined area to calculate average raster values. Based on this, use a tight band of 1km around roads, excluding towns and cities. The extracted areas are shown as red lines in Figure A.1(h) (Tan, 2016).
- In separate steps, we also check our estimates for robustness by dropping particularly large emissions (Liu et al., 2020).

References

- Anderson, James E. and Eric Van Wincoop**, “Trade costs,” *Journal of Economic Literature*, 2004, 42 (3), 691–751.
- Black, Paul E.**, “all simple paths,” in Dictionary of Algorithms and Data Structures [online], <https://www.nist.gov/dads/HTML/allSimplePaths.html> 2008. Accessed: 2024-11-15.
- Brodeur, Abel**, “The Effect of Terrorism on Employment and Consumer Sentiment: Evidence from Successful and Failed Terror Attacks,” *American Economic Journal: Applied Economics*, October 2018, 10 (4), 246–82.
- Christ, Nannette and Michael J. Ferrantino**, “Land transport for export: The effects of cost, time, and uncertainty in sub-Saharan Africa,” *World Development*, 2011, 39 (10), 1749–1759.
- Donaldson, Dave**, “Railroads of the Raj: Estimating the Impact of Transportation Infrastructure,” *American Economic Review*, April 2018, 108 (4-5), 899–934.
- Earth Observation Group**, “VIIRS Nighttime Light.,” Retrieved from <https://www.nist.gov/dads/HTML/allSimplePaths.html> (n.d.).
- FAO**, *Sorghum, Maize, and Sesame Value Chains in Somalia*, SCALA Private Sector Engagement Facility Report, 2024.
- Jedwab, Rémi and Adam Storeygard**, “The Average and Heterogeneous Effects of Transportation Investments: Evidence from Sub-Saharan Africa 1960–2010,” *Journal of the European Economic Association*, 2022, 20 (1), 1–38.
- Jones, Benjamin F. and Benjamin A. Olken**, “Hit or Miss? The Effect of Assassinations on Institutions and War,” *American Economic Journal: Macroeconomics*, July 2009, 1 (2), 55–87.
- Li, X., Y. Zhou, M. Zhao, and X. Zhao**, “A harmonized global nighttime light dataset 1992–2018,” *Scientific Data*, 2020, 7 (1), 168.
- Limao, Nuno and Anthony J. Venables**, “Infrastructure, geographical disadvantage, transport costs, and trade,” *The World Bank Economic Review*, 2001, 15 (3), 451–479.
- Liu, P., Q Wang, D Zhang, and Y Lu**, “An Improved Correction Method of Nighttime Light Data Based on EVI and WorldPop Data,” *Remote Sensing*, 2020, 12 (23), 3988.
- Mellander, C., J. Lobo, K. Stolarick, and Z. Matheson**, “Night-time light data: A good proxy measure for economic activity?,” *PLoS ONE*, 2015, 10 (10), e0139779.
- NASA’s Scientific Visualization Studio**, “Change in Night Lights between 2012 and 2023 - EIC Version,” Retrieved from <https://svs.gsfc.nasa.gov/5313/> 2023.
- PDRC**, “Re-assessment of the social, peace, and security situation in Galkacyo,” *Puntland Development and Research Center*, 2021.
- SánchezdeMiguel, A., C. C. M. Kyba, J. Zamorano, H. A. S. Lamphar, and S. J. Ribas**, “A The nature of the diffuse light near cities detected in nighttime satellite imagery,” *Sci Rep*, 2019, 10, 7829.

- Tan, Minghong**, “Use of an inside buffer method to extract the extent of urban areas from DMSP/OLS nighttime light data in North China,” *GIScience and Remote Sensing*, 2016, 53 (4), 498–514.
- Tapsoba, Augustin**, “The cost of fear: Impact of violence risk on child health during conflict,” *Journal of Development Economics*, 2023, 160, 102975.
- The World Bank**, “Eastern Africa - A study of the regional maize market and marketing costs,” 2009. Accessed 2024-12-23.
- , “Somali Poverty Profile 201,” *Report No. AUS19442. The World Bank*, 2017.