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Transportation market analysis and procurement stategies in developing countries

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Transportation procurement for food aid distribution in Ethiopia

- Project in collaboration with the World Food Programme in Ethiopia (WFP)
  - Know-how in the areas of food security analyses, nutrition, food procurement and logistics (transportation and warehousing)

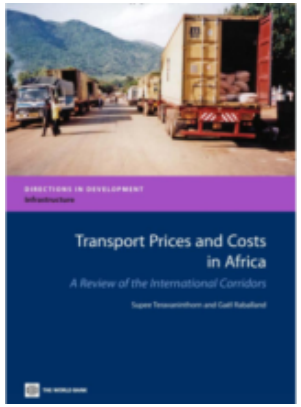
- Context
  - Ethiopia is the world food aid most dependant country (Devereau, 2000)
  - **Between 1988 and 2011, the WFP delivered about 896,000 MT of food aid per year on average (22,440 TL/year or 61 TL/day)**
  - Railways are inoperable and only 22% of the roadways are paved
  - **Transportation procurement and truckload operations processes similar to those of the commercial sector**

Transportation markets in Africa

- Africa's competiveness suffers from high transportation costs (Thoburn, 2002)
- Particularly for Sub-Saharan African countries, where the average freight costs are 20% higher than those of other countries (UNIDO, 1996)
- No significant growth in trade due to major structural and policy obstacles
  - High transportation costs
  - Lack of standardized logistics processes (e.g. packaging and quality control systems) and innovation
- Different markets across African regions
- Data collection is largely inadequate in most African countries (Teravaninthorn and Raballand, 2010)

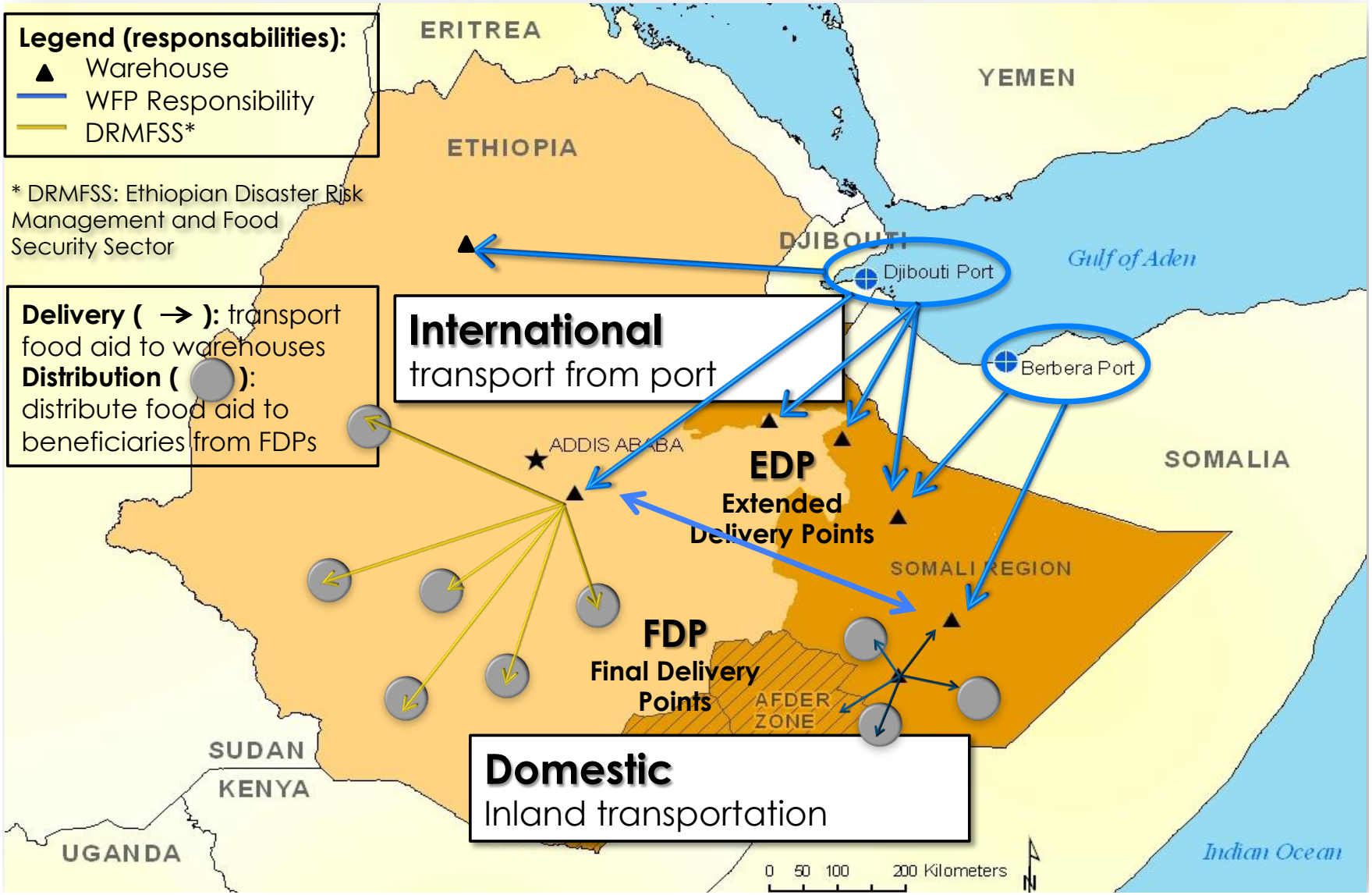
Market analysis and transportation procurement for food aid in Ethiopia

- Transportation markets in developing countries are poorly understood
  - Lack of available data and diagnostic frameworks
  - High transportation prices?



- Determining whether a shipper pays the "right" price for transportation services is a complex task
- Explain the transportation procurement costs in Ethiopia through multiple regression analysis

Food aid transportation in Ethiopia



Transportation procurement

- WFP contracts third-party transporters rather than rely on a private fleet
- Use a Request for Quotation (RFQ) mechanism
- Invite a core set of transporters to submit rate proposals (bids) on specific lanes every 6 months
- Determine the transportation tariffs and winning carriers with the RFQ

WFP's core set of transporters

- The quality of service will mainly depend on the performance of the selected carriers
- Importance of monitoring their carriers and updating their shortlist in order to only keep carriers that match their standards
- At the time of data collection, their core set of transporters was composed of 75 carriers
  - 70% of the transporters registered at the Ethiopian Road Transport Authority

Ground transportation
International vs domestic

- Operations: differences in quantity of goods to be transported, loading and offloading, road conditions, escorts, etc.
- Trucks: larger for international (40 MT) than for domestic (5 to 40 MT)
- Pricing scheme and business repartition

International

Domestic

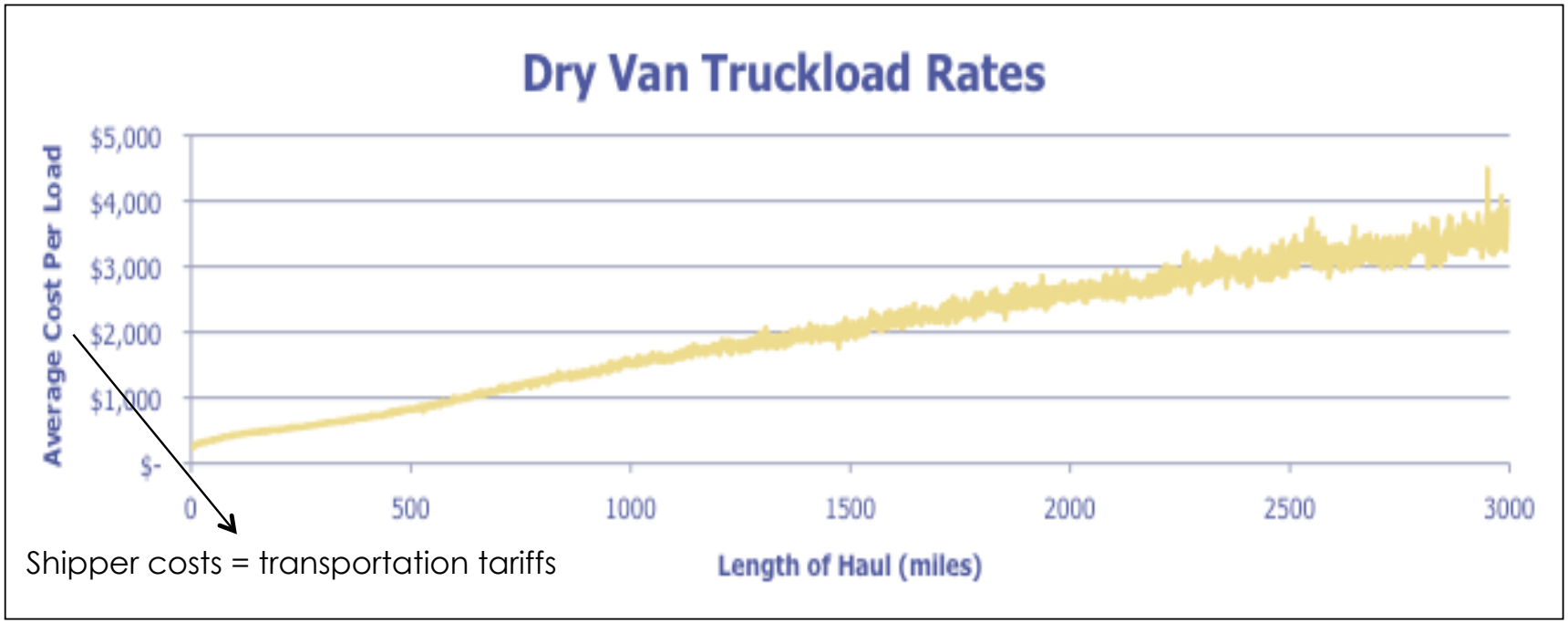
Pricing mechanism

- Domestic: lowest bid
- International: benchmark rates with rate offers and other market prices (cement, fertilizer, …)

Core set of carriers

Lane (origin, destination)		Distance	Estimated tonnage	Transporter 1 (Birr/MT)	Transporter 2 (Birr/MT)	Transporter 3 (Birr/MT)	Transporter 4 (Birr/MT)	…	Transporter m (Birr/MT)
(o_1, d_1)		km_1	ton_1	$Bid_{1,1}$	-	Benchmark	$d_{1,4}$		$Bid_{1,m}$
(o_1, d_2)		km_2	-	$Bid_{2,1}$	$Bid_{2,2}$	-	$Bid_{2,4}$		$Bid_{2,m}$
(o_1, d_3)		km_3	ton_3	**Lowest bids**	$Bid_{3,2}$	Benchmark	-		$Bid_{3,m}$
…									…
(o_1, d_n)		km_n	ton_n	$Bid_{n,1}$	$Bid_{n,2}$	Benchmark	$_{n,4}$		$Bid_{n,m}$

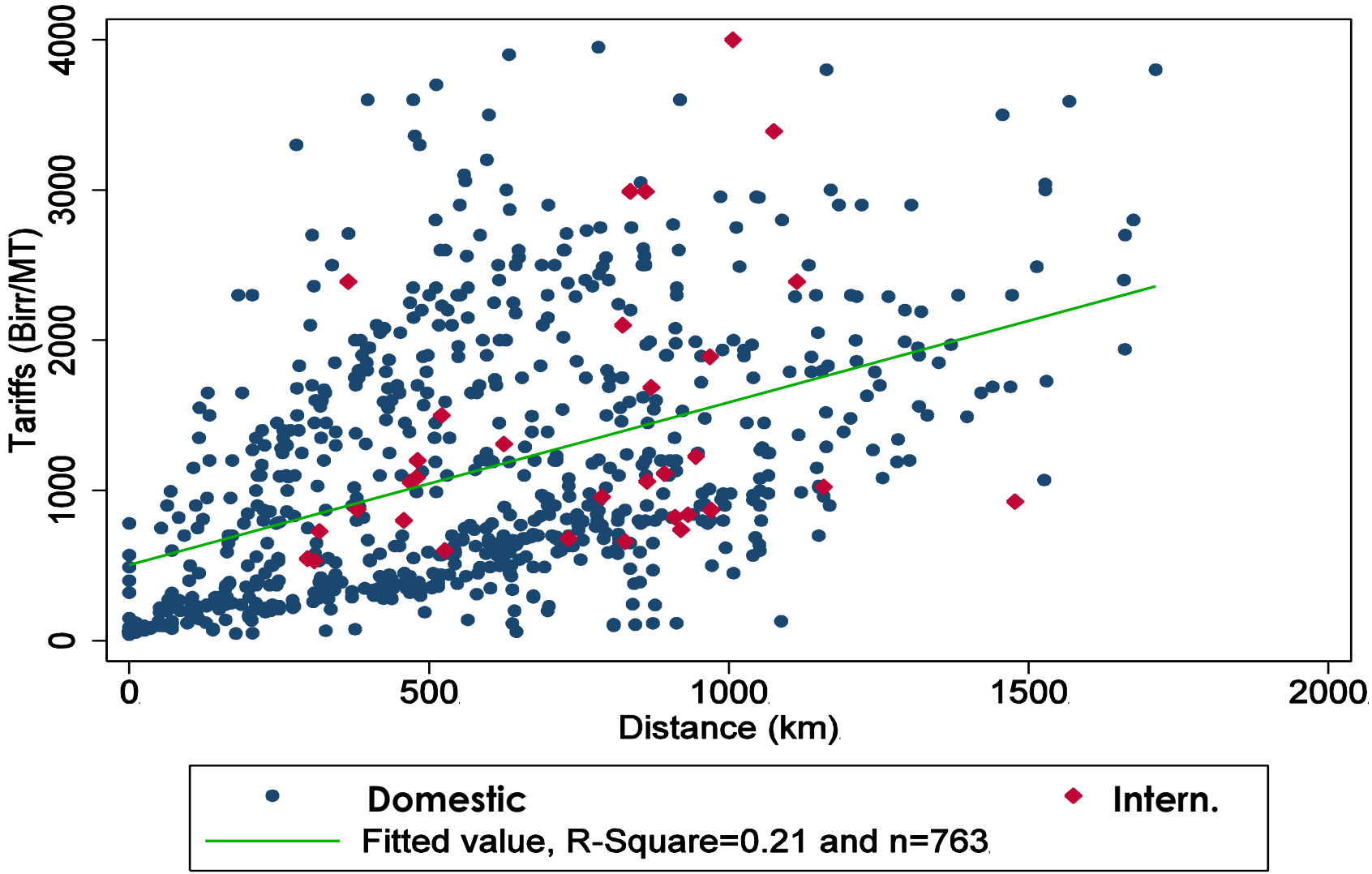
Transportation tariffs in North America



Slide source: Chris Caplice, MIT CTL. Data source: Chainalytics LLC.

In North America, distance alone explains about 80% to 85% of the variability in prices

Transportation tariffs in Ethiopia



Methodology

- Multivariate linear models to explain transportation tariffs

$$\ln(tariff) = f(C, M, E) + \varepsilon ,$$

Where ε is the random error due to unobservable factors

- Three categories of independent variables
  - Linehaul cost drivers (*C*)
  - Market structure (*M*)
  - Socio-economic factors (*E*)

Data sources

- Data provided by the WFP (**linehaul cost drivers and market structure**)
  - An RFQ executed by the WFP in Ethiopia
  - About 11,000 observations (bids)
  - Contracts derived from this RFQ were valid from September 2010 to March 2011
- Data published by the Central Statistical Agency (**socio-economic factors**)
  - Population
  - Agricultural production
  - Number of manufactures of the major industrial groups
  - Number of major livestock types

Linehaul cost drivers (C)

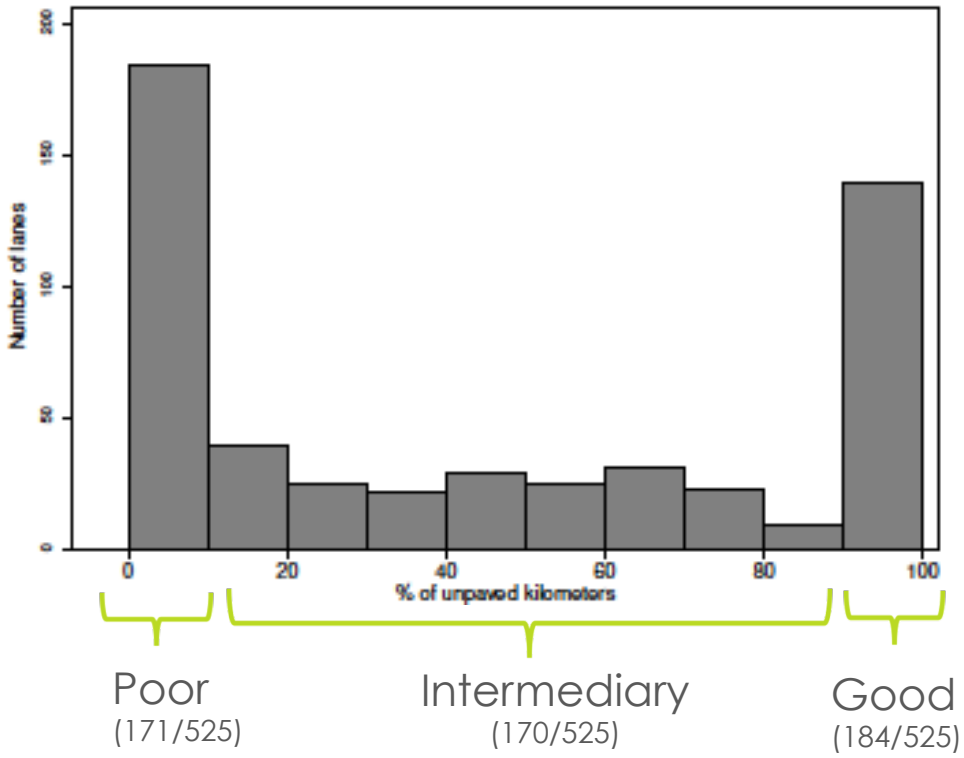
- Lane-specific variables which directly affect carrier costs
  - Distance
  - Estimated tonnage to be transported
- Variables specific to the developing country context
  - Road quality (paved and unpaved distances)
  - Risk perception (WFP categories) and indicators for transportation within the Somali region of Ethiopia

Dealing with an incomplete data set

- Some information was not given or specified on certain lanes
- In order to limit the number of observations to discard, we have created categorical variables
  - Road quality based on paved and unpaved distances (only for the domestic market)
  - Estimated tonnage
  - WFP's risk perception
    - None in Somali region (Domestic)
    - Low in Somali region (Domestic)
    - High in Somali region (International and Domestic)
    - Not specified in Somali region (International and Domestic)
    - Not specified for other regions than Somali (International and Domestic)*

* Category of reference

Road quality



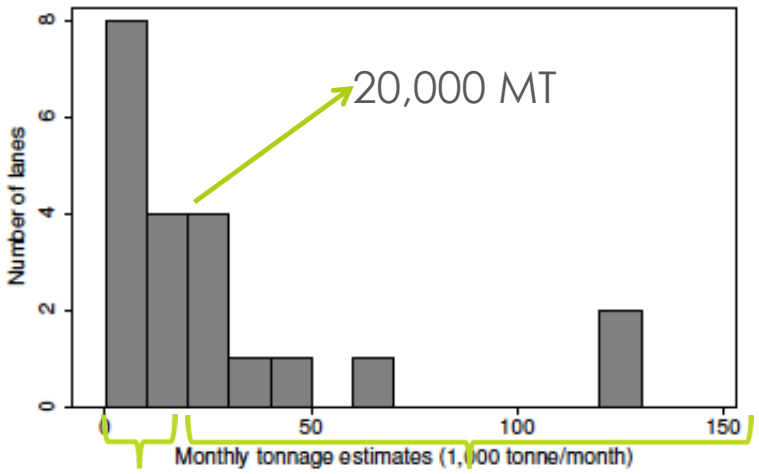
Domestic

- Categorical variable
  - Good (184/731)
  - Intermediate (170/731)
  - Poor (171/731)
  - Unknown (262/731)

Tonnage estimates

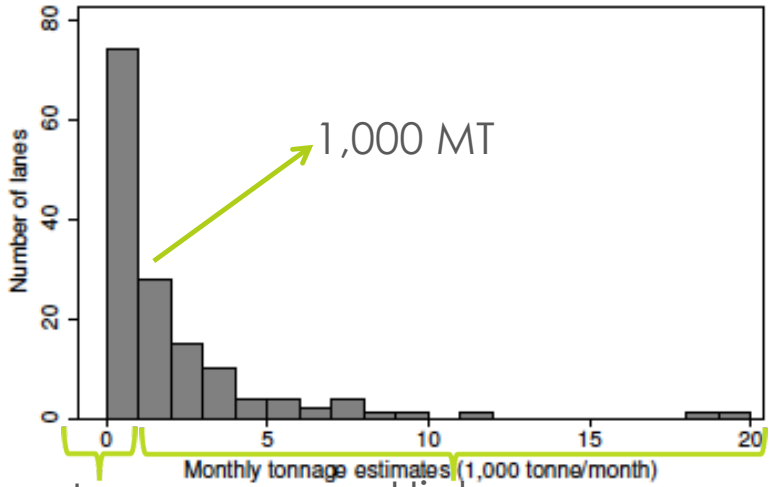
International

- Low (12/32) ; High (9/32) ; Not specified (11/32)



Domestic

- Low (66/731) ; High (65/731) ; Not specified (600/731)



Market structure (M)

- The truckload transportation market in Ethiopia is not mature, which could lead to large markups
- Considering variables to measure the impact of the market structure
  1. Competition intensity
  2. Market dispersion
  3. Market concentration

Market structure (M)

- Information from the bid distribution used as a proxy to measure the impact of market structure on transportation tariffs

Lane (origin, destination)	**Tariff (Birr/MT)**	**Distance**	**Estimated tonnage**	**Transporter 1 (Birr/MT)**	**Transporter 2 (Birr/MT)**	**Transporter 3 (Birr/MT)**	**Transporter 4 (Birr/MT)**	**…**	**Transporter m (Birr/MT)**
(o_1, d_1)	$tariff_1$	km_1	ton_1	$Bid_{1,1}$	-	$Bid_{1,3}$	$Bid_{1,4}$		$Bid_{1,m}$
(o_1, d_2)	$tariff_2$	km_2	-	$Bid_{2,1}$	$Bid_{2,2}$	-	$Bid_{2,4}$		$Bid_{2,m}$
(o_1, d_3)	$tariff_3$	km_3	ton_3	-	$Bid_{3,2}$	$Bid_{3,3}$	-		$Bid_{3,m}$
…									…
(o_1, d_n)	$tariff_4$	km_n	ton_n	$Bid_{n,1}$	$Bid_{n,2}$	-	$Bid_{n,4}$		$Bid_{n,m}$

1. Competition intensity

- Intensity of competition on a lane is measured using the **number of bids**, i.e. **ln(*# bids*)**

Lane (origin, destination)	**Tariff (Birr/MT)**	**Distance**	**Estimated tonnage**	**Transporter 1 (Birr/MT)**	**Transporter 2 (Birr/MT)**	**Transporter 3 (Birr/MT)**	**Transporter 4 (Birr/MT)**	**…**	**Transporter m (Birr/MT)**
(o_1, d_1)	$tariff_1$	km_1	ton_1	$Bid_{1,1}$	-	$Bid_{1,3}$	$Bid_{1,4}$		$Bid_{1,m}$
(o_1, d_2)	$tariff_2$	km_2	-	$Bid_{2,1}$	$Bid_{2,2}$	-	$Bid_{2,4}$		$Bid_{2,m}$
(o_1, d_3)	$tariff_3$	km_3	ton_3	-	$Bid_{3,2}$	$Bid_{3,3}$	-		$Bid_{3,m}$
…									…
(o_1, d_n)	$tariff_4$	km_n	ton_n	$Bid_{n,1}$	$Bid_{n,2}$	-	$Bid_{n,4}$		$Bid_{n,m}$

2. Market dispersion

- To measure for the market dispersion (information transparency) in the market, we compute a **standardized bid range** on each lane

Lane	Tariff	Distance	Estimated tonnage	Transporter 1 (birr/MT)	Transporter 2 (birr/MT)	…	Transporter m (birr/MT)
(o_1, d_1)	$tariff_1$	km_1	ton_1	$Bid_{1,1}$	-		$Bid_{1,m}$
(o_1, d_2)	$tariff_2$	km_2	-	$Bid_{2,1}$	$Bid_{2,2}$		$Bid_{2,m}$
(o_1, d_3)	$tariff_3$	km_3	ton_3	-	$Bid_{3,2}$		$Bid_{3,m}$
…							…
(o_1, d_n)	$Tariff_4$	km_n	ton_n	$Bid_{n,1}$	$Bid_{n,2}$		$Bid_{n,m}$

$$\frac{3^{rd}\ quartile - 1^{st}\ quartile}{median}$$

3. Market concentration

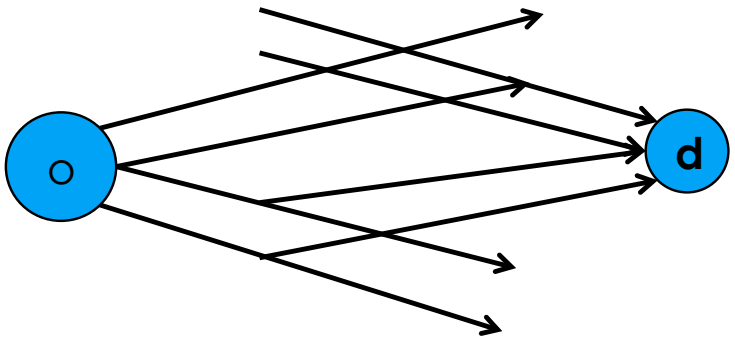
- To reflect the market concentration, the **number of active transporters** have been computed at the shipping origins and destinations

$o\_carrier$:

$$\sum_{d} number\ of\ distinct\ bidding\ carriers$$

$d\_carrier$:

$$\sum_{o} number\ of\ distinct\ bidding\ carriers$$



Network descriptive statistics

Market	International market			Domestic market		
Network	2 origins (ports) 24 destinations (EDPs) 32 lanes 46 carriers			33 origins (EDPs) 98 destinations (FDPs) 731 lanes 59 carriers		
Descriptive statistics	*n*	mean	standard deviation	*n*	mean	standard deviation
Distance (km)	32	756.1	289.7	731	589.8	356.3
Estimated tonnage per lane (tonne/month)	21	27,426.9	36,969.3	131	2,055.4	3,028.2
Number of bids per lane	32	17.9	7.3	731	14.9	10.3
Number of bids per carrier	46	14.4	5.5	59	212.3	190.5
Per cent of winning bids per carrier	46	39.0	37.6	59	8.4	12.1
Tariff per km (Birr/tonne·km)	32	2.0	1.2	731	2.4	2.1

International market

Best model obtained with a backward regression:

ln(tarrif) = f(C, M)

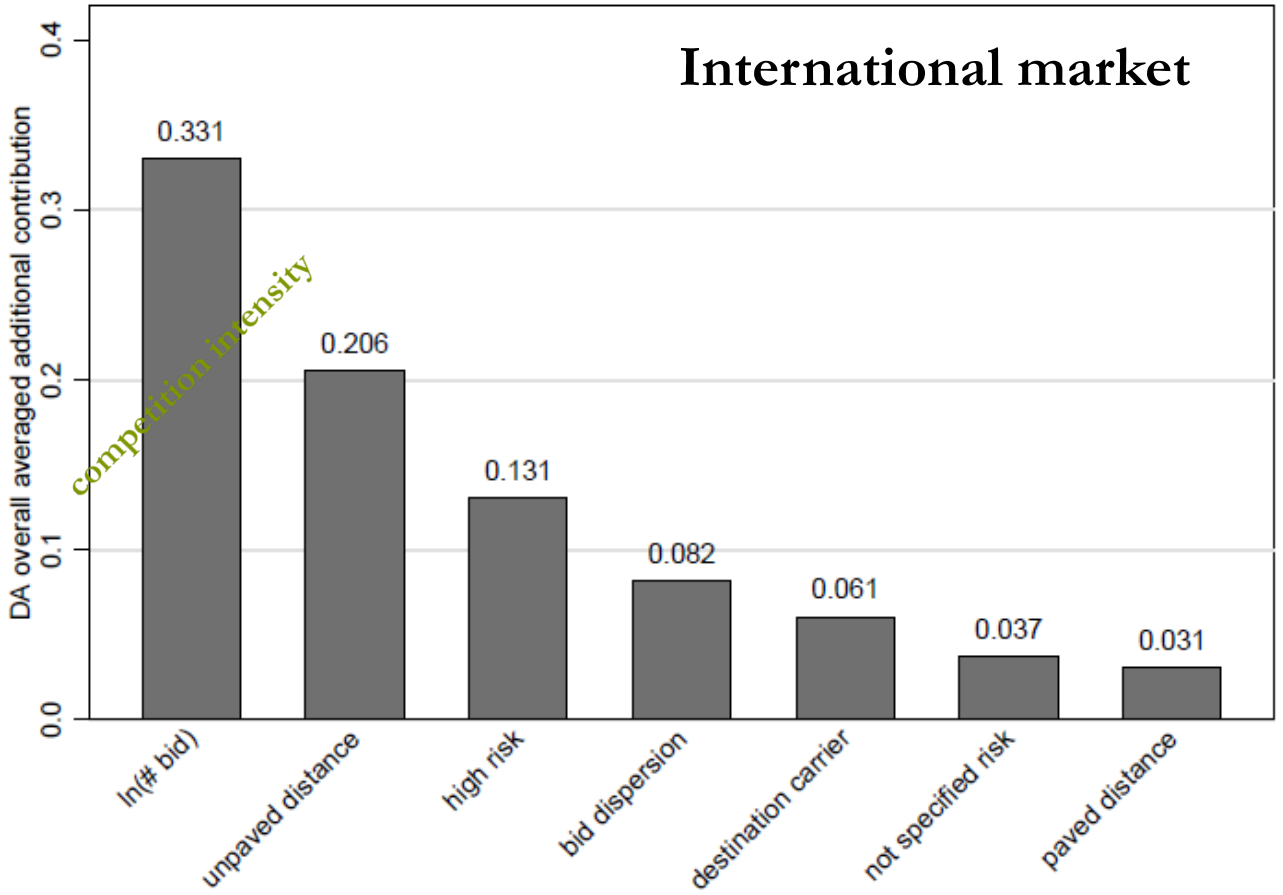
Distance alone explain less than 9% of the variability in tariffs:

ln(tarrif) = β_1 distance + β_0

	Paved & unpaved	Competition	Cost & Market
Cost driven			
Road conditions			
paved (km)	0.000137	0.000580***	0.000497**
	(0.000335)	(0.000180)	(0.000194)
unpaved (km)	0.00160***	0.00103**	0.00116***
	(0.000408)	(0.000389)	(0.000318)
Risk perception			
high			0.607***
			(0.161)
not specified			0.0604
			(0.119)
Tonnage estimates			
low			
high			
Market structure			
Competition intensity			
ln(*#bids*)		−0.823***	−0.888***
		(0.0863)	(0.105)
Market dispersion			
bid dispersion			−1.510***
			(0.282)
Market concentration			
carrier destination			−0.00525*
			(0.00272)
Constant	6.618***	8.829***	9.561***
	(0.250)	(0.328)	(0.453)
n	32	32	32
R-squared	0.442	0.738	0.878
Adj. *R*-squared	0.404	0.710	0.842
Max. VIF value	1.19	1.53	3.31

Robust standard errors in parentheses, *** p<0.01, ** p<0.05 and * p<0.1

Dominance analysis
Proposed by Azen and Budescu (2003)



Domestic market

Best model obtained with a backward regression:

ln(tarrif) = f(C,M)

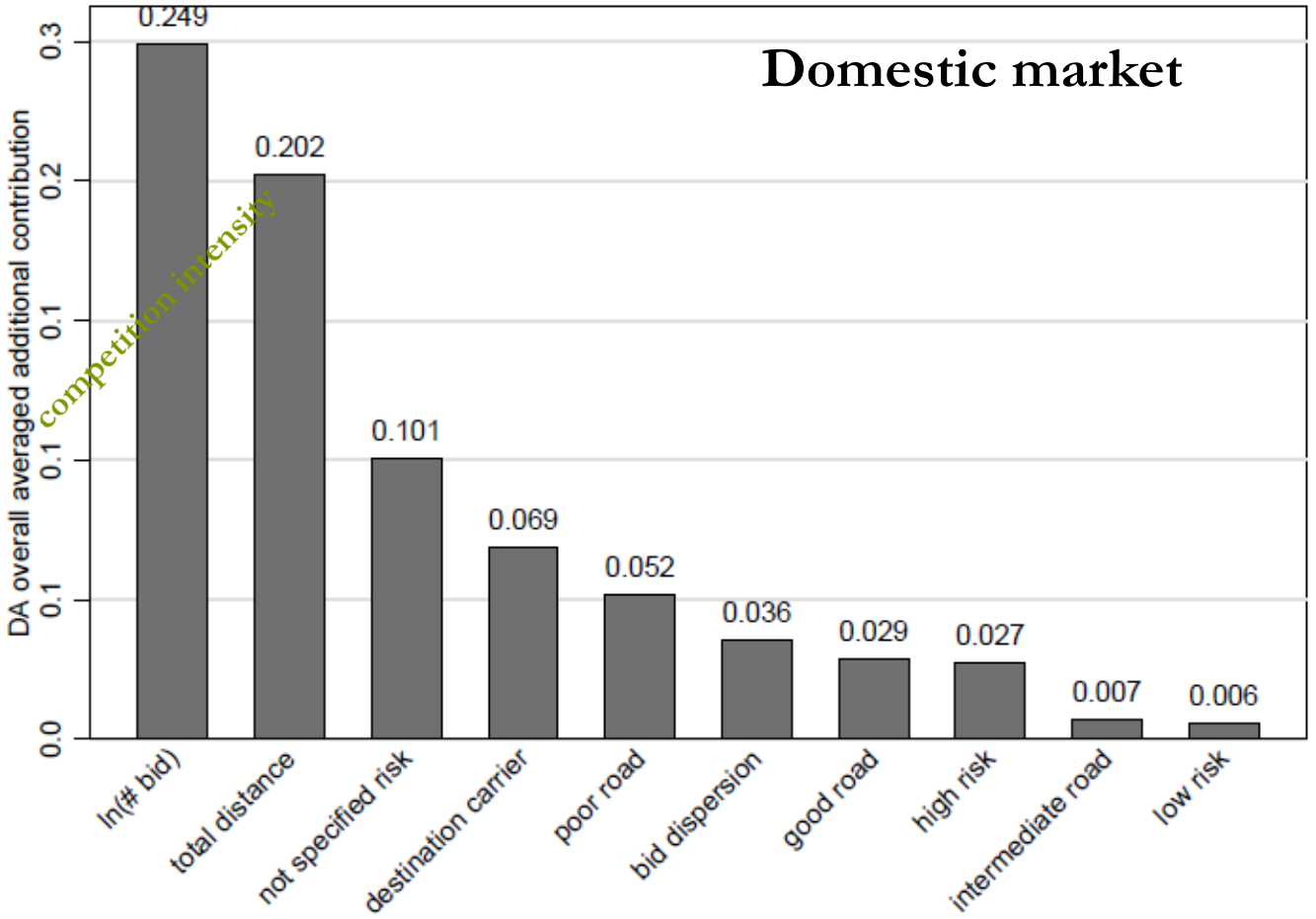
Distance alone explain less than 27% of the variability in tariff:

$ln(tarrif) = \beta_1\ distance + \beta_0$

	Paved & unpaved	Competition	Cost & Market
Cost driven			
distance (km)	0.00164***	0.00123***	0.00112***
	(7.32e-05)	(6.42e-05)	(6.14e-05)
Road conditions			
poor	1.102***	0.258***	0.204***
	(0.0685)	(0.0687)	(0.0604)
intermediate	0.310***	−0.0573	−0.0838
	(0.0701)	(0.0583)	(0.0535)
good	−0.325***	−0.256***	−0.149***
	(0.0634)	(0.0517)	(0.0495)
Risk perception			
none			−0.145
			(0.0999)
low			0.431***
			(0.0771)
high			0.644***
			(0.0701)
not specified			0.232***
			(0.0527)
Tonnage estimates			
low			
high			
Market structure			
Competition intensity			
ln(#bids)		−0.717***	−0.564***
		(0.0359)	(0.0402)
Market dispersion			
bid dispersion			−0.718***
			(0.0891)
Market concentration			
carrier origin			
carrier destination			−0.00557***
			(0.00107)
Constant	5.471***	7.737***	7.806***
	(0.0716)	(0.120)	(0.140)
n	731	731	731
R-squared			
Adj. *R*-squared	0.561	0.725	0.775
Max. VIF value			

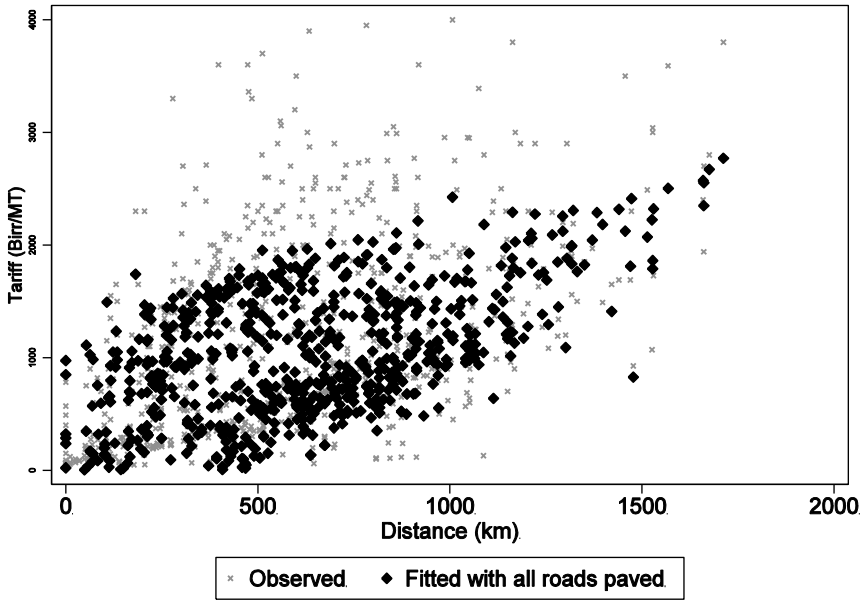
Robust standard errors in parentheses, *** p<0.01, ** p<0.05 and * p<0.1

Dominance analysis
Proposed by Azen and Budescu (2003)

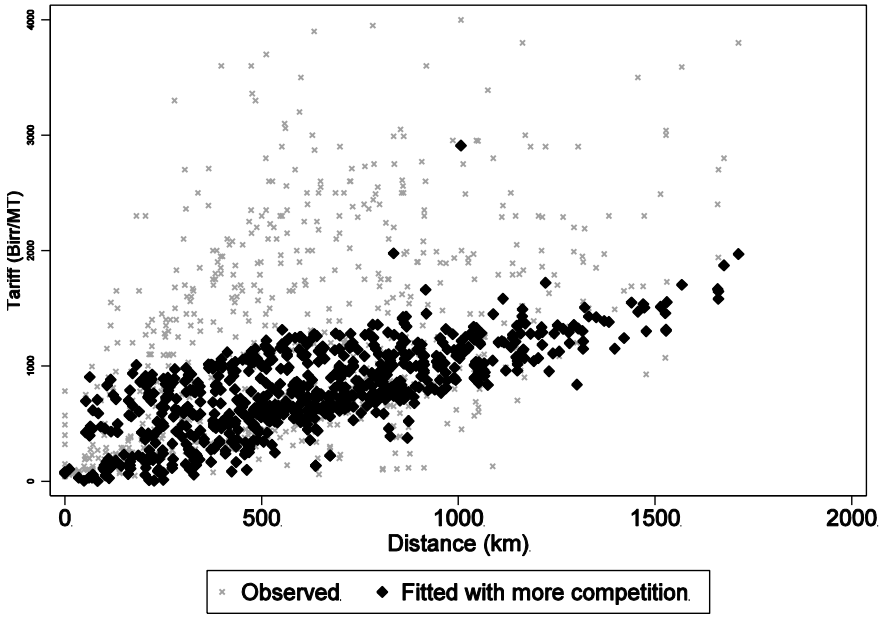


Illustrations of the counterfactual costs
"What if" scenarios

"Paved roads"



"More competition"



International corridors:

- Better road conditions should reduce shipping costs by 18% and increase competition by up to 44%.

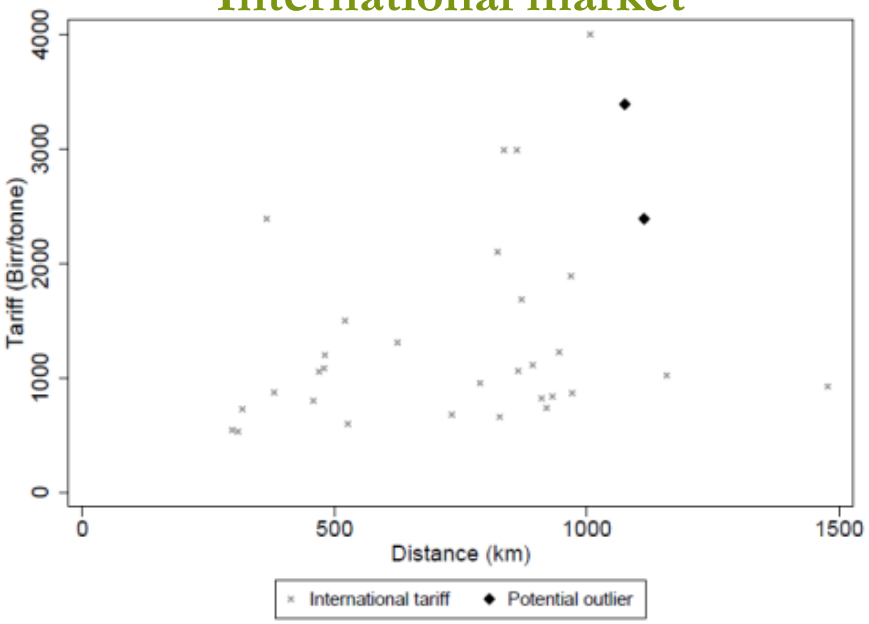
Domestic lanes:

- Better road conditions should reduce shipping costs by 12% and increase competition by up to 39%.

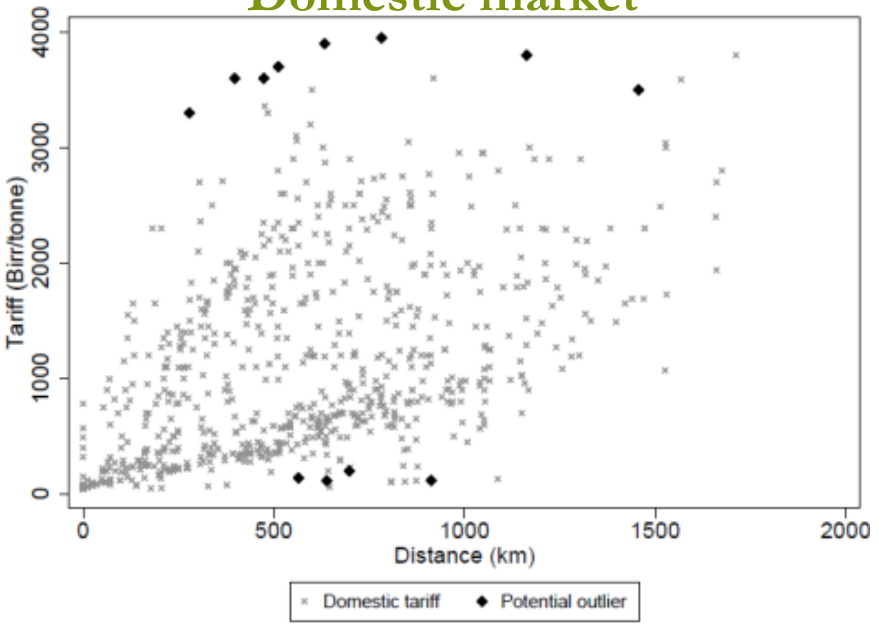
Decision support tool

- Accurate cost estimates to improve supply chain decisions
- Improve contracting process: potential outliers identified with a Bonferroni test

International market



Domestic market



Similar analysis with socio-economic factors (S)

International

- Same significant variables, but high tonnage and not specified risk
- Adj. R-Square: 62.5%
- Compare with the market structure model: 84.2%

Domestics

- Same significant variables, but high tonnage
- Adj. R-Square: 68.3%
- Compare with the market structure model: 77.5%

Contributions

- First such study in the humanitarian sector
- The main determinants of tariffs are the road quality and competition intensity
- The low level of competition explains high transportation prices
- The statistical tariff models help identify lanes that may require managerial intervention

Discussions

- How can transportation procurement processes be facilitated for organisations operating in Africa?
- What can be done to increase competition in African transportation markets?
- What policies should be implemented to reduce transportation tariffs?
- Can humanitarian organisations, like the WFP, have an influence on such policies?
- Would it be useful to create an African Logistics Cluster assembling all involved stakeholders (governmental authorities, logistics service providers and shippers)? Would it be feasible?