High Trade Costs and Their Consequences: An Estimated Dynamic Model of African Agricultural Storage and Trade

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Online Appendix

A1 Data: Market Selection

Table A1, which begins on the next page, includes two lists of markets by country and town population (in thousands). Population data is from the most recent available national censuses as reported in various online databases (e.g. citypopulation.de) and should be taken as approximate as census years vary by country. The "ideal" list starts with the 178 towns with a population of at least 100,000 that are at least 200 kilometers apart[1] (plain font). When two towns of over 100,000 population are closer than 200 kilometers the larger is chosen. An additional 85 towns (italics) on this list are either located at important transport hubs (road junctions or ports) or are additional major towns in countries with high initial population-to-market ratios. The "actual" list is my final network of 230 markets. This includes 218 of the 263 markets on my ideal list for which I was able to obtain price data (plain font) as well as an additional 12 markets with price data which are located close to 12 of the missing markets and which I therefore use as substitutes (italics).

Table A2, which follows table A1, shows the population-to-market ratios by country for the two sets of markets. In the ideal list of markets, only Nigeria and Ethiopia — the two most populous countries — have population-to-market ratios above 4 million. In the final network, the three countries with more than two missing markets (Angola, Cameroon, and Uganda) are the only ones besides Nigeria and Ethiopia that are significantly above this threshold.

[1]Note that Johannesburg is the only town included in South Africa due to its special treatment in my model.

Table A1: List of Markets by Country and Town Population (1/6)

Country	Ideal	Population	Actual	Population
Angola	Luanda	2584	Luanda	2584
	Cabinda	378		
	Huambo	333		
	Lubango	251		
	Malanje	157		
	Lobito	145		
	Uige	116		
	Luena	*85*		
	Saurimo	*78*		
Benin	Cotonou	818	Cotonou	818
	Parakou	227	Parakou	227
	Kandi	150	*Malanville*	*36*
	Natitingou	120	Natitingou	120
Botswana	Gaborone	186	Gaborone	186
	Francistown	*83*		
Burkina Faso	Ouagadougou	1182	Ouagadougou	1182
	Bobo Dioulasso	436	Bobo Dioulasso	436
	Ouahigouya	*71*		
	Fada Ngourma	*41*	Fada Ngourma	41
	Dedougou	*38*	Dedougou	38
Burundi	Bujumbura	340	Bujumbura	340
	Gitega	*47*	Gitega	47
	Muyinga	*45*	Muyinga	45
Cameroon	Douala	1907	Douala	1907
	Yaounde	1818	Yaounde	1818
	Bamenda	270	Bamenda	270
	Garoua	236	Garoua	236
	Maroua	201		
	Ngaoundere	153		
	Kousseri	*89*		
	Bertoua	*88*		
Central African Republic	Bangui	623	Bangui	623
	Berberati	*77*		
	Bambari	*41*	Bambari	41
	Bouar	*40*		
	Bangassou	*32*	Bangassou	32
Chad	Ndjamena	818	Ndjamena	818
	Moundou	141	Moundou	141
	Sarh	119	Sarh	119
	Abeche	*77*	Abeche	77
Congo	Brazzaville	1373	Brazzaville	1373
	Pointe-Noire	715	Pointe-Noire	715
	Impfondo	*34*	Impfondo	34

Table A1: List of Markets by Country and Town Population (2/6)

Country	Ideal	Population	Actual	Population
Côte d'Ivoire	Abdijan	3677	Abdijan	3677
	Bouake	567	Bouake	567
	Daloa	216	Daloa	216
	San Pedro	197		
	Korhogo	167	*Odienne*	*43*
	Man	*139*	Man	139
	Abengourou	*71*	Abengourou	71
D.R. Congo	Kinshasa	8901	Kinshasa	8901
	Lubumbashi	1630	Lubumbashi	1630
	Mbuji-Mayi	1559	Mbuji-Mayi	1559
	Kisangani	868	Kisangani	868
	Bukavu	707	Bukavu	707
	Tshikapa	524	Tshikapa	524
	Kolwezi	451	Kolwezi	451
	Goma	377	Goma	377
	Kikwit	370	Kikwit	370
	Bunia	327	Bunia	327
	Mbandaka	324	Mbandaka	324
	Matadi	291	Matadi	291
	Butembo	204	Butembo	204
	Isiro	175	Isiro	175
	Kindu	164	Kindu	164
	Kamina	144	Kamina	144
	Bandundu	137	Bandundu	137
	Gemena	133	*Zongo*	*33*
	Bumba	103	*Gbadolite*	*48*
	Kananga	*967*	Kananga	967
	Uvira	*337*	Uvira	337
	Kalemie	*92*	Kalemie	92
Djibouti	Djibouti	624	Djibouti	624
Eritrea	Asmara	650	Asmara	650
	Teseney	*65*		
	Massawa	*37*	Massawa	37
Ethiopia	Addis Ababa	3041	Addis Ababa	3041
	Dire Dawa	274	Dire Dawa	274
	Mekele	272	Mekele	272
	Gondar	254	Gondar	254
	Awasa	213	Awasa	213
	Jimma	149	Jimma	149
	Dessie	148	Dessie	148
	Bahir Dar	*191*	Bahir Dar	191
	Jijiga	*147*	Jijiga	147
	Arba Minch	*96*		
	Nekemte	*89*	Nekemte	89
	Gode	*68*	Gode	68
	Adwa	*41*		
	Gambela	*39*	Gambela	39
	Moyale	*34*	*Yabelo*	*18*

Table A1: List of Markets by Country and Town Population (3/6)

Country	Ideal	Population	Actual	Population
Gabon	Libreville	591	Libreville	591
	Port Gentil	112		
Gambia	Banjul	524	Banjul	524
Ghana	Accra	2070	Accra	2070
	Kumasi	2035	Kumasi	2035
	Tamale	371	Tamale	371
	Sekondi Takoradi	539	Sekondi Takoradi	539
	Ho	*105*	Ho	105
	Wa	*71*	Wa	71
	Bolgatanga	*66*	Bolgatanga	66
Guinea	Conakry	1400	Conakry	1400
	Nzerekore	178	Nzerekore	178
	Boke	147		
	Kankan	142	Kankan	142
	Gueckedou	*96*		
	Mamou	*60*	*Labe*	*59*
Guinea Bissau	Bissau	388	Bissau	388
Kenya	Nairobi	3138	Nairobi	3138
	Mombasa	939	Mombasa	939
	Kisumu	388	Kisumu	388
	Garissa	116	Garissa	116
	Nakuru	*308*	Nakuru	308
	Eldoret	*289*	Eldoret	289
	Mandera	*88*	Mandera	88
	Wajir	*82*	Wajir	82
	Lodwar	*48*	Lodwar	48
	Isiolo	*46*		
	Moyale	*38*	Moyale	38
Lesotho	Maseru	218	Maseru	218
Liberia	Monrovia	1022	Monrovia	1022
	Gbarnga	57	Gbarnga	57
Malawi	Lilongwe	647	Lilongwe	647
	Blantyre	585	Blantyre	585
	Mzuzu	175	Mzuzu	175
	Mangochi	*40*	Mangochi	40
	Karonga	*34*	Karonga	34
Mali	Bamako	1809	Bamako	1809
	Sikasso	226	Sikasso	226
	Segou	131	Segou	131
	Kayes	127	Kayes	127
	Mopti	114	Mopti	114
	Gao	*87*	Gao	87

Table A1: List of Markets by Country and Town Population (4/6)

Country	Ideal	Population	Actual	Population
Mauritania	Nouakchott	719	Nouakchott	719
	Nouadhibou	*90*		
	Adel Bagrou	*58*	Adel Bagrou	58
	Kiffa	*40*	*Tintane*	*22*
Mozambique	Maputo	1766	Maputo	1766
	Beira	546	Beira	546
	Nampula	478	Nampula	478
	Chimoio	239	Chimoio	239
	Quelimane	193	Quelimane	193
	Tete	156	Tete	156
	Lichinga	142	Lichinga	142
	Pemba	141	Pemba	141
	Gurue	117	*Cuamba*	*95*
	Xai Xai	116	Xai Xai	116
	Maxixe	106	Maxixe	106
	Nacala	*208*	Nacala	208
	Milange	*30*	Milange	30
Namibia	Windhoek	268	Windhoek	268
	Rundu	*58*	*Katima Mulilo*	*28*
	Walvis Bay	*52*	*Swakopmund*	*44*
	Oshakati	*37*	Oshakati	37
Niger	Niamey	1303	Niamey	1303
	Zinder	275	Zinder	275
	Maradi	206	Maradi	206
	Agadez	124	Agadez	124
	Tahoua	123	Tahoua	123
	Arlit	112	Arlit	112
	Diffa	*48*	Diffa	48
Nigeria	Lagos	8029	Lagos	8029
	Kano	3249	Kano	3249
	Kaduna	1459	Kaduna	1459
	Port Harcourt	1054	Port Harcourt	1054
	Benin City	1052	Benin City	1052
	Maiduguri	972	Maiduguri	972
	Ilorin	756	Ilorin	756
	Jos	742	Jos	742
	Enugu	593	Enugu	593
	Sokoto	501	Sokoto	501
	Okene	445	*Lokoja*	*90*
	Calabar	431	Calabar	431
	Makurdi	249	Makurdi	249
	Gombe	231	Gombe	231
	Yola	218	Yola	218
	Abuja	160	Abuja	160
	Gashua	110		
	Ibadan	*3078*	Ibadan	3078
	Katsina	*387*	Katsina	387
	Akure	*370*	Akure	370

Table A1: List of Markets by Country and Town Population (5/6)

Country	Ideal	Population	Actual	Population
Rwanda	Kigali	745	Kigali	745
	Butare	*90*	Butare	90
	Gisenyi	*84*	Gisenyi	84
Senegal	Dakar	1999	Dakar	1999
	Ziguinchor	162	Ziguinchor	162
	Saint Louis	131	Saint Louis	131
	Touba	*428*	Touba	428
	Kaolack	*174*	Kaolack	174
	Tambacounda	*75*	Tambacounda	75
Sierra Leone	Freetown	773	Freetown	773
	Bo	150	Bo	150
	Kabala	*14*	Kabala	14
Somalia	Mogadishu	1353	Mogadishu	1353
	Hargeisa	1200	Hargeisa	1200
	Bosaso	700	Bosaso	700
	Galkayo	545	Galkayo	545
	Kismayo	183	Kismayo	183
	Baidoa	158	Baidoa	158
	Berbera	*233*		
	Beledweyne	*67*	Beledweyne	67
	Garoowe	*57*	Garoowe	57
South Africa	Johannesburg	957	Johannesburg	957
South Sudan	Juba	372	Juba	372
	Wau	151	Wau	151
	Malakal	139	Malakal	139
	Yambio	*40*		
	Rumbek	*32*	Rumbek	32
	Bor	*27*	Bor	27
Sudan	Khartoum	4273	Khartoum	4273
	Nyala	493	Nyala	493
	Port Sudan	395	Port Sudan	395
	El Obeid	345	El Obeid	345
	Kassala	299	Kassala	299
	Al Qadarif	269	Al Qadarif	269
	Al Fashir	218	Al Fashir	218
	Kostil	213	Kostil	213
	Ad Damazin	137	Ad Damazin	137
	El Geneina	134	El Geneina	134
	Atbarah	112		
	Kadugli	*67*	Kadugli	67
Swaziland	*Mbabane*	*95*	Mbabane	95

Table A1: List of Markets by Country and Town Population (6/6)

Country	Ideal	Population	Actual	Population
Tanzania	Dar es Salaam	4365	Dar es Salaam	4365
	Mwanza	707	Mwanza	707
	Arusha	416	Arusha	416
	Dodoma	411	Dodoma	411
	Mbeya	385	Mbeya	385
	Tanga	273	Tanga	273
	Tabora	227	Tabora	227
	Kigoma	215	Kigoma	215
	Sumbawanga	210	Sumbawanga	210
	Songea	203	Songea	203
	Musoma	178	Musoma	178
	Iringa	151	Iringa	151
	Singida	150	Singida	150
	Bukoba	129	Bukoba	129
	Mtwara	108	Mtwara	108
	Mpanda	102		
Togo	Lome	729	Lome	729
	Sokode	118	*Kara*	*104*
Uganda	Kampala	1660	Kampala	1660
	Gulu	154	Gulu	154
	Lira	*108*	Lira	108
	Mbale	*92*		
	Jinja	*90*	Jinja	90
	Mbarara	*84*	Mbarara	84
	Kasese	*74*		
	Masaka	*74*		
	Arua	*59*	Arua	59
	Masindi	*45*	Masindi	45
Zambia	Lusaka	2147	Lusaka	2147
	Kitwe	410	Kitwe	410
	Chipata	117	Chipata	117
	Livingstone	113	Livingstone	113
	Kasama	102	Kasama	102
	Kabwe	*193*	Kabwe	193
	Solwezi	*91*	Solwezi	91
	Mongu	*52*	Mongu	52
Zimbabwe	Harare	1607	Harare	1607
	Bulawayo	713	Bulawayo	713
	Mutare	194	Mutare	194
	Masvingo	*81*	Masvingo	81
	Hwange	*37*	Hwange	37

Table A2: Population (2010, Millions) per Market by Country

Country	Population	Ideal	Popn/Mkt	Actual	Popn/Mkt
Angola	19.55	9	2.17	1	19.55
Benin	9.51	4	2.38	4	2.38
Botswana	1.97	2	0.98	1	1.97
Burkina Faso	15.54	5	3.11	4	3.89
Burundi	9.23	3	3.08	3	3.08
Cameroon	20.62	8	2.58	4	5.16
Central African Republic	4.35	5	0.87	3	1.45
Chad	11.72	4	2.93	4	2.93
Congo	4.11	3	1.37	3	1.37
Côte d'Ivoire	18.98	7	2.71	6	3.16
D.R. Congo	62.19	22	2.83	22	2.83
Djibouti	0.83	1	0.83	1	0.83
Eritrea	5.74	3	1.91	2	2.87
Ethiopia	87.10	15	5.81	13	6.70
Gabon	1.56	2	0.78	1	1.56
Gambia	1.68	1	1.68	1	1.68
Ghana	24.26	7	3.47	7	3.47
Guinea	10.88	6	1.81	4	2.72
Guinea Bissau	1.59	1	1.59	1	1.59
Kenya	40.91	11	3.72	10	4.09
Lesotho	2.01	1	2.01	1	2.01
Liberia	3.96	2	1.98	2	1.98
Malawi	15.01	5	3.00	5	3.00
Mali	13.99	6	2.33	6	2.33
Mauritania	3.61	4	0.90	3	1.20
Mozambique	23.97	13	1.84	13	1.84
Namibia	2.18	4	0.54	4	0.54
Niger	15.89	7	2.27	7	2.27
Nigeria	159.71	20	7.99	19	8.41
Rwanda	10.84	3	3.61	3	3.61
Senegal	12.95	6	2.16	6	2.16
Sierra Leone	5.75	3	1.92	3	1.92
Somalia	9.64	9	1.07	8	1.20
South Africa	NA	1	NA	1	NA
South Sudan	9.94	6	1.66	5	1.99
Sudan	35.65	12	2.97	11	3.24
Swaziland	1.19	1	1.19	1	1.19
Tanzania	44.97	16	2.81	15	3.00
Togo	6.31	2	3.15	2	3.15
Uganda	33.99	10	3.40	7	4.86
Zambia	13.22	8	1.65	8	1.65
Zimbabwe	13.08	5	2.62	5	2.62
Total	842.31	263	3.20	230	3.66

A2 Data: Grain Types and Data Sources

Table A3, which begins on the next page, lists the seasonal regime and the grain types for each of the 230 markets in my final network. 112 markets fall into the Northern Hemisphere zone (N) with a single annual grain harvest in October, 70 markets fall into the Equatorial zone (E) with a larger grain harvest (two-thirds of the annual total) in July and a smaller grain harvest (one-third of the annual total) in December, and 48 markets fall into the Southern Hemisphere zone (S) with a single annual grain harvest in May.

To determine the grain types for each market, I first made a list for each country of all cereal grains constituting at least 5 percent of national cereal grain production. I excluded barley (Eritrea and Ethiopia) and fonio (Guinea) as they are relatively minor grains. I then searched for available price data for these grains and removed a few from the final list so as to have contiguous areas for each grain for my trade network. 86 percent of total cereal grain production in my countries of interest is covered by a grain price series in its associated market.

Table A4, which follows table A3, lists the data sources by country for my price data. Most series were obtained from secondary sources, particularly the online databases maintained by the World Food Programme's VAM unit and FAO's GIEWS project. However, table A3 also includes the primary sources from which these databases obtained their price data. Although the price data are often collected by different government ministries in different countries, the methodology is typically quite similar and the mandate usually falls into one of three categories: (i) agricultural market information systems (MIS) intended to provide information to farmers and traders on market prices in different locations; (ii) price monitoring by national statistics offices for the monthly consumer price index (CPI); or (iii) food security monitoring by agencies like the World Food Programme.

Table A3: Seasonal Regime and Grain Types by Market (1/6)

Country	Market	Season	Maize	Millet	Rice	Sorghum	Teff	Wheat
Angola	Luanda	E	X					
Benin	Cotonou	N	X		X			
	Malanville	N	X			X		
	Natitingou	N	X		X	X		
	Parakou	N	X		X			
Botswana	Gaborone	S	X					
Burkina Faso	Bobo Dioulasso	N		X		X		
	Dedougou	N		X		X		
	Fada Ngourma	N		X		X		
	Ouagadougou	N		X		X		
Burundi	Bujumbura	E	X			X		
	Gitega	E	X			X		
	Muyinga	E	X			X		
Cameroon	Bamenda	N	X		X			
	Douala	N	X		X			
	Garoua	N	X		X			
	Yaounde	N	X		X			
Central African Republic	Bambari	E	X		X			
	Bangassou	E	X		X			
	Bangui	E	X		X			
Chad	Abeche	N		X		X		
	Moundou	N		X		X		
	Ndjamena	N	X	X	X	X		
	Sarh	N		X		X		
Congo	Brazzaville	E			X			
	Impfondo	E			X			
	Pointe Noire	E			X			
Côte d'Ivoire	Abengourou	N	X		X			
	Abidjan	N	X		X			
	Bouake	N	X		X			
	Daloa	N	X		X			
	Man	N	X		X			
	Odienne	N	X		X			

Table A3: Seasonal Regime and Grain Types by Market (2/6)

Country	Market	Season	Maize	Millet	Rice	Sorghum	Teff	Wheat
D.R. Congo	Bandundu	E	X		X			
	Bukavu	E	X		X			
	Bunia	E	X		X			
	Butembo	E	X		X			
	Gbadolite	E	X		X			
	Goma	E	X		X			
	Isiro	E	X		X			
	Kalemie	S	X		X			
	Kamina	S	X		X			
	Kananga	E	X		X			
	Kikwit	E	X		X			
	Kindu	E	X		X			
	Kinshasa	E	X		X			
	Kisangani	E	X		X			
	Kolwezi	S	X		X			
	Lubumbashi	S	X		X			
	Matadi	E	X		X			
	Mbandaka	E	X		X			
	Mbuji Mayi	E	X		X			
	Tshikapa	E	X		X			
	Uvira	E	X		X			
	Zongo	E	X		X			
Djibouti	Djibouti	N			X			
Eritrea	Asmara	N				X		
	Massawa	N				X		
Ethiopia	Addis Ababa	N	X			X	X	X
	Awasa	N	X			X	X	X
	Bahir Dar	N	X			X	X	X
	Dessie	N	X			X	X	X
	Dire Dawa	N	X			X	X	X
	Gambela	N	X			X	X	X
	Gode	E	X			X		X
	Gondar	N	X			X		X
	Jijiga	E	X			X		X
	Jimma	N	X			X	X	X
	Mekele	N	X			X	X	X
	Nekemte	N	X			X	X	
	Yabelo	E	X					X
Gabon	Libreville	N			X			
Gambia	Banjul	N	X	X	X	X		
Ghana	Accra	N	X	X	X	X		
	Bolgatanga	N	X	X	X	X		
	Ho	N	X		X			
	Kumasi	N	X	X	X	X		
	Sekondi Takoradi	N	X		X			
	Tamale	N	X	X	X	X		
	Wa	N	X	X	X	X		

Table A3: Seasonal Regime and Grain Types by Market (3/6)

Country	Market	Season	Maize	Millet	Rice	Sorghum	Teff	Wheat
Guinea	Conakry	N			X			
	Kankan	N			X			
	Labe	N			X			
	Nzerekore	N			X			
Guinea Bissau	Bissau	N	X	X	X	X		
Kenya	Eldoret	E	X					
	Garissa	E	X					
	Kisumu	E	X					
	Lodwar	E	X					
	Mandera	E	X					
	Mombasa	E	X					
	Moyale	E	X					
	Nairobi	E	X					
	Nakuru	E	X					
	Wajir	E	X					
Lesotho	Maseru	S	X					
Liberia	Gbarnga	N			X			
	Monrovia	N			X			
Malawi	Blantyre	S	X					
	Karonga	S	X					
	Lilongwe	S	X					
	Mangochi	S	X					
	Mzuzu	S	X					
Mali	Bamako	N		X	X	X		
	Gao	N		X	X	X		
	Kayes	N		X	X	X		
	Mopti	N		X	X	X		
	Segou	N		X	X	X		
	Sikasso	N		X	X	X		
Mauritania	Adel Bagrou	N			X	X		
	Nouakchott	N			X	X		
	Tintane	N			X	X		
Mozambique	Beira	S	X		X			
	Chimoio	S	X		X			
	Cuamba	S	X		X			
	Lichinga	S	X		X			
	Maputo	S	X		X			
	Maxixe	S	X		X			
	Milange	S	X		X			
	Nacala	S	X		X			
	Nampula	S	X		X			
	Pemba	S	X		X			
	Quelimane	S	X		X			
	Tete	S	X		X			
	Xai Xai	S	X		X			

Table A3: Seasonal Regime and Grain Types by Market (4/6)

Country	Market	Season	Maize	Millet	Rice	Sorghum	Teff	Wheat
Namibia	Katima Mulilo	S	X					
	Oshakati	S	X					
	Swakopmund	S	X					
	Windhoek	S	X					
Niger	Agadez	N		X		X		
	Arlit	N		X		X		
	Diffa	N		X		X		
	Maradi	N		X		X		
	Niamey	N		X		X		
	Tahoua	N		X		X		
	Zinder	N		X		X		
Nigeria	Abuja	N	X	X	X	X		
	Akure	N	X	X	X	X		
	Benin City	N	X	X	X	X		
	Calabar	N	X	X	X	X		
	Enugu	N	X	X	X	X		
	Gombe	N	X	X	X	X		
	Ibadan	N	X	X	X	X		
	Ilorin	N	X	X	X	X		
	Jos	N	X	X	X	X		
	Kaduna	N	X	X	X	X		
	Kano	N	X	X	X	X		
	Katsina	N	X	X	X	X		
	Lagos	N	X	X	X	X		
	Lokoja	N	X	X	X	X		
	Maiduguri	N	X	X	X	X		
	Makurdi	N	X	X	X	X		
	Port Harcourt	N	X	X	X	X		
	Sokoto	N	X	X	X	X		
	Yola	N	X	X	X	X		
Rwanda	Butare	E	X			X		
	Gisenyi	E	X			X		
	Kigali	E	X			X		
Senegal	Dakar	N	X	X	X	X		
	Kaolack	N	X	X	X	X		
	Saint Louis	N	X	X	X	X		
	Tambacounda	N	X	X	X	X		
	Touba	N	X	X	X	X		
	Ziguinchor	N	X	X	X	X		
Sierra Leone	Bo	N			X			
	Freetown	N			X			
	Kabala	N			X			

Table A3: Seasonal Regime and Grain Types by Market (5/6)

Country	Market	Season	Maize	Millet	Rice	Sorghum	Teff	Wheat
Somalia	Baidoa	E	X			X		
	Beledweyne	E	X			X		
	Bosaso	E	X			X		
	Galkayo	E	X			X		
	Garoowe	E	X			X		
	Hargeisa	E	X			X		
	Kismayo	E	X			X		
	Mogadishu	E	X			X		
South Africa	Johannesburg	S	X					
South Sudan	Bor	N	X			X		
	Juba	E	X			X		
	Malakal	N	X			X		
	Rumbek	N	X			X		
	Wau	N	X			X		
Sudan	Ad Damazin	N		X		X		X
	Al Fashir	N		X		X		X
	Al Qadarif	N		X		X		X
	El Geneina	N		X		X		X
	El Obeid	N		X		X		X
	Kadugli	N		X		X		X
	Kassala	N		X		X		X
	Khartoum	N		X		X		X
	Kosti	N		X		X		X
	Nyala	N		X		X		X
	Port Sudan	N		X		X		X
Swaziland	Mbabane	S	X					
Tanzania	Arusha	E	X		X			
	Bukoba	E	X		X			
	Dar es Salaam	E	X		X			
	Dodoma	E	X		X			
	Iringa	S	X		X			
	Kigoma	E	X		X			
	Mbeya	S	X		X			
	Mtwara	S	X		X			
	Musoma	E	X		X			
	Mwanza	E	X		X			
	Singida	E	X		X			
	Songea	S	X		X			
	Sumbawanga	S	X		X			
	Tabora	E	X		X			
	Tanga	E	X		X			
Togo	Kara	N	X		X	X		
	Lome	N	X		X	X		

Table A3: Seasonal Regime and Grain Types by Market (6/6)

Country	Market	Season	Maize	Millet	Rice	Sorghum	Teff	Wheat
Uganda	Arua	E	X					
	Gulu	E	X			X		
	Jinja	E	X			X		
	Kampala	E	X			X		
	Lira	E	X			X		
	Masindi	E	X			X		
	Mbarara	E	X			X		
Zambia	Chipata	S	X					
	Kabwe	S	X					
	Kasama	S	X					
	Kitwe	S	X					
	Livingstone	S	X					
	Lusaka	S	X					
	Mongu	S	X					
	Solwezi	S	X					
Zimbabwe	Bulawayo	S	X					
	Harare	S	X					
	Hwange	S	X					
	Masvingo	S	X					
	Mutare	S	X					
	Total		180	64	126	110	9	23

Table A4: Primary and Secondary Data Sources by Country

Country	Markets	Series	Primary Source	Secondary Source
Angola	1	1	National Institute of Statistics	
Benin	4	9	Min. of Ag., Livestock, and Fisheries	FAO GIEWS
Botswana	1	1	Central Statistics Office	BIDPA
Burkina Faso	4	8	Afrique Verte	FAO GIEWS
Burundi	3	6	World Food Programme	USAID FEWS NET
Cameroon	4	8	National Institute of Statistics	FAO GIEWS
C.A.R.	3	6	World Food Programme	WFP VAM
Chad	4	10	USAID FEWS NET	FAO GIEWS
Congo	3	3	World Food Programme	WFP VAM
Côte d'Ivoire	6	12	World Food Programme	WFP VAM
D.R. Congo	22	44	FAO-DRC and Min. of Ag. and Rural Dev't	
Djibouti	1	1	Dept. of Statistics and Demographic Studies	USAID FEWS NET
Eritrea	2	2	UN OCHA Eritrea	FAO GIEWS
Ethiopia	13	46	Ethiopian Grain Trade Enterprise;	FAO GIEWS;
			World Food Programme	WFP VAM
Gabon	1	1	Ministry of Economy and Planning	FAO GIEWS
Gambia	1	4	Bureau of Statistics	WFP VAM
Ghana	7	24	Ministry of Food and Agriculture	FAO GIEWS; WFP VAM
Guinea	4	4	World Food Programme	WFP VAM
Guinea Bissau	1	4	World Food Programme	WFP VAM
Kenya	10	10	Min. of Ag., Livestock, & Fish.; Nat'l	USAID FEWS NET;
			Drought Managem. Authority; RATIN	FAO GIEWS
Lesotho	1	1	Bureau of Statistics	FAO GIEWS
Liberia	2	2	World Food Programme	WFP VAM
Malawi	5	5	Ministry of Agriculture and Food Security	
Mali	6	18	Afrique Verte	FAO GIEWS
Mauritania	3	6	World Food Programme	WFP VAM
Mozambique	13	26	Ministry of Agriculture	WFP VAM
Namibia	4	4	Namibia Statistics Agency	
Niger	7	14	Min. of Trade and Private Sector Promotion	FAO GIEWS; WFP VAM
Nigeria	19	76	National Bureau of Statistics	D. Donaldson
Rwanda	3	6	Min. of Ag. and Animal Resources	WFP VAM
Senegal	6	24	Food Security Commission	WFP VAM
Sierra Leone	3	3	World Food Programme	WFP VAM
Somalia	8	16	Food Security and Nutrition Analysis Unit	
South Africa	1	1	South African Futures Exchange	FAO GIEWS
South Sudan	5	10	World Food Programme	WFP VAM
Sudan	11	33	World Food Programme;	WFP VAM
			Food Security Information for Action	FAO GIEWS
Swaziland	1	1	Ministry of Agriculture	WFP VAM
Tanzania	15	30	Min. of Industry, Trade, and Marketing	WFP VAM
Togo	2	6	Min. of Ag., Livestock, and Fisheries	FAO GIEWS
Uganda	7	13	Infotrade Uganda;	WFP VAM;
			Farmgain Africa	USAID FEWS NET
Zambia	8	8	Central Statistics Office	WFP VAM
Zimbabwe	5	5	World Food Programme	WFP VAM
Total	230	512		

A3 Data: Retail and Wholesale Price Series

390 (76 percent) of the 512 price series are identified as retail price series for quantities ranging from 0.5 to 3.5 kg, while the remainder are identified as wholesale price series for quantities ranging from 50 to 100 kg. Table A5 on the next page reports results from a statistical test of 37 series from 17 markets in 5 countries for which both "retail" and "wholesale" prices are available. My null hypothesis is that retail prices and wholesale prices are not significantly different, which is consistent with interviews of market participants suggesting that separate retail and wholesale markets typically do not exist and that prices per kilogram often do not vary with quantity sold. To test this hypothesis, I subtract each wholesale price series from its respective retail price series and then regress each resulting series of differences on a constant. I fail to reject the null for 9 of 37 series (24.3 percent), I find retail prices significantly greater than wholesale prices for 23 of 37 series (62.2 percent), and I find wholesale prices significantly greater than retail prices for 5 of 37 series (13.5 percent). Interestingly, all 9 of the 9 series from 4 large commercial capital cities have retail price series significantly greater than wholesale price series, suggesting that more sophisticated, separate markets may exist in these environments. These 4 cities all have populations over 1 million, whereas the remaining 28 series come from cities with populations less than 500,000. Without the 9 series from the large cities, exactly 50 percent of the remaining 28 series have retail prices significantly greater than wholesale prices while 50 percent have retail prices not different or significantly smaller than wholesale price series.

While I cannot reject my null hypothesis of equality across all markets, there do appear to be some individual markets with a significant difference between retail and wholesale prices. This would be problematic for my estimation of trade costs in cases where a market with a wholesale price series is directly connected to a market with a retail price series. Fortunately, such cases are few – only 60 of the 413 links in my network (14.5 percent). Of these, only 29 (7.0 percent) involve a city with a population larger than 500,000. In table A6, I compare my estimated trade costs along these 29 links to estimated trade costs along similar nearby links with identical series types (wholesale-wholesale or retail-retail). Although direct comparisons are difficult to make due to the particularities of each link, the costs per tonne-km of the 29 potentially affected links do not appear to be systematically larger than those of their comparison links. The estimated trade costs along the 29 potentially affected links are also all much higher than the counterfactual trade cost of $0.05/t-km, suggesting that any small bias in my trade cost estimates for these links due to retail-wholesale price discrepancies would not affect my results significantly.

Table A5: Statistical Test of Retail–Wholesale Price Difference

Market	Country	Crop	Observ.	Coefficient	Std. Error	Result	Large City
Ad Damazin	Sudan	Millet	79	0.0935	(0.0143)	+	
		Sorghum	86	0.0629	(0.0067)	+	
Addis Ababa	Ethiopia	Maize	52	0.2525	(0.0173)	+	X
		Sorghum	64	0.1875	(0.0132)	+	X
		Teff	72	0.0373	(0.0036)	+	X
		Wheat	72	0.0812	(0.0066)	+	X
Agadez	Niger	Millet	76	–1.49E-04	(0.0031)	=	
		Sorghum	49	–4.79E-04	(0.0049)	=	
Al Fashir	Sudan	Millet	82	0.0458	(0.0110)	+	
		Sorghum	60	0.1203	(0.0147)	+	
Bahir Dar	Ethiopia	Teff	71	–0.0106	(0.0048)	–	
		Wheat	67	0.0263	(0.0063)	+	
Dar es Salaam	Tanzania	Maize	100	0.1646	(0.0090)	+	X
		Rice	79	0.0937	(0.0118)	+	X
Dire Dawa	Ethiopia	Maize	41	0.1972	(0.0162)	+	
		Sorghum	55	0.0360	(0.0081)	+	
		Teff	65	0.0775	(0.0175)	+	
El Geneina	Sudan	Millet	72	–0.0153	(0.0086)	=	
		Sorghum	66	–0.0259	(0.0107)	–	
El Obeid	Sudan	Millet	109	0.0171	(0.0086)	=	
		Sorghum	94	0.0228	(0.0065)	+	
Kadugli	Sudan	Millet	71	0.0345	(0.0185)	=	
		Sorghum	103	0.0176	(0.0059)	+	
		Wheat	43	–0.0134	(0.0204)	=	
Kampala	Uganda	Maize	118	0.0840	(0.0025)	+	X
Maradi	Niger	Millet	76	–1.17E-04	(0.0024)	=	
		Sorghum	76	–0.0098	(0.0033)	–	
Mekele	Ethiopia	Teff	66	0.0362	(0.0097)	+	
Niamey	Niger	Millet	76	0.0593	(0.0030)	+	X
		Sorghum	76	0.0865	(0.0032)	+	X
Nyala	Sudan	Millet	72	0.0136	(0.0101)	=	
		Sorghum	70	0.0139	(0.0058)	+	
Port Sudan	Sudan	Millet	91	0.0788	(0.0183)	+	
		Sorghum	96	0.0086	(0.0037)	+	
		Wheat	55	0.0064	(0.0174)	=	
Zinder	Niger	Millet	76	–0.0328	(0.0037)	–	
		Sorghum	52	–0.0213	(0.0039)	–	

Note: Result column indicates whether the retail price is greater than (+), less than (–), or not different from (=) the wholesale price at 5 percent significance.

Table A6: Estimated Trade Costs Along Potentially Affected Links and Nearby Comparison Links

Potentially Affected Link	τ_{mn}	/t-km	Comparison Link	τ_{mn}	/t-km
Monrovia LR – Bo SL	0.238	0.667	Freetown SL – Conakry GN	0.398	1.279
Bamako ML – Odienne CI	0.091	0.225	Odienne CI – Kankan GN	0.120	0.398
Bamako ML – Kankan GN	0.160	0.429	Labe GN – Tambac. SN	0.179	0.424
Bamako ML – Adel Bagrou MR	0.110	0.256	Kayes ML – Tambac. SN	0.088	0.309
Bamako ML – Tintane MR	0.394	0.560			
Ouaga. BF – Kara TG	0.132	0.248	Ouaga. BF – Bolgatanga GH	0.096	0.451
Niamey NE – Gao ML	0.127	0.284	Niamey NE – Malanville BJ	0.083	0.281
Niamey NE – Fada Ng. BF	0.152	0.520			
Accra GH – Lome TG	0.249	1.298	Cotonou BJ – Lagos NG	0.188	1.563
Kumasi GH – Abeng. CI	0.161	0.606	Abeng. CI – Bouake CI[d]	0.211	0.611
Abidjan CI – Sek.-Tak. GH	0.163	0.509	Abidjan CI – Bouake CI[d]	0.147	0.418
Bouake CI – Sikasso ML	0.061	0.123	Sikasso ML – Bobo Diou. BF	0.022	0.122
Luanda AO – Matadi CD	1.074	1.168	Matadi CD – Kinshasa CD[d]	0.366	1.012
Luanda AO – Kinshasa CD	1.041	1.960			
Jo'burg ZA – Maseru LS	0.071	0.168	Jo'burg ZA – Mbabane SZ	0.089	0.251
Jo'burg ZA – Gaborone BW	0.114	0.312	Bulaw. ZW – Masv. ZW[d]	0.118	0.415
Jo'burg ZA – Maputo MZ	0.213	0.391			
Jo'burg ZA – Windhoek NA	0.260	0.190			
Jo'burg ZA – Bulaw. ZW	0.081	0.093			
Jo'burg ZA – Masv. ZW	0.111	0.134			
Maputo MZ – Mbabane SZ	0.100	0.451	Maputo MZ – Xai Xai MZ[d]	0.105	0.485
Nairobi KE – Garissa KE[d]	0.202	0.553	Garissa KE – Wajir KE[d]	0.155	0.480
Mombasa KE – Garissa KE[d]	0.151	0.327			
Kigali RW – Mwanza TZ	0.079	0.147	Kigali RW – Mbarara UG	0.141	0.582
Kampala UG – Bukoba TZ	0.136	0.456	Kigali RW – Mbarara UG	0.141	0.582
Khartoum SD – Ad Dam. SD[d]	0.112	0.211	Ad Dam. SD – Kosti SD[d]	0.077	0.220
Khartoum SD – Kosti SD[d]	0.062	0.196	Khartoum SD – Al Qad. SD[d]	0.066	0.186
Asmara ER – Mekele ET	0.560	1.801	Asmara ER – Gondar ET	0.611	1.136
Asmara ER – Kassala SD	0.689	1.610			

Note: [d] Domestic link

A4 Model: Derivation of Inverse Demand and Welfare

In this section I derive expressions for inverse demand and welfare (indirect utility). The consumer's utility maximization problem is as follows:

$$\max_{\{Q_{imt}\}_{i\in I_m}, X_{mt}} \frac{\theta_{mt}\left(\left[\sum_{i\in I_m} \alpha_{im}^{1/\sigma} Q_{imt}^{(\sigma-1)/\sigma}\right]^{\sigma/(\sigma-1)}\right)^{1+\frac{1}{\epsilon}}}{1+\frac{1}{\epsilon}} + X_{mt} \text{ such that } \sum_{i\in I_m} P_{imt}Q_{imt} + X_{mt} \leq Y_{mt}$$

The first order condition for X_{mt} is $\lambda = 1$ where λ is the Lagrange multiplier. The first order condition for any grain i is:

$$\theta_{mt}\left(\left[\sum_{j\in I_m} \alpha_{jm}^{1/\sigma} Q_{jmt}^{(\sigma-1)/\sigma}\right]^{\sigma/(\sigma-1)}\right)^{1/\epsilon}\left[\sum_{j\in I_m} \alpha_{jm}^{1/\sigma} Q_{jmt}^{(\sigma-1)/\sigma}\right]^{1/(\sigma-1)} \alpha_{im}^{1/\sigma} Q_{imt}^{-1/\sigma} = \lambda P_{imt} = P_{imt}$$

Rearranging and letting $\theta_{mt}^{-\epsilon} = A_m N_{mt}$ gives the inverse demand function for any grain i:

$$P_{imt} = \frac{\alpha_{im}^{1/\sigma}}{Q_{imt}^{1/\sigma}} * \frac{Q_{mt}^{1/\sigma+1/\epsilon}}{(A_m N_{mt})^{1/\epsilon}}$$

where $Q_{mt} = \left[\sum_{i\in I_m} \alpha_{im}^{1/\sigma} Q_{imt}^{(\sigma-1)/\sigma}\right]^{\sigma/(\sigma-1)}$ is the CES quantity index (the grain composite).

I next turn to deriving an expression for welfare (indirect utility). Rearranging the previous expression gives the demand function for any grain i:

$$Q_{imt} = \frac{\alpha_{im}}{P_{imt}^{\sigma}} * \frac{Q_{mt}^{1+\sigma/\epsilon}}{(A_m N_{mt})^{\sigma/\epsilon}}$$

Taking the ratio of any two such equations for grains j and i gives:

$$\frac{Q_{jmt}}{Q_{imt}} = \frac{\alpha_{jm} P_{imt}^{\sigma}}{\alpha_{im} P_{jmt}^{\sigma}}$$

$$\Rightarrow Q_{jmt} = \frac{\alpha_{jm} Q_{imt} P_{imt}^{\sigma}}{\alpha_{im} P_{jmt}^{\sigma}}$$

$$\Rightarrow P_{jmt} Q_{jmt} = \frac{\alpha_{jm} P_{jmt}^{1-\sigma} Q_{imt} P_{imt}^{\sigma}}{\alpha_{im}}$$

$$\Rightarrow \sum_{j\in I_m} P_{jmt} Q_{jmt} = \frac{Q_{imt} P_{imt}^{\sigma}}{\alpha_{im}} \sum_{j\in I_m} \alpha_{jm} P_{jmt}^{1-\sigma}$$

$$\Rightarrow Q_{imt} = \frac{\alpha_{im} \sum_{j\in I_m} P_{jmt} Q_{jmt}}{P_{imt}^{\sigma} \sum_{j\in I_m} \alpha_{jm} P_{jmt}^{1-\sigma}}$$

I can use this last expression to rewrite the grain composite as follows:

$$Q_{mt} = \left[\sum_{i\in I_m} \alpha_{im}^{1/\sigma} Q_{imt}^{(\sigma-1)/\sigma}\right]^{\sigma/(\sigma-1)} = \frac{\sum_{j\in I_m} P_{jmt} Q_{jmt}}{\sum_{j\in I_m} \alpha_{jm} P_{jmt}^{1-\sigma}} \left[\sum_{i\in I_m} \alpha_{im}^{1/\sigma} \left(\frac{\alpha_{im}}{P_{imt}^{\sigma}}\right)^{(\sigma-1)/\sigma}\right]^{\sigma/(\sigma-1)}$$

$$\Rightarrow Q_{mt} = \frac{\sum_{j\in I_m} P_{jmt} Q_{jmt}}{\sum_{j\in I_m} \alpha_{jm} P_{jmt}^{1-\sigma}} \left[\sum_{i\in I_m} \alpha_{im} P_{imt}^{1-\sigma}\right]^{\sigma/(\sigma-1)}$$

$$\Rightarrow Q_{mt} = \frac{\sum_{j \in I_m} P_{jmt} Q_{jmt}}{\left[\sum_{j \in I_m} \alpha_{jm} P_{jmt}^{1-\sigma}\right]^{1/(1-\sigma)}} = \frac{\sum_{j \in I_m} P_{jmt} Q_{jmt}}{P_{mt}}$$

where $P_{mt} = \left[\sum_{j \in I_m} \alpha_{jm} P_{jmt}^{1-\sigma}\right]^{1/(1-\sigma)}$ is the CES grain price index. Plugging this into the demand function derived above gives:

$$Q_{imt} = \frac{\alpha_{im}}{P_{imt}^{\sigma}} * \frac{\left(\frac{\sum_{j \in I_m} P_{jmt} Q_{jmt}}{P_{mt}}\right)^{1+\sigma/\epsilon}}{(A_m N_{mt})^{\sigma/\epsilon}}$$

$$\Rightarrow P_{imt} Q_{imt} = \alpha_{im} P_{imt}^{1-\sigma} * \frac{\left(\frac{\sum_{j \in I_m} P_{jmt} Q_{jmt}}{P_{mt}}\right)^{1+\sigma/\epsilon}}{(A_m N_{mt})^{\sigma/\epsilon}}$$

$$\Rightarrow \sum_{j \in I_m} P_{jmt} Q_{jmt} = \sum_{j \in I_m} \alpha_{jm} P_{jmt}^{1-\sigma} * \frac{\left(\frac{\sum_{j \in I_m} P_{jmt} Q_{jmt}}{P_{mt}}\right)^{1+\sigma/\epsilon}}{(A_m N_{mt})^{\sigma/\epsilon}}$$

$$\Rightarrow \left(\sum_{j \in I_m} P_{jmt} Q_{jmt}\right)^{-\sigma/\epsilon} = \frac{P_{mt}^{-\sigma(1+1/\epsilon)}}{(A_m N_{mt})^{\sigma/\epsilon}}$$

$$\Rightarrow \sum_{j \in I_m} P_{jmt} Q_{jmt} = A_m N_{mt} P_{mt}^{\epsilon+1}$$

Plugging this into the expression for the quantity index derived above gives:

$$Q_{mt} = A_m N_{mt} P_{mt}^{\epsilon}$$

I next plug the two previous expressions into the utility function to obtain indirect utility V_{mt}:

$$U_{mt} = \theta_{mt} \frac{Q_{mt}^{1+\frac{1}{\epsilon}}}{1+\frac{1}{\epsilon}} + X_{mt} = (A_m N_{mt})^{-\frac{1}{\epsilon}} \frac{Q_{mt}^{1+\frac{1}{\epsilon}}}{1+\frac{1}{\epsilon}} + Y_{mt} - \sum_{j \in I_m} P_{jmt} Q_{jmt}$$

$$\Rightarrow V_{mt} = \frac{\epsilon}{\epsilon+1} A_m N_{mt} P_{mt}^{\epsilon+1} + Y_{mt} - A_m N_{mt} P_{mt}^{\epsilon+1}$$

$$\Rightarrow V_{mt} = Y_{mt} - \frac{1}{\epsilon+1} A_m N_{mt} P_{mt}^{\epsilon+1}$$

This last expression is identical to equation 5 in the main paper.

A5 Estimation: Demand Parameters

To estimate the elasticity of substitution (σ) I use standard techniques for CES utility. The expenditure share on grain i (s_{imt}) is given by:

$$s_{imt} \equiv \frac{P_{imt}Q_{imt}}{\sum_{j\in I_m} P_{jmt}Q_{jmt}} = \frac{\alpha_{im}P_{imt}^{1-\sigma}}{\sum_{j\in I_m} \alpha_{jm}P_{jmt}^{1-\sigma}}$$

Taking the natural logarithm of both sides gives:

$$\ln s_{imt} = \ln \alpha_{im} + (1-\sigma)\ln P_{imt} - \ln\left(\sum_{j\in I_m} \alpha_{jm}P_{jmt}^{1-\sigma}\right)$$

Using data on consumption and prices I then run the following regression:

$$\ln s_{imt} = \mu_{im} + \beta \ln P_{imt} + \mu_{mt} + v_{imt}$$

where μ_{im} and μ_{mt} are crop-country and country-year fixed effects and v_{imt} is an error term. My estimate for σ is then $1-\beta$.

Results are summarized in table A7. A simple OLS regression yields an estimate of $\sigma = 0.51$, with a clustered standard error of 0.21. However, OLS is unlikely to yield consistent estimates of β since equilibrium prices are affected by unobserved demand shocks, i.e. $Cov(P_{imt}, v_{imt}) \neq 0$. I therefore use an instrumental variables regression with the landed world price as the instrument. I define the landed world price Z_{imt} as the world price plus the average price difference between the world price and the country's largest city, which is a lower bound on trade costs. Crops with no world price (millet, teff) are excluded. The identifying assumption is that $Cov(Z_{imt}, v_{imt}) = 0$, i.e. that the landed world price only affects the expenditure share through its effect on local prices.

The first stage regression is as follows:

$$\ln P_{imt} = \mu_{im} + \gamma \ln Z_{imt} + \mu_{mt} + v_{imt}$$

which yields an estimate of $\gamma = 0.495$ with an unclustered standard error of 0.073 and a standard error of 0.202 when clustering by country-crop (387 observations, 56 clusters). There is thus a strong positive correlation between the landed world price and local prices in Africa, which is to be expected given Africa's position as a net grain importer. The first stage F statistic is 45.7 without clustering and 6.0 with clustering by country-crop.

Table A7: Elasticity Estimates

	OLS: σ	OLS: ϵ	IV: σ	IV: ϵ
Estimate	0.51	–0.256	0.90	–0.136
	(0.21)	(0.071)	(0.18)	(0.116)
1st Stage F Stat			6.0	70.3
Observations	463	289	387[b]	289
Clustered Errors	country-crop	country	country-crop	country
Clusters	67	28	56	28

Note: Robust standard errors in () and F statistic clustered as indicated.
[b]Crops with no world price (millet, teff) excluded.

The full instrumental variables regression yields an estimate of $\sigma = 0.90$, with a clustered standard error of 0.18 and a 95 percent confidence interval of $[0.56, 1.25]$. The estimated σ is close to the Cobb-Douglas benchmark of $\sigma = 1$, implying that expenditure shares are only slightly affected by price changes, if at all.

For a particular σ (e.g. $\sigma = 1$ in my baseline case, $\sigma = 3$ in my robustness checks) I proceed to estimate the associated α_{im} by estimating individual regressions for each country m of the form:

$$(\ln s_{imt} - (1 - \sigma) \ln P_{imt}) = \mu_{im} + \mu_{mt} + v_{imt}$$

I back out the α_{im} parameters from the coefficients on the fixed effect indicator variables μ_{im}. To compute standard errors, I bootstrap by resampling the data with replacement (10,000 iterations).

To estimate the price elasticity of grain demand (ϵ), I first compute the price and quantity indices for the relevant σ and its of α_{im}. For my baseline case, I set $\sigma = 1$, so I use the Cobb-Douglas price and quantity indices: $P_{mt} = \prod_{i \in I_m} P_{imt}^{\alpha_{im}}$ and $Q_{mt} = \prod_{i \in I_m} \left(\frac{Q_{imt}}{\alpha_{im}}\right)^{\alpha_{im}}$. As shown in the previous section, overall grain demand in terms of price and quantity indices is given by:

$$Q_{mt} = A_m N_{mt} P_{mt}^{\epsilon}$$

Letting q_{mt} denote per-capita grain consumption gives:

$$q_{mt} \equiv \frac{Q_{mt}}{N_{mt}} = A_m P_{mt}^{\epsilon}$$

$$\Rightarrow \ln q_{mt} = \ln A_m + \epsilon \ln P_{mt}$$

I then run the following regression:

$$\ln q_{mt} = \mu_m + \epsilon \ln P_{mt} + v_{mt}$$

where μ_m are country fixed effects. A simple OLS regression yields an estimate of $\epsilon = -0.256$ with a clustered standard error of 0.071. However, once again OLS is unlikely to yield consistent estimates of ϵ since equilibrium prices are affected by unobserved demand shocks, i.e. $Cov(P_{mt}, v_{mt}) \neq 0$. I therefore again use an instrumental variables regression with the landed world price index Z_{mt} as the instrument (local prices of millet and teff are used in this index as necessary). The identifying assumption is that $Cov(Z_{mt}, v_{mt}) = 0$, i.e. that the landed world price index only affects the expenditure share through its effect on local prices.

The first stage regression is as follows:

$$\ln P_{mt} = \mu_m + \gamma \ln Z_{mt} + v_{mt}$$

which yields an estimate of $\gamma = 1.02$ with a standard error of 0.12 when clustering by country (289 observations, 28 clusters). The clustered first stage F statistic is 70.3. Once again there is a strong positive correlation between the world price indices and the local price indices in Africa.

The full instrumental variables regression yields an estimate of $\epsilon = -0.136$ with a clustered standard error of 0.116 and a 95 percent confidence interval for ϵ of $[-0.363, 0.091]$. The estimated ϵ is close to zero, consistent with the estimate of Roberts and Schlenker 2013 of -0.066.

The last parameters to estimate are the demand shifters A_m. Given a particular σ, an associated estimated set of α_{im}, and a particular ϵ, I estimate A_m as an average across years:

$$A_m = \frac{1}{T} \sum_t \frac{Q_{mt}}{N_{mt} P_{mt}^{\epsilon}}$$

To compute standard errors, I implement a two-stage bootstrap procedure with 10,000 iterations in which I first re-estimate the set of α_{im} and then the associated average A_m.

Table A8 reports estimates for A_m and α_{im} for 20 individual countries and 8 groups of countries.

Different values of A_m (a per-capita variable) may reflect several factors including the relative importance of cereal grains in local diets vis-à-vis other foods like tubers. Country groups were formed due to the limited number of annual observations. Countries with less than 7 observations were given special priority for group formation. Groups were formed from contiguous countries having the same set of grains and similar per-capita consumption of each grain. The maximum number of annual observations for a given country is 9 as trade data for 2013 was unavailable at the time of estimation. Even with the aggregation of some countries into groups, the number of annual observations per unit remains low. However, using multiple observations per country is an improvement over using a single year (the standard in the literature) and allows me to quantify the variation among observations.

Table A8: Demand Parameter Estimates for 28 Countries or Country Groups (1/2)

	A	α_{maize}	α_{millet}	α_{rice}	$\alpha_{sorghum}$	α_{teff}	α_{wheat}	Observ.
Benin	179.4	0.329		0.614	0.058			9
	(10.1)	(0.034)		(0.037)	(0.004)			
Burkina Faso	170.5		0.421		0.579			7
	(7.5)		(0.009)		(0.009)			
Cameroon	90.7	0.618		0.382				8
	(3.2)	(0.015)		(0.015)				
Chad	115.9	0.145	0.363	0.140	0.352			9
	(4.9)	(0.007)	(0.015)	(0.005)	(0.011)			
Côte d'Ivoire	101.4	0.172		0.828				7
	(3.8)	(0.008)		(0.008)				
Djibouti	45.0			1				9
	(5.5)			(0)				
Eritrea	38.3				1			3
	(11.0)				(0)			
Ethiopia	143.0	0.210			0.176	0.308	0.306	7
	(5.2)	(0.006)			(0.010)	(0.015)	(0.011)	
Ghana	102.5	0.401	0.074	0.436	0.088			7
	(5.2)	(0.024)	(0.006)	(0.021)	(0.007)			
Kenya	79.1	1						9
	(2.9)	(0)						
Malawi	169.0	1						9
	(14.7)	(0)						
Mali	234.7		0.285	0.515	0.201			7
	(13.2)		(0.018)	(0.017)	(0.007)			

Table A8: Demand Parameter Estimates for 28 Countries or Country Groups (2/2)

	A	α_{maize}	α_{millet}	α_{rice}	$\alpha_{sorghum}$	α_{teff}	α_{wheat}	Observ.
Mauritania	70.1			0.680	0.320			5
	(4.4)			(0.049)	(0.049)			
Mozambique	70.0	0.602		0.398				8
	(4.2)	(0.027)		(0.027)				
Niger	251.2		0.766		0.234			9
	(11.8)		(0.006)		(0.006)			
Nigeria	166.9	0.218	0.257	0.223	0.302			7
	(7.4)	(0.011)	(0.009)	(0.013)	(0.015)			
Somalia	29.6	0.590			0.410			9
	(2.6)	(0.033)			(0.033)			
Tanzania	98.1	0.561		0.439				7
	(5.7)	(0.025)		(0.025)				
Togo	158.9	0.400		0.406	0.194			9
	(3.3)	(0.013)		(0.011)	(0.008)			
Uganda	72.1	0.833			0.167			2
	(0.7)	(0.002)			(0.002)			
Angola/Botswana/	48.8	1						9
Namibia	(10.2)	(0)						
Burundi/Rwanda	31.6	0.627			0.373			12
	(3.7)	(0.026)			(0.026)			
C.A.R./D.R. Congo	32.1	0.712		0.288				14
	(2.1)	(0.018)		(0.018)				
Congo/Gabon	40.6			1				8
	(1.7)			(0)				
Gambia/G.Bissau/	170.6	0.125	0.229	0.570	0.076			19
Senegal	(9.0)	(0.011)	(0.024)	(0.030)	(0.006)			
Guinea/Liberia/	108.3			1				17
Sierra Leone	(5.4)			(0)				
Lesotho/Swaziland/	105.5	1						16
Zambia/Zimbabwe	(7.8)	(0)						
South Sudan/Sudan	212.7	0.018	0.089		0.465		0.428	5
	(10.1)	(0.005)	(0.008)		(0.026)		(0.033)	

A6 Estimation: External Variation and Standard Errors

The main paper reports standard errors using resampled data from within the sets $\mathbb{S}$ and $\mathbb{T}$ associated with the fixed point obtained when starting from my preferred initial guess $\mathbb{C}^0$. I also assessed the external variation in my parameter estimates and results by re-estimating the parameters starting from 20 different smaller initial guesses $\mathbb{C}^0$. These included initial guesses with trade costs set at \$0.01/t-km, \$0.02/t-km, and \$0.04/t-km (with r_m and k_m set at 0.001, 0.002, and 0.004 respectively), with all parameters set to one-half and one-quarter of my preferred initial guess, and 15 initial guesses in which each parameter was drawn from a uniform distribution from 0 up to its value in my preferred initial guess. Each initial guess converged to a distinct fixed point, taking between 11 and 22 iterations. I then solved for equilibrium using the fixed point's associated parameters under both newly-estimated high and counterfactual low trade costs. The number of initial guesses was limited to 20 due to the extremely long run-time involved (one month per initial guess). External standard errors reported below were obtained by taking the standard deviation of the values from the 20 different initial guesses.

Table A9 compares the external standard errors for the storage cost parameters to the point estimates and internal standard errors reported in table 3 of the main paper. All external standard errors are substantially smaller than the associated internal standard errors. All storage cost parameters obtained from the 20 different initial guesses are well within 95 percent confidence intervals constructed around the initial point estimates using the internal standard errors. External standard errors for the trade cost parameters are presented alongside internal standard errors in the following section.

Table A10 compares the external standard errors for the aggregate results from the main counterfactual to the point estimates and internal standard errors reported in table 8 of the main paper. Again, all external standard errors are substantially smaller than the associated internal standard errors, and all results obtained from the 20 different initial guesses are well within 95 percent confidence intervals constructed around the initial point estimates using the internal standard errors.

Table A9: Comparison of Standard Errors for Storage Cost Parameters

Region	Parameter	Pt. Estimate	Internal SE	External SE
Southern	r_m	0.0269	(0.0082)	(0.0020)
East/Horn	r_m	0.0281	(0.0034)	(0.0012)
Central	r_m	0.0404	(0.0150)	(0.0025)
West Coast	r_m	0.0174	(0.0029)	(0.0007)
Sahel	r_m	0.0259	(0.0068)	(0.0013)
Southern	k_m	0.0069	(0.0020)	(0.0005)
East/Horn	k_m	0.0061	(0.0011)	(0.0002)
Central	k_m	0.0218	(0.0099)	(0.0006)
West Coast	k_m	0.0122	(0.0013)	(0.0004)
Sahel	k_m	0.0050	(0.0023)	(0.0006)

Table A10: Comparison of Standard Errors for Aggregate Results

	Quantity	Internal SE	External SE	Percent	Internal SE	External SE
Avg. Grain Price Index	–$0.25/kg	($0.01/kg)	($0.003/kg)	–46.4	(1.0)	(0.3)
Net Ag. Revenues	–$117.4 bill	($10.2 bill)	($3.8 bill)	–42.1	(1.7)	(0.7)
Expend. on Grains	–$226.4 bill	($14.1 bill)	($4.7 bill)	–44.1	(1.0)	(0.5)
Net Grain Imports	+32.0 mill t	(4.6 mill t)	(1.7 mill t)	+17.5	(1.8)	(1.1)
Trade Cost Expend.	–$65.5 bill	($3.0 bill)	($1.0 bill)	–72.8	(1.0)	(0.4)
Storage Cost Expend.	–$27.3 bill	($1.6 bill)	($0.5 bill)	–41.0	(2.0)	(0.5)
Outside Good Cons'n	+$109.0 bill	($4.7 bill)	($1.1 bill)	+2.08	(0.097)	(0.023)
Welfare (EV)	+$125.0 bill	($5.6 bill)	($1.4 bill)	+2.17	(0.097)	(0.024)

A7 Estimation: Trade Cost Parameters

Table A11, which begins on the next page, shows estimated trade costs τ_{mn} for each of the 413 overland links in my model. Each link is only listed once, i.e. a link with a given "Market 1" is only listed if its "Market 2" has not yet been listed as a "Market 1". Links are listed by country of "Market 1" (both domestic and overland international links are included). Distances are in kilometers, with cost per tonne-kilometer also reported. Observations listed are observations with trade on the last iteration in which trade costs for that particular link were estimated prior to convergence. Internal standard errors were obtained by bootstrapping (10,000 iterations) using this set of final-iteration observations for resampling with replacement. External standard errors were obtained using the 20 different initial guesses described in the previous section. Unlike the storage cost parameters, a substantial portion of the trade cost parameters (41%) have external standard errors that exceed their internal standard errors. However, as was shown in Table A10, the external standard errors for the aggregate counterfactual results are all much smaller than the associated internal standard errors.

Table A12, which follows Table A11, shows estimated trade costs τ_{mn} for the 47 links between 30 African ports and the world market (Bangkok for rice and the US Gulf for maize, sorghum, and wheat). Whether or not a port is linked to Bangkok and/or the US Gulf depends on its mix of crops. Observations and standard errors were obtained using the same procedure as for table A11. Over 70 percent of links have costs between \$0.10 and \$0.50/kg (\$100 – \$500/tonne). The lowest cost ports (\$70 – \$100/tonne) are Nacala (Mozambique), Mombasa (Kenya), Mogadishu (Somalia), and Dakar (Senegal) while the highest cost ports (>\$1000/tonne) are Luanda (Angola), Massawa (Eritrea), and Bissau (Guinea-Bissau).

Table A13, which follows Table A12, shows correlations between these port-to-world-market trade costs and port characteristics. Although none of the correlations are significant at the 5 percent level (which is likely due to the small sample size and the idiosyncratic nature of port costs), most of the point estimates have the expected signs, with higher costs correlated with smaller port populations, lower port volumes, lower Corruption Perception Indices, and higher import tariffs. Import tariffs were obtained for the relevant grains from the World Bank's World Integrated Trade Solution (WITS). "High Volume" is an indicator variable for whether the port handled more than 500,000 TEUs in 2007 (African Development Bank 2010).

Table A11: Estimated Overland Trade Costs (1/10)

	Market 1	Market 2	τ_{mn}	Intern. SE	Extern. SE	Observ.	Distance	/t-km
Botswana	Gaborone	Johannesburg	0.1142	(0.0076)	(0.0000)	52	366	0.3120
Lesotho	Maseru	Johannesburg	0.0707	(0.0087)	(0.0000)	31	420	0.1683
Malawi	Blantyre	Lilongwe	0.0536	(0.0236)	(0.0149)	2	365	0.1468
	Blantyre	Mangochi	0.0601	(0.0137)	(0.0095)	17	191	0.3147
	Blantyre	Milange	0.0883	(0.0185)	(0.0129)	14	115	0.7682
	Blantyre	Tete	0.0609	(0.0227)	(0.0266)	4	215	0.2835
	Karonga	Mzuzu	0.0530	(0.0088)	(0.0028)	21	222	0.2389
	Karonga	Mbeya	0.1131	(0.0359)	(0.0090)	5	161	0.7023
	Lilongwe	Mangochi	0.0558	(0.0097)	(0.0111)	5	272	0.2053
	Lilongwe	Mzuzu	0.0323	(0.0022)	(0.0055)	92	358	0.0901
	Lilongwe	Tete	0.0533	(0.0079)	(0.0072)	15	370	0.1441
	Lilongwe	Chipata	0.0644	(0.0044)	(0.0156)	95	145	0.4441
	Mangochi	Cuamba	0.0804	(0.0049)	(0.0072)	40	205	0.3924
	Mangochi	Lichinga	0.0665	(0.0139)	(0.0079)	14	221	0.3008
Mozamb.	Beira	Chimoio	0.0989	(0.0132)	(0.0124)	36	204	0.4848
	Beira	Quelimane	0.0424	(0.0100)	(0.0072)	12	487	0.0871
	Chimoio	Maxixe	0.1286	(0.0084)	(0.0215)	90	677	0.1900
	Chimoio	Quelimane	0.1516	(0.0179)	(0.0159)	20	552	0.2747
	Chimoio	Tete	0.1919	(0.0272)	(0.0009)	44	381	0.5036
	Chimoio	Mutare	0.0597	(0.0210)	(0.0133)	3	96	0.6218
	Cuamba	Lichinga	0.3503	(0.0528)	(0.0400)	9	315	1.1119
	Cuamba	Nampula	0.1566	(0.0242)	(0.0180)	46	358	0.4374
	Maputo	XaiXai	0.1047	(0.0112)	(0.0035)	34	216	0.4847
	Maputo	Mbabane	0.0997	(0.0117)	(0.0146)	24	221	0.4510
	Maputo	Johannesburg	0.2131	(0.0115)	(0.0098)	38	545	0.3910
	Maxixe	XaiXai	0.0738	(0.0111)	(0.0075)	30	256	0.2883
	Milange	Quelimane	0.0833	(0.0159)	(0.0223)	19	320	0.2603
	Nacala	Nampula	0.0744	(0.0141)	(0.0102)	27	192	0.3875
	Nampula	Pemba	0.0926	(0.0067)	(0.0022)	79	404	0.2293
	Nampula	Quelimane	0.0488	(0.0041)	(0.0119)	76	551	0.0885
	Pemba	Mtwara	0.1822	(0.0341)	(0.0270)	18	445	0.4095
	Tete	Chipata	0.1590	(0.0213)	(0.0194)	9	379	0.4196
	Tete	Harare	0.0324	(0.0075)	(0.0025)	14	383	0.0845
Namibia	KatimaMulilo	Oshakati	0.1634	(0.0137)	(0.0150)	14	1114	0.1467
	KatimaMulilo	Windhoek	0.1026	(0.0228)	(0.0093)	12	1226	0.0837
	KatimaMulilo	Livingstone	0.2864	(0.0345)	(0.0098)	10	208	1.3772
	KatimaMulilo	Mongu	0.3367	(0.0174)	(0.0077)	15	312	1.0792
	Oshakati	Windhoek	0.0902	(0.0118)	(0.0076)	14	716	0.1259
	Swakopmund	Windhoek	0.0279	(0.0040)	(0.0006)	16	362	0.0771
	Windhoek	Johannesburg	0.2600	(0.0058)	(0.0052)	16	1365	0.1905
Swaziland	Mbabane	Johannesburg	0.0894	(0.0062)	(0.0104)	89	357	0.2505

Table A11: Estimated Overland Trade Costs (2/10)

	Market 1	Market 2	τ_{mn}	Intern. SE	Extern. SE	Observ.	Distance	/t-km
Zambia	Chipata	Lusaka	0.0368	(0.0044)	(0.0023)	46	572	0.0644
	Kabwe	Kasama	0.1438	(0.0325)	(0.0142)	4	721	0.1994
	Kabwe	Kitwe	0.0425	(0.0023)	(0.0005)	119	221	0.1922
	Kabwe	Lusaka	0.0571	(0.0068)	(0.0027)	24	140	0.4081
	Kabwe	Mbeya	0.0921	(0.0228)	(0.0082)	14	986	0.0934
	Kasama	Mbeya	0.0935	(0.0142)	(0.0049)	11	400	0.2337
	Kasama	Sumbawanga	0.0902	(0.0113)	(0.0105)	17	287	0.3144
	Kitwe	Solwezi	0.0362	(0.0059)	(0.0054)	22	223	0.1625
	Kitwe	Lubumbashi	0.8285	(0.3733)	(0.1650)	5	187	4.4306
	Livingstone	Lusaka	0.0323	(0.0041)	(0.0062)	27	477	0.0678
	Livingstone	Mongu	0.0854	(0.0165)	(0.0015)	10	508	0.1680
	Livingstone	Hwange	0.1884	(0.0110)	(0.0003)	9	117	1.6103
	Lusaka	Mongu	0.0662	(0.0145)	(0.0086)	9	607	0.1091
	Lusaka	Harare	0.0807	(0.0092)	(0.0184)	24	493	0.1636
	Mongu	Solwezi	0.1750	(0.0106)	(0.0159)	3	591	0.2961
	Solwezi	Lubumbashi	0.4837	(0.0522)	(0.0415)	60	166	2.9139
Zimbabwe	Bulawayo	Harare	0.0344	(0.0081)	(0.0065)	32	447	0.0769
	Bulawayo	Hwange	0.0422	(0.0094)	(0.0039)	9	339	0.1245
	Bulawayo	Masvingo	0.1175	(0.0065)	(0.0143)	4	283	0.4152
	Bulawayo	Johannesburg	0.0805	(0.0214)	(0.0345)	10	863	0.0933
	Harare	Masvingo	0.0485	(0.0033)	(0.0087)	39	294	0.1648
	Harare	Mutare	0.0155	(0.0095)	(0.0042)	11	254	0.0608
	Masvingo	Mutare	0.0500	(0.0082)	(0.0018)	3	298	0.1678
	Masvingo	Johannesburg	0.1110	(0.0061)	(0.0162)	40	827	0.1342
Angola	Luanda	Kinshasa	1.0407	(0.0187)	(0.0795)	4	531	1.9599
	Luanda	Matadi	1.0745	(0.0667)	(0.0166)	4	920	1.1679
Burundi	Bujumbura	Gitega	0.0706	(0.0034)	(0.0074)	184	101	0.6986
	Bujumbura	Uvira	0.1002	(0.0060)	(0.0088)	60	31	3.2335
	Bujumbura	Butare	0.1755	(0.0554)	(0.0255)	7	162	1.0834
	Bujumbura	Kigoma	0.1225	(0.0090)	(0.0023)	34	229	0.5350
	Gitega	Muyinga	0.0842	(0.0031)	(0.0093)	183	96	0.8773
	Gitega	Kigoma	0.0847	(0.0192)	(0.0068)	18	218	0.3885
	Muyinga	Butare	0.0811	(0.0039)	(0.0044)	108	118	0.6871
	Muyinga	Mwanza	0.1016	(0.0134)	(0.0053)	33	423	0.2402
C.A.R.	Bambari	Bangassou	0.3381	(0.0386)	(0.1362)	48	353	0.9577
	Bambari	Bangui	0.6447	(0.0457)	(0.0224)	14	385	1.6744
	Bambari	Gbadolite	0.4744	(0.0806)	(0.1192)	23	250	1.8975
	Bangassou	Gbadolite	0.4891	(0.0863)	(0.0309)	11	290	1.6866
	Bangui	Impfondo	0.1576	(0.0259)	(0.0065)	5	320	0.4924
	Bangui	Zongo	0.4158	(0.0895)	(0.0269)	4	2	207.8856
Congo	Brazzaville	Impfondo	0.2016	(0.0489)	(0.0222)	9	780	0.2584
	Brazzaville	PointeNoire	0.1169	(0.0302)	(0.0152)	10	548	0.2133
	Brazzaville	Kinshasa	0.3888	(0.0602)	(0.0396)	14	4	97.2042
	Impfondo	Mbandaka	0.4169	(0.0229)	(0.0205)	10	352	1.1845

Table A11: Estimated Overland Trade Costs (3/10)

	Market 1	Market 2	τ_{mn}	Intern. SE	Extern. SE	Observ.	Distance	/t-km
D.R. Congo	Bandundu	Kikwit	0.3097	(0.0610)	(0.0871)	18	395	0.7841
	Bandundu	Kinshasa	0.3963	(0.0584)	(0.0239)	18	395	1.0033
	Bandundu	Mbandaka	0.4737	(0.0712)	(0.1274)	20	580	0.8167
	Bukavu	Goma	0.2805	(0.0366)	(0.0058)	42	199	1.4097
	Bukavu	Kindu	0.4623	(0.0291)	(0.1188)	119	695	0.6652
	Bukavu	Kisangani	0.3585	(0.0137)	(0.0507)	119	641	0.5593
	Bukavu	Uvira	0.3384	(0.0388)	(0.0320)	41	137	2.4700
	Bukavu	Butare	0.1966	(0.0163)	(0.0058)	48	147	1.3375
	Bunia	Butembo	0.3463	(0.0559)	(0.0344)	27	251	1.3798
	Bunia	Isiro	0.2737	(0.0321)	(0.0027)	40	486	0.5632
	Bunia	Kisangani	0.3564	(0.0127)	(0.0673)	120	706	0.5049
	Bunia	Juba	0.2254	(0.0131)	(0.0143)	59	633	0.3560
	Bunia	Arua	0.2819	(0.0170)	(0.0264)	5	256	1.1013
	Bunia	Gulu	0.3151	(0.0386)	(0.0094)	13	350	0.9004
	Butembo	Goma	0.3609	(0.0933)	(0.0316)	8	313	1.1531
	Butembo	Mbarara	0.1645	(0.0109)	(0.0104)	25	303	0.5430
	Gbadolite	Mbandaka	0.5745	(0.0806)	(0.1134)	2	675	0.8511
	Gbadolite	Zongo	0.5942	(0.1088)	(0.2071)	2	404	1.4708
	Goma	Gisenyi	0.1481	(0.0239)	(0.0019)	35	9	16.4538
	Isiro	Kisangani	0.4951	(0.1192)	(0.0507)	9	577	0.8581
	Isiro	Juba	0.2966	(0.0179)	(0.0417)	43	674	0.4401
	Kalemie	Kamina	0.3238	(0.0379)	(0.0061)	40	990	0.3271
	Kalemie	Kindu	0.4430	(0.0325)	(0.0667)	120	802	0.5524
	Kalemie	Uvira	0.7118	(0.2536)	(0.0940)	2	312	2.2814
	Kalemie	Kigoma	0.3550	(0.0467)	(0.0089)	31	148	2.3986
	Kamina	Kolwezi	0.3372	(0.0407)	(0.0035)	37	512	0.6586
	Kamina	Lubumbashi	0.2104	(0.0305)	(0.0125)	42	578	0.3640
	Kamina	MbujiMayi	0.2612	(0.0353)	(0.0165)	35	458	0.5702
	Kananga	Kisangani	0.3761	(0.0399)	(0.1105)	120	1282	0.2934
	Kananga	MbujiMayi	0.5579	(0.2753)	(0.1817)	6	179	3.1169
	Kananga	Tshikapa	0.7875	(0.2223)	(0.1986)	5	236	3.3371
	Kikwit	Kinshasa	0.3412	(0.0404)	(0.0211)	42	347	0.9832
	Kikwit	Tshikapa	0.4704	(0.0275)	(0.0473)	118	519	0.9064
	Kindu	Kisangani	0.4090	(0.1099)	(0.0281)	34	592	0.6910
	Kindu	MbujiMayi	0.7201	(0.1357)	(0.0422)	8	752	0.9576
	Kinshasa	Matadi	0.3663	(0.0257)	(0.0875)	117	362	1.0119
	Kinshasa	Mbandaka	0.3287	(0.0154)	(0.0557)	120	620	0.5302
	Kisangani	Mbandaka	0.1624	(0.0187)	(0.0025)	89	976	0.1664
	Kolwezi	Lubumbashi	0.2304	(0.0167)	(0.0404)	112	304	0.7578
	Mbandaka	Zongo	0.2274	(0.0318)	(0.0057)	55	672	0.3384
	Uvira	Kigoma	0.1787	(0.0165)	(0.0072)	54	172	1.0390

Table A11: Estimated Overland Trade Costs (4/10)

	Market 1	Market 2	τ_{mn}	Intern. SE	Extern. SE	Observ.	Distance	/t-km
Kenya	Eldoret	Kisumu	0.0508	(0.0156)	(0.0057)	10	117	0.4342
	Eldoret	Lodwar	0.2718	(0.0126)	(0.0007)	109	367	0.7406
	Eldoret	Nakuru	0.0224	(0.0017)	(0.0012)	64	155	0.1444
	Eldoret	Jinja	0.0693	(0.0054)	(0.0144)	25	268	0.2585
	Garissa	Mombasa	0.1514	(0.0117)	(0.0205)	103	463	0.3269
	Garissa	Nairobi	0.2024	(0.0201)	(0.0231)	36	366	0.5529
	Garissa	Wajir	0.1552	(0.0069)	(0.0383)	115	323	0.4804
	Garissa	Kismayo	0.2042	(0.0055)	(0.0105)	4	410	0.4981
	Kisumu	Nakuru	0.1075	(0.0207)	(0.0146)	5	183	0.5877
	Kisumu	Musoma	0.0743	(0.0046)	(0.0209)	82	307	0.2421
	Kisumu	Jinja	0.1623	(0.0054)	(0.0204)	25	238	0.6821
	Lodwar	Juba	0.1741	(0.0197)	(0.0476)	50	641	0.2716
	Mandera	Wajir	0.1687	(0.0237)	(0.0121)	11	420	0.4016
	Mandera	Baidoa	0.2629	(0.0125)	(0.0344)	109	269	0.9773
	Mandera	Awasa	0.1598	(0.0171)	(0.0140)	31	704	0.2270
	Mombasa	Nairobi	0.0246	(0.0014)	(0.0006)	108	500	0.0493
	Mombasa	Tanga	0.1103	(0.0138)	(0.0107)	14	164	0.6727
	Moyale	Wajir	0.4087	(0.0287)	(0.0792)	2	258	1.5839
	Moyale	Yabelo	0.0979	(0.0083)	(0.0000)	67	213	0.4594
	Nairobi	Nakuru	0.0388	(0.0033)	(0.0009)	39	159	0.2439
	Nairobi	Arusha	0.1556	(0.0003)	(0.0083)	2	269	0.5785
Rwanda	Butare	Gisenyi	0.0655	(0.0238)	(0.0033)	2	202	0.3240
	Butare	Kigali	0.0972	(0.0144)	(0.0037)	23	123	0.7906
	Gisenyi	Kigali	0.0905	(0.0082)	(0.0012)	49	151	0.5996
	Gisenyi	Mbarara	0.0785	(0.0115)	(0.0174)	7	299	0.2625
	Kigali	Mwanza	0.0786	(0.0329)	(0.0237)	11	533	0.1474
	Kigali	Mbarara	0.1409	(0.0342)	(0.0085)	10	242	0.5820
Somalia	Baidoa	Mogadishu	0.0604	(0.0037)	(0.0010)	112	247	0.2447
	Baidoa	Awasa	0.3026	(0.0446)	(0.0065)	6	891	0.3396
	Beledweyne	Galkayo	0.1293	(0.0062)	(0.0043)	176	389	0.3325
	Beledweyne	Mogadishu	0.0494	(0.0024)	(0.0005)	182	339	0.1459
	Beledweyne	Gode	0.0903	(0.0088)	(0.0025)	101	263	0.3432
	Beledweyne	Jijiga	0.1001	(0.0052)	(0.0156)	118	599	0.1672
	Bosaso	Garoowe	0.1210	(0.0065)	(0.0043)	191	443	0.2731
	Galkayo	Garoowe	0.4358	(0.0728)	(0.0852)	8	230	1.8947
	Garoowe	Hargeisa	0.3701	(0.0478)	(0.0708)	5	594	0.6230
	Hargeisa	Jijiga	0.1663	(0.0065)	(0.0016)	149	165	1.0081
	Kismayo	Mogadishu	0.0698	(0.0203)	(0.0095)	10	485	0.1438

Table A11: Estimated Overland Trade Costs (5/10)

	Market 1	Market 2	τ_{mn}	Intern. SE	Extern. SE	Observ.	Distance	/t-km
Tanzania	Arusha	Dodoma	0.0712	(0.0115)	(0.0083)	13	423	0.1682
	Arusha	Musoma	0.0693	(0.0122)	(0.0021)	27	504	0.1375
	Arusha	Singida	0.0642	(0.0104)	(0.0159)	37	350	0.1834
	Arusha	Tanga	0.0464	(0.0074)	(0.0019)	37	436	0.1065
	Bukoba	Mwanza	0.0628	(0.0086)	(0.0017)	63	434	0.1446
	Bukoba	Kampala	0.1363	(0.0114)	(0.0144)	2	299	0.4560
	Bukoba	Mbarara	0.1799	(0.0115)	(0.0251)	25	313	0.5747
	DaresSalaam	Dodoma	0.0669	(0.0128)	(0.0051)	47	449	0.1490
	DaresSalaam	Iringa	0.0686	(0.0038)	(0.0077)	174	501	0.1369
	DaresSalaam	Mtwara	0.0640	(0.0068)	(0.0047)	52	559	0.1144
	DaresSalaam	Tanga	0.0595	(0.0122)	(0.0023)	57	355	0.1675
	Dodoma	Iringa	0.0765	(0.0033)	(0.0046)	174	265	0.2886
	Dodoma	Singida	0.0925	(0.0112)	(0.0118)	37	250	0.3699
	Iringa	Mbeya	0.0740	(0.0069)	(0.0020)	74	336	0.2201
	Iringa	Songea	0.0594	(0.0030)	(0.0098)	134	436	0.1362
	Kigoma	Sumbawanga	0.1178	(0.0113)	(0.0046)	34	536	0.2197
	Kigoma	Tabora	0.1190	(0.0099)	(0.0083)	59	716	0.1663
	Mbeya	Songea	0.0622	(0.0031)	(0.0077)	132	423	0.1472
	Mbeya	Sumbawanga	0.0757	(0.0041)	(0.0106)	149	317	0.2388
	Mtwara	Songea	0.0996	(0.0129)	(0.0070)	20	655	0.1521
	Musoma	Mwanza	0.0743	(0.0089)	(0.0056)	67	223	0.3330
	Mwanza	Singida	0.1024	(0.0104)	(0.0085)	38	475	0.2156
	Mwanza	Tabora	0.0707	(0.0111)	(0.0048)	24	367	0.1927
	Singida	Tabora	0.1839	(0.0175)	(0.0078)	16	357	0.5151
Uganda	Arua	Gulu	0.0590	(0.0091)	(0.0128)	9	232	0.2545
	Arua	Juba	0.5288	(0.0422)	(0.0415)	12	336	1.5737
	Gulu	Kampala	0.0755	(0.0064)	(0.0235)	50	339	0.2227
	Gulu	Lira	0.0580	(0.0036)	(0.0072)	50	135	0.4293
	Gulu	Masindi	0.0877	(0.0059)	(0.0127)	14	175	0.5010
	Gulu	Juba	0.8681	(0.0850)	(0.0484)	15	281	3.0892
	Jinja	Kampala	0.0649	(0.0045)	(0.0129)	50	79	0.8214
	Kampala	Lira	0.0864	(0.0073)	(0.0017)	34	342	0.2527
	Kampala	Masindi	0.1442	(0.0459)	(0.0178)	3	214	0.6737
	Kampala	Mbarara	0.3276	(0.0673)	(0.0418)	3	265	1.2364
	Lira	Masindi	0.0702	(0.0090)	(0.0162)	14	180	0.3898
Djibouti	Djibouti	AddisAbaba	0.1481	(0.0192)	(0.0026)	53	920	0.1610
	Djibouti	Dessie	0.1333	(0.0151)	(0.0066)	98	548	0.2432
	Djibouti	DireDawa	0.1411	(0.0197)	(0.0080)	58	323	0.4368
Eritrea	Asmara	Massawa	0.4333	(0.0709)	(0.0000)	2	110	3.9394
	Asmara	Gondar	0.6112	(0.0419)	(0.2675)	16	538	1.1360
	Asmara	Mekele	0.5602	(0.0468)	(0.2156)	14	311	1.8012
	Asmara	Kassala	0.6892	(0.0533)	(0.2654)	16	428	1.6103

Table A11: Estimated Overland Trade Costs (6/10)

	Market 1	Market 2	τ_{mn}	Intern. SE	Extern. SE	Observ.	Distance	/t-km
Ethiopia	AddisAbaba	Awasa	0.0843	(0.0046)	(0.0049)	222	272	0.3100
	AddisAbaba	BahirDar	0.1069	(0.0112)	(0.0089)	44	551	0.1941
	AddisAbaba	Dessie	0.0612	(0.0059)	(0.0051)	59	385	0.1590
	AddisAbaba	DireDawa	0.0349	(0.0013)	(0.0011)	299	507	0.0688
	AddisAbaba	Jimma	0.0490	(0.0018)	(0.0041)	283	306	0.1600
	AddisAbaba	Nekemte	0.1202	(0.0064)	(0.0382)	147	325	0.3699
	Awasa	Gode	0.1498	(0.0068)	(0.0050)	134	629	0.2382
	Awasa	Jimma	0.1876	(0.0432)	(0.0326)	12	416	0.4509
	Awasa	Yabelo	0.1260	(0.0077)	(0.0059)	96	295	0.4271
	BahirDar	Dessie	0.0537	(0.0024)	(0.0032)	273	474	0.1134
	BahirDar	Gondar	0.0389	(0.0016)	(0.0020)	224	176	0.2208
	BahirDar	Nekemte	0.0575	(0.0027)	(0.0120)	148	399	0.1442
	BahirDar	AdDamazin	0.1034	(0.0058)	(0.0323)	112	466	0.2219
	Dessie	Gondar	0.0582	(0.0067)	(0.0023)	78	528	0.1102
	Dessie	Mekele	0.0603	(0.0053)	(0.0038)	103	388	0.1555
	DireDawa	Jijiga	0.1178	(0.0097)	(0.0099)	78	155	0.7597
	Gambela	Jimma	0.1162	(0.0050)	(0.0194)	136	420	0.2768
	Gambela	Nekemte	0.1511	(0.0056)	(0.0222)	92	390	0.3875
	Gambela	Malakal	0.2816	(0.0831)	(0.1943)	11	445	0.6328
	Gode	Jijiga	0.0934	(0.0092)	(0.0100)	40	572	0.1632
	Gondar	Mekele	0.0468	(0.0022)	(0.0158)	221	599	0.0781
	Gondar	AlQadarif	0.2117	(0.0274)	(0.0211)	31	357	0.5929
	Jimma	Nekemte	0.0875	(0.0055)	(0.0485)	155	244	0.3588
South Sudan	Bor	Malakal	0.4707	(0.0433)	(0.0358)	63	472	0.9971
	Bor	Juba	0.2114	(0.0215)	(0.0091)	37	200	1.0571
	Juba	Rumbek	0.7834	(0.0966)	(0.0227)	34	678	1.1554
	Malakal	AdDamazin	0.4076	(0.0322)	(0.1391)	80	484	0.8421
	Malakal	Kadugli	0.3680	(0.0331)	(0.0954)	79	334	1.1018
	Malakal	Kosti	0.3487	(0.0350)	(0.2340)	69	500	0.6975
	Rumbek	Wau	0.8301	(0.0749)	(0.0139)	42	226	3.6732
	Wau	Kadugli	0.4991	(0.0542)	(0.0012)	48	610	0.8182
Sudan	AdDamazin	AlQadarif	0.0683	(0.0032)	(0.0068)	169	523	0.1307
	AdDamazin	Khartoum	0.1124	(0.0081)	(0.0050)	89	533	0.2109
	AdDamazin	Kosti	0.0774	(0.0139)	(0.0054)	12	352	0.2198
	AlFashir	ElGeneina	0.1326	(0.0108)	(0.0068)	126	352	0.3768
	AlFashir	ElObeid	0.1442	(0.0127)	(0.0088)	98	613	0.2352
	AlFashir	Nyala	0.0755	(0.0089)	(0.0025)	72	194	0.3894
	AlQadarif	Kassala	0.0779	(0.0056)	(0.0037)	101	271	0.2873
	AlQadarif	Khartoum	0.0662	(0.0032)	(0.0024)	254	356	0.1859
	AlQadarif	Kosti	0.0360	(0.0018)	(0.0042)	209	396	0.0910
	ElGeneina	Nyala	0.1391	(0.0050)	(0.0180)	240	376	0.3700
	ElGeneina	Abeche	0.0555	(0.0026)	(0.0017)	217	197	0.2816
	ElObeid	Kadugli	0.0941	(0.0043)	(0.0250)	211	262	0.3592
	ElObeid	Kosti	0.0354	(0.0020)	(0.0006)	222	311	0.1139
	Kassala	PortSudan	0.0951	(0.0032)	(0.0068)	252	575	0.1654
	Khartoum	Kosti	0.0622	(0.0016)	(0.0013)	292	317	0.1963
	Khartoum	PortSudan	0.0611	(0.0037)	(0.0019)	214	821	0.0744

Table A11: Estimated Overland Trade Costs (7/10)

	Market 1	Market 2	τ_{mn}	Intern. SE	Extern. SE	Observ.	Distance	/t-km
Benin	Cotonou	Parakou	0.1162	(0.0129)	(0.0058)	37	425	0.2735
	Cotonou	Lagos	0.1875	(0.0154)	(0.0214)	113	120	1.5627
	Cotonou	Lome	0.0957	(0.0041)	(0.0129)	240	147	0.6513
	Malanville	Parakou	0.1461	(0.0763)	(0.0276)	4	320	0.4566
	Malanville	Niamey	0.0834	(0.0034)	(0.0055)	88	297	0.2810
	Malanville	Sokoto	0.1050	(0.0192)	(0.0026)	16	334	0.3144
	Natitingou	Parakou	0.1500	(0.0685)	(0.0193)	4	217	0.6914
	Natitingou	FadaNgourma	0.1718	(0.0287)	(0.0019)	15	253	0.6790
	Natitingou	Kara	0.1051	(0.0068)	(0.0071)	110	119	0.8833
	Parakou	Ibadan	0.1142	(0.0210)	(0.0066)	14	301	0.3794
	Parakou	Ilorin	0.1164	(0.0094)	(0.0921)	70	284	0.4099
	Parakou	Kara	0.1281	(0.0369)	(0.0237)	10	200	0.6407
Burkina	BoboDiou.	Dedougou	0.0222	(0.0016)	(0.0030)	82	179	0.1238
Faso	BoboDiou.	Ouagadougou	0.0228	(0.0014)	(0.0018)	82	356	0.0639
	BoboDiou.	Wa	0.1386	(0.0056)	(0.0224)	82	313	0.4429
	BoboDiou.	Mopti	0.0532	(0.0106)	(0.0139)	8	475	0.1120
	BoboDiou.	Segou	0.0675	(0.0055)	(0.0145)	4	377	0.1791
	BoboDiou.	Sikasso	0.0215	(0.0017)	(0.0012)	82	176	0.1223
	Dedougou	Ouagadougou	0.0263	(0.0013)	(0.0039)	128	225	0.1170
	FadaNgourma	Ouagadougou	0.0538	(0.0088)	(0.0024)	33	223	0.2414
	FadaNgourma	Niamey	0.1517	(0.0026)	(0.0036)	104	292	0.5196
	Ouagadougou	Bolgatanga	0.0955	(0.0170)	(0.0187)	20	212	0.4505
	Ouagadougou	Kara	0.1317	(0.0203)	(0.0203)	18	531	0.2481
Cameroon	Bamenda	Douala	0.0686	(0.0042)	(0.0070)	158	305	0.2248
	Bamenda	Yaounde	0.1053	(0.0031)	(0.0052)	200	368	0.2862
	Bamenda	Calabar	0.1774	(0.0268)	(0.0209)	20	331	0.5361
	Bamenda	Enugu	0.2563	(0.0205)	(0.0217)	2	511	0.5016
	Douala	Yaounde	0.1092	(0.0058)	(0.0010)	101	236	0.4627
	Douala	Calabar	0.1254	(0.0063)	(0.0086)	103	453	0.2768
	Douala	Enugu	0.1697	(0.0154)	(0.0117)	30	632	0.2685
	Garoua	Yaounde	0.1058	(0.0044)	(0.0145)	200	939	0.1127
	Garoua	Ndjamena	0.1142	(0.0136)	(0.0079)	39	495	0.2306
	Garoua	Maiduguri	0.0848	(0.0137)	(0.0046)	20	425	0.1995
	Garoua	Yola	0.1072	(0.0141)	(0.0038)	33	167	0.6421
	Yaounde	Libreville	0.2128	(0.0296)	(0.0091)	2	933	0.2281
Chad	Abeche	Ndjamena	0.0980	(0.0068)	(0.0042)	95	753	0.1301
	Moundou	Ndjamena	0.0796	(0.0053)	(0.0012)	84	474	0.1680
	Moundou	Sarh	0.0600	(0.0150)	(0.0038)	18	305	0.1969
	Ndjamena	Sarh	0.0700	(0.0059)	(0.0005)	103	558	0.1255
	Ndjamena	Maiduguri	0.0956	(0.0136)	(0.0073)	52	260	0.3678

Table A11: Estimated Overland Trade Costs (8/10)

	Market 1	Market 2	τ_{mn}	Intern. SE	Extern. SE	Observ.	Distance	/t-km
Cote d'Ivoire	Abengourou	Abidjan	0.1216	(0.0107)	(0.0120)	45	205	0.5932
	Abengourou	Bouake	0.2114	(0.0225)	(0.0537)	45	346	0.6108
	Abengourou	Kumasi	0.1612	(0.0146)	(0.0218)	45	266	0.6059
	Abidjan	Bouake	0.1468	(0.0127)	(0.0254)	50	351	0.4182
	Abidjan	Daloa	0.0968	(0.0128)	(0.0456)	51	385	0.2513
	Abidjan	Sek.Tak.	0.1635	(0.0274)	(0.0019)	19	321	0.5092
	Bouake	Daloa	0.1068	(0.0113)	(0.0222)	50	241	0.4432
	Bouake	Sikasso	0.0607	(0.0044)	(0.0113)	62	492	0.1234
	Daloa	Man	0.0979	(0.0137)	(0.0147)	52	188	0.5205
	Man	Odienne	0.0799	(0.0046)	(0.0050)	104	268	0.2982
	Man	Nzerekore	0.2739	(0.0497)	(0.0120)	4	205	1.3363
	Man	Gbarnga	0.0946	(0.0092)	(0.0017)	41	270	0.3505
	Odienne	Kankan	0.1197	(0.0107)	(0.0278)	39	301	0.3978
	Odienne	Bamako	0.0914	(0.0058)	(0.0112)	52	406	0.2251
Gambia	Banjul	Kaolack	0.1662	(0.0354)	(0.0259)	5	153	1.0864
	Banjul	Ziguinchor	0.0875	(0.0038)	(0.0040)	154	115	0.7612
Ghana	Accra	Ho	0.1589	(0.0307)	(0.0330)	31	156	1.0188
	Accra	Kumasi	0.1309	(0.0055)	(0.0231)	347	253	0.5175
	Accra	Sek.Tak.	0.1692	(0.0116)	(0.0564)	118	248	0.6824
	Accra	Lome	0.2492	(0.1001)	(0.0543)	5	192	1.2978
	Bolgatanga	Tamale	0.1485	(0.0541)	(0.0389)	2	172	0.8635
	Bolgatanga	Wa	0.0485	(0.0016)	(0.0036)	347	264	0.1839
	Ho	Tamale	0.1826	(0.0089)	(0.0446)	114	469	0.3893
	Ho	Kara	0.1503	(0.0263)	(0.0286)	4	462	0.3252
	Ho	Lome	0.2800	(0.0286)	(0.0247)	28	129	2.1704
	Kumasi	Sek.Tak.	0.1084	(0.0121)	(0.0128)	51	281	0.3858
	Kumasi	Tamale	0.1256	(0.0101)	(0.0148)	79	380	0.3305
	Kumasi	Wa	0.0860	(0.0045)	(0.0020)	222	446	0.1928
	Tamale	Wa	0.1587	(0.0287)	(0.0359)	2	303	0.5237
	Tamale	Kara	0.1221	(0.0058)	(0.0319)	260	258	0.4733
Guinea	Conakry	Kankan	0.1724	(0.0270)	(0.0196)	8	651	0.2648
	Conakry	Labe	0.2316	(0.0189)	(0.0216)	7	404	0.5733
	Conakry	Nzerekore	0.1077	(0.0220)	(0.0078)	3	845	0.1275
	Conakry	Freetown	0.3976	(0.0460)	(0.0288)	4	311	1.2786
	Kankan	Labe	0.0882	(0.0068)	(0.0067)	50	518	0.1703
	Kankan	Nzerekore	0.2030	(0.1054)	(0.0483)	2	450	0.4511
	Kankan	Bamako	0.1596	(0.0100)	(0.0243)	53	372	0.4291
	Labe	Nzerekore	0.1482	(0.0394)	(0.0244)	4	727	0.2039
	Labe	Bissau	0.2681	(0.0168)	(0.0985)	51	539	0.4974
	Labe	Tambacounda	0.1789	(0.0763)	(0.0000)	2	422	0.4240
	Nzerekore	Gbarnga	0.3618	(0.0372)	(0.0247)	6	168	2.1533
G. Bissau	Bissau	Ziguinchor	1.0714	(0.0736)	(0.0065)	46	145	7.3892
Liberia	Gbarnga	Monrovia	0.0513	(0.0060)	(0.0003)	33	196	0.2619
	Monrovia	Bo	0.2382	(0.0024)	(0.0265)	3	357	0.6671

Table A11: Estimated Overland Trade Costs (9/10)

	Market 1	Market 2	τ_{mn}	Intern. SE	Extern. SE	Observ.	Distance	/t-km
Mali	Bamako	Kayes	0.0644	(0.0023)	(0.0043)	264	613	0.1051
	Bamako	Segou	0.0383	(0.0015)	(0.0023)	192	236	0.1621
	Bamako	Sikasso	0.0416	(0.0061)	(0.0023)	28	364	0.1144
	Bamako	AdelBagrou	0.1103	(0.0070)	(0.0123)	82	431	0.2559
	Bamako	Tintane	0.3943	(0.0733)	(0.2202)	17	704	0.5601
	Gao	Mopti	0.0435	(0.0029)	(0.0065)	163	583	0.0747
	Gao	Niamey	0.1270	(0.0032)	(0.0099)	98	447	0.2842
	Kayes	Tintane	0.3863	(0.0759)	(0.2074)	17	563	0.6861
	Kayes	Tambacounda	0.0878	(0.0117)	(0.0031)	43	284	0.3092
	Mopti	Segou	0.0506	(0.0037)	(0.0030)	52	401	0.1263
	Segou	Sikasso	0.0385	(0.0044)	(0.0043)	33	291	0.1323
Mauritania	AdelBagrou	Tintane	0.2659	(0.0488)	(0.1617)	17	479	0.5552
	Nouakchott	Tintane	0.1165	(0.0277)	(0.0228)	4	747	0.1560
	Nouakchott	SaintLouis	0.4857	(0.0641)	(0.0360)	7	303	1.6029
Niger	Agadez	Arlit	0.0532	(0.0055)	0.0000	72	241	0.2207
	Agadez	Tahoua	0.0546	(0.0034)	(0.0068)	70	406	0.1344
	Agadez	Zinder	0.0771	(0.0024)	(0.0011)	193	446	0.1728
	Diffa	Zinder	0.0703	(0.0079)	(0.0068)	14	475	0.1479
	Diffa	Maiduguri	0.0764	(0.0048)	(0.0173)	32	220	0.3472
	Maradi	Niamey	0.1763	(0.0065)	(0.0250)	2	664	0.2654
	Maradi	Tahoua	0.1108	(0.0039)	(0.0160)	70	352	0.3148
	Maradi	Zinder	0.0325	(0.0095)	(0.0074)	11	238	0.1367
	Maradi	Katsina	0.0902	(0.0279)	(0.0100)	11	92	0.9803
	Maradi	Sokoto	0.1053	(0.0388)	(0.0146)	6	342	0.3080
	Niamey	Tahoua	0.0356	(0.0032)	(0.0044)	70	553	0.0643
	Niamey	Sokoto	0.0666	(0.0157)	(0.0057)	10	513	0.1298
	Tahoua	Sokoto	0.0783	(0.0051)	(0.0094)	36	230	0.3406
	Zinder	Kano	0.0700	(0.0230)	(0.0155)	8	240	0.2917

Table A11: Estimated Overland Trade Costs (10/10)

	Market 1	Market 2	τ_{mn}	Intern. SE	Extern. SE	Observ.	Distance	/t-km
Nigeria	Abuja	Ilorin	0.1351	(0.0727)	(0.0306)	2	453	0.2982
	Abuja	Jos	0.0656	(0.0024)	(0.0090)	288	275	0.2387
	Abuja	Kaduna	0.1263	(0.0259)	(0.0261)	8	211	0.5987
	Abuja	Lokoja	0.0963	(0.0062)	(0.0015)	144	202	0.4767
	Abuja	Makurdi	0.1837	(0.0716)	(0.0349)	4	283	0.6491
	Akure	BeninCity	0.1252	(0.0049)	(0.0299)	283	172	0.7282
	Akure	Ibadan	0.0957	(0.0030)	(0.0124)	282	178	0.5378
	Akure	Ilorin	0.1327	(0.0060)	(0.0036)	197	203	0.6539
	BeninCity	Enugu	0.1244	(0.0091)	(0.0221)	100	254	0.4899
	BeninCity	Ibadan	0.1798	(0.0054)	(0.0229)	278	282	0.6375
	BeninCity	Lagos	0.1629	(0.0660)	(0.0347)	13	326	0.4996
	BeninCity	Lokoja	0.1561	(0.0119)	(0.0069)	90	276	0.5657
	BeninCity	PortHarcourt	0.1326	(0.0061)	(0.0225)	287	332	0.3993
	Calabar	Enugu	0.1540	(0.0269)	(0.0072)	129	263	0.5857
	Calabar	PortHarcourt	0.2567	(0.0341)	(0.0165)	62	216	1.1886
	Enugu	Makurdi	0.1455	(0.0153)	(0.0117)	63	257	0.5662
	Enugu	PortHarcourt	0.1679	(0.0126)	(0.0226)	172	233	0.7204
	Enugu	Yola	0.1830	(0.0111)	(0.0054)	133	761	0.2404
	Gombe	Jos	0.0859	(0.0030)	(0.0142)	272	279	0.3080
	Gombe	Maiduguri	0.1146	(0.0457)	(0.0329)	3	319	0.3594
	Gombe	Yola	0.0862	(0.0092)	(0.0096)	96	250	0.3447
	Ibadan	Ilorin	0.0703	(0.0046)	(0.0019)	177	159	0.4420
	Ibadan	Lagos	0.2131	(0.0164)	(0.0181)	121	142	1.5005
	Ilorin	Kaduna	0.0573	(0.0056)	(0.0030)	127	492	0.1164
	Ilorin	Lokoja	0.2157	(0.0444)	(0.0373)	6	326	0.6617
	Ilorin	Sokoto	0.0678	(0.0024)	(0.0049)	276	682	0.0994
	Jos	Kaduna	0.0605	(0.0027)	(0.0077)	280	274	0.2208
	Jos	Kano	0.0791	(0.0030)	(0.0078)	284	392	0.2018
	Jos	Maiduguri	0.1016	(0.0206)	(0.0271)	4	587	0.1730
	Jos	Makurdi	0.0874	(0.0101)	(0.0121)	77	310	0.2818
	Kaduna	Kano	0.0529	(0.0026)	(0.0046)	288	233	0.2271
	Kaduna	Sokoto	0.0588	(0.0055)	(0.0010)	84	468	0.1255
	Kano	Katsina	0.0614	(0.0061)	(0.0013)	91	173	0.3547
	Kano	Maiduguri	0.0748	(0.0099)	(0.0088)	29	636	0.1176
	Kano	Sokoto	0.0912	(0.0297)	(0.0108)	7	540	0.1689
	Maiduguri	Yola	0.1032	(0.0167)	(0.0301)	62	406	0.2542
	Makurdi	Yola	0.0811	(0.0032)	(0.0311)	276	617	0.1314
Senegal	Dakar	Kaolack	0.0778	(0.0045)	(0.0016)	80	214	0.3636
	Dakar	SaintLouis	0.0457	(0.0022)	(0.0017)	152	245	0.1864
	Dakar	Touba	0.0752	(0.0027)	(0.0147)	135	181	0.4155
	Kaolack	Tambacounda	0.0404	(0.0033)	(0.0016)	73	375	0.1077
	Kaolack	Touba	0.0366	(0.0021)	(0.0030)	177	154	0.2379
	SaintLouis	Touba	0.0940	(0.0114)	(0.0092)	7	176	0.5341
	Tambacounda	Ziguinchor	0.1128	(0.0267)	(0.0152)	6	408	0.2765
S. Leone	Bo	Freetown	0.0622	(0.0076)	(0.0037)	25	237	0.2624
	Bo	Kabala	0.0679	(0.0153)	(0.0273)	18	253	0.2684
	Freetown	Kabala	0.0667	(0.0253)	(0.0102)	3	302	0.2209
Togo	Kara	Lome	0.1858	(0.0092)	(0.0118)	97	412	0.4510

Table A12: Estimated Port-to-World-Market Trade Costs

	Market 1	Market 2	τ_{mn}	Internal SE	External SE	Observ.
Mozambique	Beira	Gulf	0.1084	(0.0166)	(0.0036)	36
	Beira	Bangkok	0.2419	(0.0160)	(0.0057)	61
	Maputo	Gulf	0.1838	(0.0103)	(0.0146)	65
	Maputo	Bangkok	0.2092	(0.0083)	(0.0000)	120
	Nacala	Gulf	0.0732	(0.0096)	(0.0099)	28
	Nacala	Bangkok	0.2384	(0.0144)	(0.0078)	26
Namibia	Swakopmund	Gulf	0.2751	(0.0170)	(0.0128)	4
Angola	Luanda	Gulf	1.4519	(0.0116)	(0.0000)	4
Congo	PointeNoire	Bangkok	0.6152	(0.0649)	(0.0000)	10
D.R. Congo	Matadi	Gulf	0.3994	(0.0239)	(0.0019)	55
	Matadi	Bangkok	0.7986	(0.0492)	(0.0228)	57
Kenya	Mombasa	Gulf	0.1000	(0.0070)	(0.0030)	64
Somalia	Bosaso	Gulf	0.3319	(0.0142)	(0.0015)	184
	Kismayo	Gulf	0.1182	(0.0112)	(0.0012)	55
	Mogadishu	Gulf	0.0764	(0.0067)	(0.0062)	117
Tanzania	DaresSalaam	Gulf	0.1062	(0.0117)	(0.0032)	33
	DaresSalaam	Bangkok	0.3191	(0.0137)	(0.0181)	87
Djibouti	Djibouti	Gulf	0.0912	(0.0032)	0.0000	112
	Djibouti	Bangkok	0.2737	(0.0095)	(0.0000)	112
Eritrea	Massawa	Gulf	1.5038	(0.0754)	(0.3223)	9
Sudan	PortSudan	Gulf	0.2723	(0.0113)	(0.0017)	137
Benin	Cotonou	Gulf	0.2571	(0.0182)	(0.0211)	53
	Cotonou	Bangkok	0.4291	(0.0071)	(0.0016)	120
Cameroon	Douala	Gulf	0.3615	(0.0072)	(0.0091)	100
	Douala	Bangkok	0.2482	(0.0067)	(0.0014)	97
Cote d'Ivoire	Abidjan	Gulf	0.2730	(0.0127)	(0.0053)	26
	Abidjan	Bangkok	0.2413	(0.0178)	(0.0034)	25
Gabon	Libreville	Bangkok	0.5394	(0.0119)	(0.0006)	74
Gambia	Banjul	Gulf	0.3193	(0.0046)	(0.0154)	156
	Banjul	Bangkok	0.1151	(0.0093)	(0.0002)	61
Ghana	Accra	Gulf	0.2816	(0.0082)	(0.0188)	112
	Accra	Bangkok	0.4399	(0.0315)	(0.0830)	73
Guinea	Conakry	Bangkok	0.5813	(0.0478)	(0.0144)	9
Guinea Bissau	Bissau	Gulf	1.5468	(0.1344)	(0.0483)	8
	Bissau	Bangkok	0.4296	(0.0304)	(0.0336)	32
Liberia	Monrovia	Bangkok	0.1156	(0.0117)	(0.0007)	39
Mauritania	Nouakchott	Gulf	0.6870	(0.0536)	(0.0455)	11
	Nouakchott	Bangkok	0.1219	(0.0048)	(0.0024)	48
Nigeria	Lagos	Gulf	0.4879	(0.0309)	(0.0469)	47
	Lagos	Bangkok	0.5720	(0.0337)	(0.0055)	41
	PortHarcourt	Gulf	0.4651	(0.0096)	(0.0752)	147
	PortHarcourt	Bangkok	0.6436	(0.0201)	(0.0161)	74
Senegal	Dakar	Gulf	0.2202	(0.0062)	(0.0055)	88
	Dakar	Bangkok	0.0919	(0.0280)	(0.0020)	8
Sierra Leone	Freetown	Bangkok	0.2129	(0.0257)	(0.0000)	10
Togo	Lome	Gulf	0.3925	(0.0366)	(0.0317)	14
	Lome	Bangkok	0.3816	(0.0136)	(0.0030)	120

Table A13: Correlation of Port-to-World-Market Trade Costs with Port Characteristics

	(1)	(2)
Population $< 500,000$	0.184	0.169
	(0.151)	(0.142)
High volume	-0.0213	-0.0378
	(0.0990)	(0.124)
Corruption index	-0.0109	-0.0208
	(0.0102)	(0.0121)
LPI customs index	0.184	0.241
	(0.237)	(0.209)
GDP per capita	5.07E-05	4.89E-05
	(3.21E-05)	(3.02E-05)
Import tariff		4.06E-04
		(0.00176)
Constant	0.203	0.404
	(0.430)	(0.354)
Observations	47	43
Clusters	25	23

Note: Robust standard errors in () clustered by country. Tariff data was unavailable for Liberia and Somalia, so they and their 4 ports are excluded from column (2).

A8 Estimation: Price Differences Elsewhere

In this section, I assess whether my counterfactual trade costs of \$0.05/t-km for overland market links and \$50/tonne for port-to-world-market links are in line with observed price differences within the US and between major global maize ports. Importantly, I do not develop a full model of production, consumption, storage, and trade as I do for Africa, so I do not identify when and where trade occurs. The price differences I consider are thus lower bounds on the actual trade costs, with the upper end of the range of price differences likely closest to actual trade costs.

I start by considering price series of maize for the 8 major US markets included in the USDA Feed Grains Database. I identify 11 transportation links along which direct trade between pairs of these markets is feasible. The median pair-wise price difference across all 1,320 observations during my period of interest (May 2003 – April 2013) is \$0.012/t-km, with only 15 observations (1.1 percent) higher than \$0.05/t-km. Details for each link are shown in table A14. Given that the US is a major maize exporter through the Gulf ports near New Orleans, this evidence is highly suggestive that trade costs within the US rarely if ever exceed \$0.05/t-km.

Table A14: Domestic US Price Differences

Market 1	Market 2	Avg. Difference	Distance (km)	Avg. /t-km	Percent > \$0.05
Chicago	Minneapolis	0.0115	657	0.0175	0
Chicago	Omaha	0.0061	758	0.0081	0
Chicago	St. Louis	0.0053	478	0.0110	0.83
Chicago	Toledo	0.0036	394	0.0092	0
Kansas City	Minneapolis	0.0097	702	0.0139	0
Kansas City	Omaha	0.0035	303	0.0115	0
Kansas City	St. Louis	0.0077	399	0.0193	2.50
Memphis	New Orleans	0.0183	636	0.0287	6.67
Memphis	St. Louis	0.0039	455	0.0085	1.67
Minneapolis	Omaha	0.0075	615	0.0121	0
Minneapolis	St. Louis	0.0134	900	0.0148	0.83

I next consider prices at the major maize export ports for the US, Argentina, and Ukraine, which are the first, second, and fifth largest exporters of maize globally (Brazil and China are third and fourth). Pairing each of these three markets together and computing monthly price differences for my study period as above I find an average price difference of \$0.015 (\$15/tonne), with only 2.8 percent of observations higher than \$0.05 (\$50/tonne). Details for each pair are shown in table A15. Although these ports may not regularly trade directly with each other, this evidence suggests that trade costs between major global maize ports do not significantly exceed \$50/tonne.

Table A15: Price Differences Between Major Global Maize Ports

Market 1	Market 2	Avg. Difference	Percent > \$0.05
US Gulf	Argentina	0.0106	0
US Gulf	Ukraine	0.0185	3.96
Argentina	Ukraine	0.0170	4.95

A9 Results: Comparison to Static Annual Model

To implement a static annual model, I remove storage S_{imt} and associated costs r_m and k_m from the model. There are now 10 time periods (years) instead of 120 (months). In each time period, traders must decide how much of the local harvest H_{imt} to trade with other markets (T_{imnt}) and to sell for local consumption (Q_{imt}). The market clearing condition from the main paper becomes:

$$Q_{imt} = H_{imt} - \sum_{n \neq m} T_{imnt}$$

While the spatial arbitrage conditions still hold, there are no temporal arbitrage conditions, so equilibrium for each year can be solved independently. I proceed to re-estimate trade costs τ_{mn} using the same iterative algorithm as before with the price series from my baseline estimated model as my price data. Trade cost estimates converge in 6 iterations.

Trade cost estimates are 23.4 percent lower on average using the static annual model. The static annual model underestimates 12.2 percent of the trade cost parameters by 50–97 percent, 25.2 percent by 25–50 percent, 33.0 percent by 10–25 percent, and 19.1 percent by 2–10 percent. The percentage change for the remaining 10.4 percent of parameters is between –2 and +2 percent.

I next re-solve the model under counterfactual trade costs and compare equilibrium outcomes to those under the (underestimated) baseline trade costs. It is not surprising that the effects of reducing trade costs are smaller. The overall welfare gain is 33.6 percent smaller than under the dynamic monthly model with storage. Of the 229 markets excluding Johannesburg, the welfare effects for 23.6 percent are underestimated by 50–98 percent, 30.1 percent by 25–50 percent, 23.6 percent by 10–25 percent, and 7.4 percent by 0.5–10 percent, while 7.4 percent of markets have a welfare effect that changes sign and 7.9 percent of markets have a welfare effect that is overestimated.

The intuition for the underestimation of trade costs and welfare effects is clear from the example in figure A1. For ease of illustration, I consider a case in which trade occurs between an African port and the world market. The left panel shows baseline maize price series in Accra, Ghana and the US Gulf, as well as the parity price for imports from the US Gulf to Accra under baseline trade costs. As is clear from the figure, Accra is an importer of maize. In keeping with Proposition 2, traders in Accra store maize first and import maize later, so that maize prices are significantly below import parity at harvest time and then increase to reach import parity as local stocks are consumed. Whereas my dynamic model estimates trade costs using price differences during the months when trade occurs at the end of the harvest cycle (i.e. from the peaks in the blue line to the black line), the static annual model using farm-gate prices estimates trade costs at the beginning of the harvest cycle (i.e. from the troughs in the blue line to the black line). The static annual model underestimates trade costs between the US Gulf and Accra by 22 percent. The right panel shows counterfactual maize price series in Accra (in red) as well as the parity price for imports from the US Gulf to Accra under counterfactual trade costs. The welfare effect of lowering trade costs depends on the change in prices, which for the dynamic monthly model is the difference between the blue and the red lines. In contrast, in the static annual model the change in prices is the difference between the troughs in the blue line and the dashed black line. This change in prices is always less than in the dynamic monthly model. The static annual model underestimates the welfare effect of lowering trade costs for Accra by 24 percent.

For inland market pairs, the changes that take place under the counterfactual are less easily visualized as they depend on interactions between multiple markets. However, figure A2 illustrates the difference between the two models using baseline maize price series in Butembo, D.R. Congo

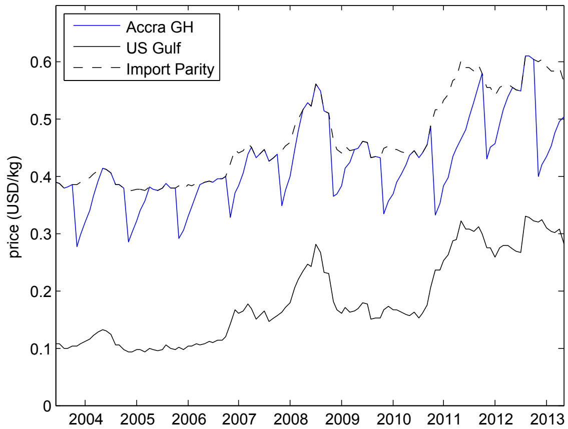

Figure A1: Maize Price Series for Accra, Ghana and the US Gulf Under Baseline and Counterfactual Trade Costs, May 2003 – April 2013

and Mbarara, Uganda, as well as the parity price for imports from Mbarara to Butembo under baseline trade costs. These markets are both in the equatorial zone with two annual harvests. As in the previous case, traders in Butembo store maize first and import maize later, so that maize prices are significantly below import parity at harvest time and then increase to reach import parity as local stocks are consumed. Again, the dynamic model estimates trade costs using price differences during the months when trade occurs at the end of the harvest cycle (i.e. from the peaks in the blue line to the black line), while the static annual model using farm-gate prices estimates trade costs at the beginning of the harvest cycle (i.e. from the troughs in the blue line to the black line). The static annual model underestimates trade costs between Mbarara and Butembo by 58 percent and the welfare effect of lowering trade costs for Butembo by 37 percent.

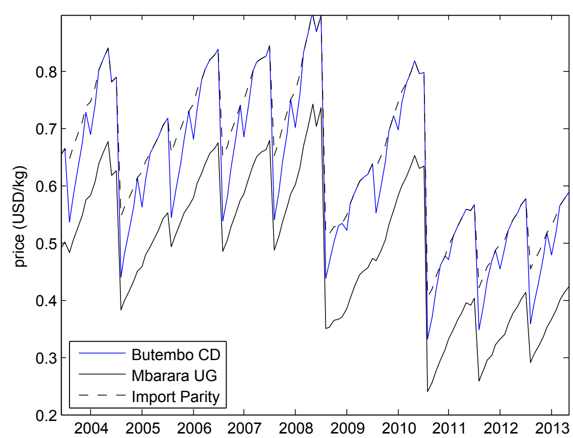

Figure A2: Maize Price Series for Butembo, D.R. Congo and Mbarara, Uganda Under Baseline Trade Costs, May 2003 – April 2013

A10 Results: Corridor Selection Exercise

This section describes in greater detail the selection of overland links for the trade corridor extension in the main paper. I first compared the absolute difference in welfare between the "only sea" scenario in which only port-to-world-market costs are reduced and the main counterfactual in which all trade costs are reduced. Table A16 shows these differences for the 34 markets with a welfare difference of over $500 million equivalent variation, which together account for 65.5 percent of the total welfare difference. 28 of these 34 markets are from only 4 countries (Nigeria, South Sudan, Sudan, and Ethiopia). I then identified 30 critical links for closing the welfare gap by looking at equilibrium trade flows to and from each of the 34 markets.

Of the 34 markets in Table A16, 6 (Enugu, Benin City, and Ibadan, Nigeria; Wau, Rumbek, and Juba, South Sudan) have a welfare difference of over $2 billion equivalent variation each. I identified 6 critical links (in bold) for these markets and tried reducing trade costs along each of these links individually or in combination in order to identify the 1 and 5 links for which trade cost reduction would have the biggest effect (reported in the main paper).

Table A17 shows the 24 markets in 14 countries which have a welfare gap of over $300 million equivalent variation after my initial reduction of trade costs along the 30 critical links. I proceeded to identify an additional 45 links important for closing the welfare gap for these markets. 88 percent of the welfare gains from reducing trade costs everywhere can be achieved by lowering trade costs on the 75 links in tables A16 and A17 along with port-to-world-market trade costs. A map of the 75 targeted links is included in figure A3.

My corridor selection exercise suggests that certain types of trade corridors may be particularly beneficial. First, reducing trade costs all the way from the world market to "dry ports" in densely-populated inland areas can achieve significant welfare gains even if trade costs to areas further inland remain high. Table A18 shows the welfare effects of reducing trade costs along a single link between the port of Matadi in the Democratic Republic of Congo and the capital city Kinshasa. The table compares the potential gains from trade cost reduction on all links with the gains achieved by reducing trade costs on this single link, both for Kinshasa and for the seven further inland markets in western D.R. Congo that are either directly linked to Kinshasa or have only a single market in between. Reducing trade costs for this one link results in 53.7 percent of the welfare gain achievable by reducing trade costs on all 11 links connecting these markets. This is due both to the large population in the Kinshasa market catchment, which accounts for 39.5 percent of the potential welfare gains for the eight markets, as well as the secondary effects on the other seven markets, which achieve 26.9 percent of their potential welfare gains as lower prices in Kinshasa translate into lower prices everywhere despite continued high trade costs further inland.

Second, reducing trade costs along major inland corridors with significant imbalances or fluctuations in production and consumption can lead to major gains. My second, 75-link corridor counterfactual includes trade cost reduction along the complete east-west trans-Sahelian highway from Dakar, Senegal to Port Sudan, Sudan (22 links). This route traverses 7 countries (including 4 land-locked countries) which are major producers of millet and sorghum and include 6 of the 8 countries with the highest estimated per-capita grain demand parameters (A_m). The Sahel is also subject to large fluctuations in local harvests due to its arid climate and erratic rainfall. Of a total possible welfare gain of $65.2 billion equivalent variation from reducing trade costs on all 413 overland links, the 23 markets on the trans-Sahelian highway gain $9.1 billion (14.0 percent) in my 75-link corridor counterfactual. This figure increases to $15.2 billion (23.3 percent) when the 35 markets with direct connections to one of these 23 markets are included.

Finally, targeting inland areas isolated by extreme trade costs can lead to very large gains. The five markets of South Sudan are perhaps the continent's most isolated grain deficit areas. Together they account for $10.5 billion (16.1 percent) of the total possible welfare gain from reducing trade costs on all 413 overland links. My 75-link corridor counterfactual achieves all of these gains.

Table A19 lists the 90 links corresponding most closely to the proposed Trans-African Highways. The table is organized according to the 9 proposed highways (African Development Bank and UNECA 2003). The first 4 highways all begin in North Africa – the portions of these highways in and connecting to North Africa are excluded as they are not part of my network. Otherwise, I have kept as close to the proposed routes as possible. If a link is on more than one highway it is only listed once. Several of the highways are not complete in my network due to missing markets from my ideal list (in Angola, Cameroon, Central African Republic, and Guinea).

Table A16: Initial Targeting of 30 Overland Links

Country	Market	Welfare Diff.	30 Targeted Links
Nigeria/	Enugu	3187	**PortHarcourt–Enugu**
Niger	BeninCity	2969	**Lagos–BeninCity**
	Ibadan	2542	**Lagos–Ibadan**
	PortHarcourt	1776	Enugu–Makurdi
	Kano	1547	Kano–Katsina
	Lagos	1386	BeninCity–Enugu
	Akure	1294	Ibadan–Ilorin
	Calabar	931	PortHarcourt–Calabar
	Tahoua	668	Katsina–Maradi
	Maiduguri	658	Kaduna–Kano
	Makurdi	593	Makurdi–Jos
	Ilorin	575	Ilorin–Kaduna
	Lokoja	569	Jos–Kano
	Gombe	523	
	Maradi	520	
South Sudan/	Wau	2527	**Rumbek–Wau**
Sudan/	Rumbek	2473	**Juba–Rumbek**
Uganda	Juba	2071	**Gulu–Juba**
	Malakal	1723	Kosti–Malakal
	Bor	1718	Juba–Bor
	Nyala	1620	Kosti–ElObeid
	AlFashir	1098	ElObeid–AlFashir
	ElGeneina	869	AlFashir–ElGeneina
	Kosti	611	Khartoum–Kosti
	Mbarara	573	Kampala–Mbarara
			Kampala–Gulu
Ethiopia	Awasa	1176	AddisAbaba–Awasa
	Dessie	1003	Djibouti–Dessie
	BahirDar	977	AddisAbaba–BahirDar
	AddisAbaba	852	Djibouti–AddisAbaba
	Yabelo	711	
	Mekele	658	
Mali	Bamako	912	
D.R. Congo	Kinshasa	876	Matadi–Kinshasa
Ghana	Kumasi	560	Accra–Kumasi

Table A17: Targeting of 45 Additional Overland Links

Country	Market	Welfare Diff.	45 Additional Targeted Links
Nigeria/	Maiduguri	915	Kano–Maiduguri
Niger/	Akure	610	Ibadan–Akure
Chad	Zinder	586	Maradi–Zinder
	Lokoja	491	BeninCity–Lokoja
	Gombe	468	Jos–Gombe
	Ndjamena	451	Maiduguri–Ndjamena
	Tahoua	405	Maradi–Tahoua
			Maradi–Niamey
			Ndjamena–Abeche
South Sudan/	Wau	1578	Kadugli–Wau
Sudan/	Juba	966	ElObeid–Kadugli
Uganda	Bor	910	Malakal–Bor
	Kampala	875	Jinja–Kampala
	Rumbek	767	Abeche–ElGeneina
	Nyala	679	AlFashir–Nyala
	Mbarara	404	Kigali–Mbarara
			Mombasa–Nairobi
			Nairobi–Nakuru
			Nakuru–Eldoret
			Eldoret–Jinja
			PortSudan–Kassala
			Kassala–AlQadarif
			AlQadarif–Kosti
Ethiopia/	Yabelo	353	Awasa–Yabelo
Eritrea	Asmara	349	Massawa–Asmara
	Gambela	311	Gambela–Malakal
			Nekemte–Gambela
			AddisAbaba–Nekemte
Mali	Bamako	807	Bamako–Kayes
			Kayes–Tambacounda
			Tambacounda–Kaolack
			Kaolack–Dakar
			Sikasso–Bamako
			BoboDioulasso–Sikasso
			Ouagadougou–BoboDioulasso
			FadaNgourma–Ouagadougou
			Niamey–FadaNgourma
Ghana	Bolgatanga	371	Ouagadougou–Bolgatanga
			Bolgatanga–Tamale
			Tamale–Kumasi
D.R. Congo	Kisangani	342	Gulu–Bunia
	Lubumbashi	303	Kitwe–Lubumbashi
Guinea	Labe	333	Conakry–Labe
Zambia	Chipata	326	Chipata–Lilongwe
Cameroon	Yaounde	302	Douala–Yaounde

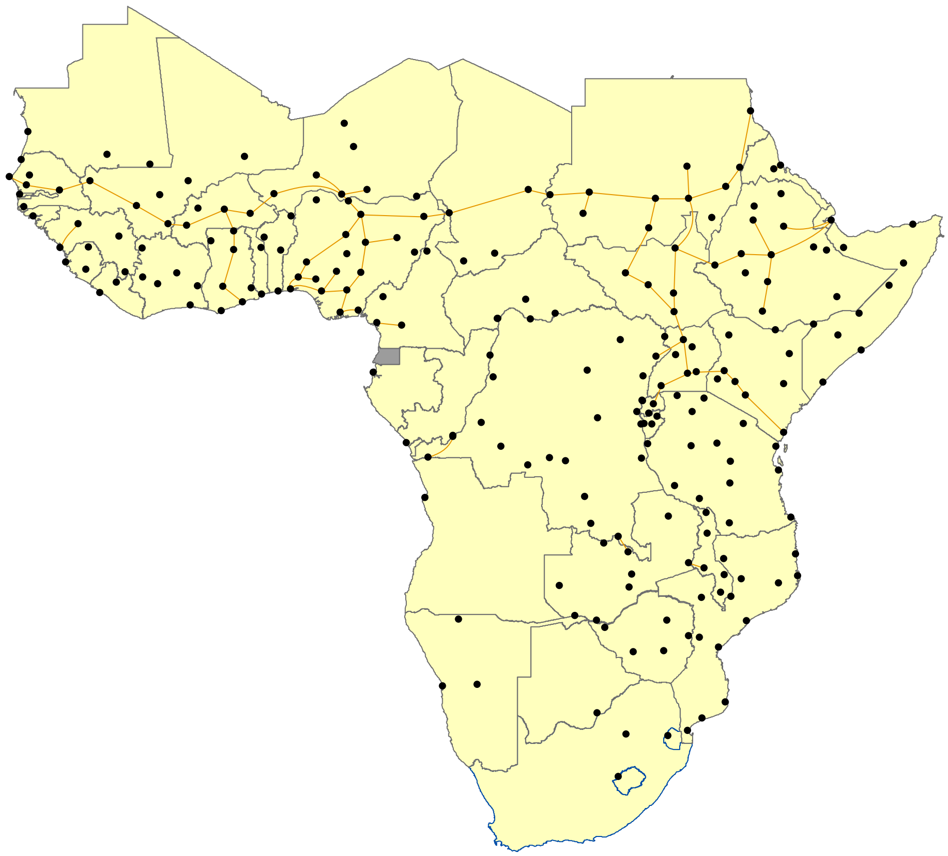

Figure A3: Map of 75 Targeted Links

Table A18: Welfare Effects of Trade Cost Reduction for Single Link (Matadi-Kinshasa, D.R.C.)

	Potential Gains	Achieved Gains	Percent Achieved
Kinshasa	876.4	831.2	94.8
Bandundu	93.3	32.6	34.9
Gbadolite	191.5	4.9	2.6
Kisangani	461.7	119.8	25.9
Kikwit	154	44.5	28.9
Mbandaka	207.3	100.4	48.4
Tshikapa	83.2	8.3	10.0
Zongo	153.4	50.8	33.1
Total	2220.8	1192.5	53.7

Table A19: 90 Links Corresponding to Proposed Trans-African Highways

Highway	Affected Countries	Corresponding Links
Cairo–Dakar	Mauritania / Senegal	Nouakchott–SaintLouis, SaintLouis–Dakar
Algiers–Lagos	Niger / Nigeria	Arlit–Agadez, Agadez–Zinder, Zinder–Kano, Kano–Kaduna, Kaduna–Ilorin, Ilorin–Ibadan, Ibadan–Lagos
Tripoli–Windhoek	Congo / D.R. Congo	Brazzaville–Kinshasa, Kinshasa–Luanda
Cairo–Gaborone	Sudan / Ethiopia / Kenya / Tanzania / Zambia / Zimbabwe / Botswana	Khartoum–AlQadarif, AlQadarif–Gondar, Gondar–BahirDar, BahirDar–AddisAbaba, AddisAbaba–Awasa, Awasa–Yabelo, Yabelo–Moyale, Moyale–Wajir, Wajir–Garissa, Garissa–Nairobi, Nairobi–Arusha, Arusha–Dodoma, Dodoma–Iringa, Iringa–Mbeya, Mbeya–Kabwe, Kabwe–Lusaka, Lusaka–Livingstone, Livingstone–Hwange, Hwange–Bulawayo, Bulawayo–Johannesburg, Johannesburg–Gaborone
Dakar–N'Djamena	Senegal / Mali / Burkina Faso / Niger Nigeria / Chad	Dakar–Kaolack, Kaolack–Tambacounda, Tambacounda–Kayes, Kayes–Bamako, Bamako–Sikasso, Sikasso–BoboDioulasso BoboDioulasso–Ouagadougou, Ouagadougou–FadaNgourma, FadaNgourma–Niamey, Niamey–Maradi Maradi–Katsina, Katsina–Kano, Kano–Maiduguri, Maiduguri–Ndjamena
N'Djamena–Djibouti	Chad / Sudan / Ethiopia / Djibouti	Ndjamena–Abeche, Abeche–ElGeneina, ElGeneina–AlFashir, AlFashir–ElObeid, ElObeid–Kosti, Kosti–AlQadarif, Gondar–Dessie, BahirDar–Dessie, Dessie-Djibouti
Dakar–Lagos	Senegal / Gambia / Guinea Bissau / Guinea / Sierra Leone / Liberia / Cote d'Ivoire / Ghana / Togo / Benin / Nigeria	Kaolack–Banjul, Banjul–Ziguinchor, Ziguinchor–Bissau, Conakry–Freetown, Freetown–Bo, Bo–Monrovia, Monrovia–Gbarnga, Gbarnga–Man, Man–Daloa, Daloa–Abidjan, Abidjan–SekondiTakoradi, SekondiTakoradi–Accra, Accra–Lome, Lome–Cotonou, Cotonou–Lagos
Lagos–Mombasa	Nigeria / Cameroon / D.R. Congo / Uganda / Kenya	Lagos–BeninCity, BeninCity–Enugu, Enugu–Bamenda, Bamenda–Yaounde, Kisangani–Bunia, Bunia–Butembo, Butembo–Mbarara, Mbarara–Kampala, Kampala–Jinja, Jinja–Eldoret, Eldoret–Nakuru, Nakuru–Nairobi, Nairobi–Mombasa
Beira–Lobito	Mozambique / Zimbabwe / Zambia / D.R. Congo	Beira–Chimoio, Chimoio–Mutare, Mutare–Harare, Harare–Lusaka, Kabwe–Kitwe, Kitwe–Lubumbashi Lubumbashi–Kolwezi