Trucks

or

The Triple Curse of Remoteness

Trebb Allen¹  David Atkin²  Santiago Cantillo³  Carlos Hernandez³

¹Dartmouth and NBER

²MIT and NBER

³U Los Andes

February 2020
How does market power shape the transportation sector?

- Transportation costs are high in developing countries.
  - Most policy (& research) focuses on reducing these costs (e.g. infrastructure improvements).
How does market power shape the transportation sector?

- Transportation costs are high in developing countries.
  - Most policy (& research) focuses on reducing these costs (e.g. infrastructure improvements).

- Transportation sector is also *uncompetitive* in developing countries.
How does market power shape the transportation sector?

- Transportation costs are high in developing countries.
  - Most policy (& research) focuses on reducing these costs (e.g. infrastructure improvements).
- Transportation sector is also *uncompetitive* in developing countries.
- With market power:
How does market power shape the transportation sector?

- Transportation costs are high in developing countries.
  - Most policy (& research) focuses on reducing these costs (e.g. infrastructure improvements).

- Transportation sector is also *uncompetitive* in developing countries.

- With market power:
  - Aggregate impact of transportation policy less clear:
    - Falling costs may increase rents of transportation firms, reducing gains to consumers.
    - Falling costs may induce greater competition, increasing gains to consumers.
How does market power shape the transportation sector?

- Transportation costs are high in developing countries.
  - Most policy (& research) focuses on reducing these costs (e.g. infrastructure improvements).

- Transportation sector is also *uncompetitive* in developing countries.

- With market power:
  - *Aggregate* impact of transportation policy less clear:
    - Falling costs may increase rents of transportation firms, reducing gains to consumers.
    - Falling costs may induce greater competition, increasing gains to consumers.

  - *Spatial* impact of transportation policy less clear:
    - Does market power attenuate or exacerbate the costs of remoteness?
This project

- Present **new spatial theory** with market power highlighting the *triple curse of remoteness*:

1. Remoteness $\Rightarrow$ higher marginal costs
2. Remoteness $\Rightarrow$ less competition, higher markups
3. Remoteness $\Rightarrow$ transportation services provided by worse firms

All three curses reduce producer wages, increase consumer prices in remote regions.

- Show presence of the three curses in Colombia by combining:
  - Unique data-set comprising all (non-ag) intra-national shipments & all trucks.
  - Causal evidence from large scale infrastructure improvements.

- Next steps (not for today!):
  - Combine theory+data to quantify how each curse shapes the welfare impacts of infrastructure improvements.
  - Assess how recent (anti) competitive policies shape these welfare impacts.
This project

- Present **new spatial theory** with market power highlighting the *triple curse of remoteness*:
  1. Remoteness $\implies$ higher marginal costs
  2. Remoteness $\implies$ less competition, higher markups
  3. Remoteness $\implies$ transportation services provided by worse firms

All three curses reduce producer wages, increase consumer prices in remote regions.

- Show presence of the three curses in Colombia by combining:
  - Unique data-set comprising all (non-ag) intra-national shipments & all trucks.
  - Causal evidence from large scale infrastructure improvements.

- Next steps (not for today!):
  - Combine theory+data to quantify how each curse shapes the welfare impacts of infrastructure improvements.
  - Assess how recent (anti) competitive policies shape these welfare impacts.
This project

• Present **new spatial theory** with market power highlighting the *triple curse of remoteness*:
  1. Remoteness $\Rightarrow$ higher marginal costs
  2. Remoteness $\Rightarrow$ less competition, higher markups
  3. Remoteness $\Rightarrow$ transportation services provided by worse firms

All three curses reduce producer wages, increase consumer prices in remote regions.

• Show presence of the three curses in Colombia by combining:
  • **Unique data-set** comprising all (non-ag) intra-national shipments & all trucks.
  • **Causal evidence** from large scale infrastructure improvements.
This project

• Present **new spatial theory** with market power highlighting the *triple curse of remoteness*:
  1. Remoteness $\implies$ higher marginal costs
  2. Remoteness $\implies$ less competition, higher markups
  3. Remoteness $\implies$ transportation services provided by worse firms

All three curses reduce producer wages, increase consumer prices in remote regions.

• Show presence of the three curses in Colombia by combining:
  • **Unique data-set** comprising all (non-ag) intra-national shipments & all trucks.
  • **Causal evidence** from large scale infrastructure improvements.

• Next steps (not for today!):
  • Combine theory+data to quantify how each curse shapes the welfare impacts of infrastructure improvements.
  • Assess how recent (anti) competitive policies shape these welfare impacts.
Related literature

• Endogenous trade costs:
  • Due to imperfect competition: Hummels, Lugovskyy and Skiba (2009), Atkin and Donaldson (2016), Asturias (2019)

• Imperfect competition and trade more generally:
Related literature

- **Endogenous trade costs:**
  - Due to imperfect competition: Hummels, Lugovskyy and Skiba (2009), Atkin and Donaldson (2016), Asturias (2019)

- **Imperfect competition and trade more generally:**

- **In this paper, market power:**
  - Determined simultaneously with trade flows.
  - Shapes the impact of infrastructure improvements on the equilibrium distribution of economic activity.
Outline of Talk

Introduction

Trucking in Colombia
  A tale of two routes
  Three stylized facts
  A unique truck dataset

A spatial model with imperfect competition

The Triple Curse of Remoteness

Next Steps and Conclusion
Trucking in Colombia: A tale of two routes
Trucking in Colombia: A tale of two routes

(a) Medellin to Cali

(b) Pasto to Mocoa
Trucking in Colombia: A tale of two routes

<table>
<thead>
<tr>
<th>Medellin to Cali</th>
<th>Pasto to Mocoa</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. Shipping price: $0.33 USD per ton-mile</td>
<td>2. Shipping price: $0.47 per ton-mile</td>
</tr>
<tr>
<td>3. Market concentration: 0.008 (HHI)</td>
<td>3. Market concentration: 0.07 (HHI)</td>
</tr>
<tr>
<td>4. 4.7 trucks owned per trucker (88 tons)</td>
<td>4. 1.1 trucks owned per trucker (7 tons)</td>
</tr>
</tbody>
</table>
Trucking in Colombia: A tale of two routes

Medellin to Cali

Figure: Coltanques Logistica y Transportes

Pasto to Mocoa

Figure: 1973 Ford F600
Trucking in Colombia: A tale of two routes

Medellin to Cali

Figure: Coltanques owner: Henry

Notes: Henry owns 1,200 trucks and makes 14,000 trips per month. He also owns an airline.

Pasto to Mocoa

Figure: 1973 Ford F600 owner: Jesus

Notes: Owns one truck, 4 trips per month. Drives on the same route since 1968. Source: Uribe (2017)
Trucking in Colombia, Fact #1: Complex geography

- Mountainous.

- Major ports on Pacific and Atlantic Oceans but industrial centers located in the interior.

- Road quality poor, transportation costs high.

- 97% of cargo shipped by truck.
Trucking in Colombia, Fact #1: Complex geography

(a) Topography

(b) Night lights
Trucking in Colombia, Fact #1: Complex geography
Trucking in Colombia, Fact #1: Complex geography

Source: BBVA (2012)
Trucking in Colombia, Fact #2: Heterogeneous truckers

Figure: Distribution across truckers

(a) Number of trucks

(b) Capacity (tons)
Trucking in Colombia, Fact #2: Heterogeneous truckers

Figure: Residences of truckers
Trucking in Colombia, Fact #3: Imperfect competition?

Figure: Distribution across routes

(a) Price (per ton-mile)  
(b) Market concentration (HHI)
Trucking in Colombia, Fact #3: Imperfect competition?

Colombia’s truck strike: The truck stops here

Why does it cost more to get a container from the coast to Bogotá than to ship it from Beijing? Gerald Barr continues his journey through some of the curiosities and contradictions of life in Colombia by demystifying the truck strike.

On Colombia’s long and windy roads you get used to being stuck behind slow-moving trucks. But that’s put into perspective when they spend more than seven weeks not moving at all, with some actively blocking the road. Yes folks, the country has just seen another truck strike. Wasn’t there one last year? And the year before? Turns out there has been a truck strike every year for the past 15 years. As regular as Christmas, you might say, or rather a kind of “anti-Christmas” because nothing gets delivered.

Colombia reaches deal with truckers to lift 45-day strike

“The deal is realistic and fair. We have ceded to the unions which backed the strike would have meant a disproportionate and permanent increase in costs for families and a hard hit to the country’s competitiveness,” President Juan Manuel Santos said in a statement.
Unique truck dataset

Unique truck dataset


- Shipment-level data (at origin-destination-truck-date level):
  - Truck license plate

- Trade data (at origin-destination-commodity-month level):
  - Quantity
  - Price paid to truck owner

- Truck level data (at truck-month level):
  - License plate
  - Characteristics of the truck (capacity, age)
  - Owner place of residence

- Road network (at origin-destination-month level):
  - Distance and travel time.
Unique truck dataset

- Shipment-level data (at origin-destination-truck-date level):
  - Truck license plate
- Trade data (at origin-destination-commodity-month level):
  - Quantity.
  - Price paid to truck owner.
Unique truck dataset


- Shipment-level data (at origin-destination-truck-date level):
  - Truck license plate

- Trade data (at origin-destination-commodity-month level):
  - Quantity.
  - Price paid to truck owner.

- Truck level data (at truck-month level):
  - License plate
  - Characteristics of the truck (capacity, age)
  - Owner place of residence
Unique truck dataset

- Shipment-level data (at origin-destination-truck-date level):
  - Truck license plate
- Trade data (at origin-destination-commodity-month level):
  - Quantity.
  - Price paid to truck owner.
- Truck level data (at truck-month level):
  - License plate
  - Characteristics of the truck (capacity, age)
  - Owner place of residence
- Road network (at origin-destination-month level):
  - Distance and travel time.
An example entry in the dataset

Truck ID: AT999X
Truck Tractor with 2 axles
Registration Year: April, 2005
Owner: 12345678
Owner’s Home: Bogotá
Number of Trucks Owned: 1
An example entry in the dataset

- Manifesto issued: June 29, 2017
- Truck ID: ATD000X
- Driver ID: 12XXXXXX
- Owner ID: 12XXXXXX
- Transportation Company ID: 87
- Trip: Bogota-Cartagena
- Load Carried: 3,676 Kgs
- Product Shipped: Glass
- Price paid by Transport Firm to Truck Owner: $442 USD
An example entry in the dataset

Manifesto issued July 1, 2017
Truck ID: ATX000X
Driver ID: 12XXXXXX
Owner ID: 12XXXXXX
Transportation Company ID: 1486
Trip: Cartagena-Tocancipá
Load carried: 3,939 Kgs
Product Shipped: Car Parts
Price paid by Transport Firm to Truck Owner: $437 USD
An example entry in the dataset
Outline of Talk

Introduction

Trucking in Colombia

A spatial model with imperfect competition
   Imperfect Competition
   Equilibrium

The Triple Curse of Remoteness

Next Steps and Conclusion
From empirics to theory

**Empirical facts**

1. Complex geography.
2. Heterogeneous truckers (in quality & place of residence).
3. Imperfectly competitive trucking industry.

**Theory ingredients**

1. Complex geography.
2. Heterogeneous truckers (in quality & place of residence).
3. Finite number of truckers competing to supply different routes.
## From empirics to theory

<table>
<thead>
<tr>
<th>Empirical facts</th>
<th>Theory ingredients</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Complex geography.</td>
<td>2. Complex geography.</td>
</tr>
<tr>
<td>3. Imperfectly competitive trucking industry.</td>
<td>4. Imperfectly competitive trucking industry.</td>
</tr>
<tr>
<td>5. Finite number of truckers competing to supply different routes.</td>
<td>6. Finite number of truckers competing to supply different routes.</td>
</tr>
</tbody>
</table>
From empirics to theory

Empirical facts

1. Complex geography.

Theory ingredients

1. Complex geography.
# From empirics to theory

## Empirical facts

1. Complex geography.
2. Heterogeneous truckers (in quality & place of residence).

## Theory ingredients

1. Complex geography.
From empirics to theory

**Empirical facts**

1. Complex geography.
2. Heterogeneous truckers (in quality & place of residence).

**Theory ingredients**

1. Complex geography.
2. Heterogeneous truckers (in quality & place of residence).
From empirics to theory

**Empirical facts**

1. Complex geography.
2. Heterogeneous truckers (in quality & place of residence).
3. Imperfectly competitive trucking industry.

**Theory ingredients**

1. Complex geography.
2. Heterogeneous truckers (in quality & place of residence).
## From empirics to theory

<table>
<thead>
<tr>
<th>Empirical facts</th>
<th>Theory ingredients</th>
</tr>
</thead>
<tbody>
<tr>
<td>3. Imperfectly competitive trucking industry.</td>
<td>3. Finite number of truckers competing to supply different routes.</td>
</tr>
</tbody>
</table>
A complex geography

- $N$ locations, separated by trade costs, indexed by origin, destination, and home.
A complex geography

- $N$ locations, separated by trade costs, indexed by origin, destination, and home.

- Origin $o$:
  - Endowed with $L_o$ workers.
  - Workers produce quantity $A_oL_o$ of differentiated variety.
  - Each worker earns wage $w_o$.
  - Factory gate price: $p^0_o = \frac{w_o}{A_o}$.
A complex geography

- \(N\) locations, separated by trade costs, indexed by origin, destination, and home.

- **Origin \(o\):**
  - Endowed with \(L_o\) workers.
  - Workers produce quantity \(A_oL_o\) of differentiated variety.
  - Each worker earns wage \(w_o\).
  - Factory gate price: \(p^0_o = \frac{w_o}{A_o}\).

- **Destination \(d\) expenditure on goods from \(o\):**

\[
X_{od} = \frac{\tau_{od}^{1-\sigma} \left(p^0_o\right)^{1-\sigma}}{\sum_{o'} \tau_{o'd}^{1-\sigma} \left(p^0_{o'}\right)^{1-\sigma}} E_d,
\]

where:
- \(\tau_{od} \geq 1\) is the **endogenous** trade cost.
- \(E_d\) is the expenditure (worker + trucker income).
Imperfect competition: Overview

Trucker $t$ plays a three stage game:

1. Choose where to live.
Imperfect competition: Overview

Trucker $t$ plays a three stage game:

1. Choose where to live.

2. Choose the capacity available for each route.
Imperfect competition: Overview

Trucker $t$ plays a three stage game:

1. Choose where to live.
2. Choose the capacity available for each route.
3. Compete on prices with other truckers on route.
Imperfect competition: Overview

Trucker $t$ plays a three stage game:

1. Choose where to live.
2. Choose the capacity available for each route.
3. Compete on prices with other truckers on route.
Stage #3: Competition on a route

• Suppose trucker $t$ has chosen capacity $\bar{Q}_{od,t}$ for route $od$. 

\[ Q_{od,t} = p - \chi_{od,t} \sum_{t'} p_{1} - \chi_{od,t'} X_{od}, \]

where $\chi > \sigma$.

• Trucker $t$ solves:

\[ \max p_{od,t} \quad \text{s.t.} \quad Q_{od,t} \leq \bar{Q}_{od,t}, \]

• Solution: Trucker $t$ chooses her price to ensure all her capacity is used.
Stage #3: Competition on a route

- Suppose trucker $t$ has chosen capacity $\bar{Q}_{od,t}$ for route $od$.
- Quantity demand for trucker $t$’s service is:

$$Q_{od,t} = \frac{p_{od,t}^{\chi}}{\sum_{t'} p_{od,t'}^{1-\chi}} X_{od},$$

where $\chi > \sigma$. 
Stage #3: Competition on a route

- Suppose trucker $t$ has chosen capacity $\bar{Q}^{c}_{od,t}$ for route $od$.
- Quantity demand for trucker $t$’s service is:

$$Q_{od,t} = \frac{p_{od,t}^{-\chi}}{\sum_{t'} p_{od,t'}^{1-\chi}} X_{od},$$

where $\chi > \sigma$.
- Trucker $t$ solves:

$$\max_{p_{od,t}} p_{od,t} Q_{od,t} \text{ s.t. } Q_{od,t} \leq \bar{Q}^{c}_{od,t}$$
Stage #3: Competition on a route

- Suppose trucker $t$ has chosen capacity $\bar{Q}_{od,t}$ for route $od$.
- Quantity demand for trucker $t$’s service is:

$$Q_{od,t} = \frac{p_{od,t}^{-\chi}}{\sum_{t'} p_{od,t'}^{1-\chi}} X_{od,t}$$

where $\chi > \sigma$.

- Trucker $t$ solves:

$$\max_{p_{od,t}} p_{od,t} Q_{od,t} \text{ s.t. } Q_{od,t} \leq \bar{Q}_{od,t}$$

- Solution: Trucker $t$ chooses her price to ensure all her capacity is used.
Stage #3: Competition on a route: Implications

- Trucker $t$’s market share on a route $od$ is:

$$s_{od,t} = \left( \tilde{Q}_{od,t}^c \right)^{\frac{\chi - 1}{\chi}} / \sum_{t'} \left( \tilde{Q}_{od,t'}^c \right)^{\frac{\chi - 1}{\chi}}$$
Trucker $t$’s market share on a route $od$ is:

$$s_{od,t} = \left( \bar{Q}_{od,t}^c \right)^{\chi-1} / \sum_{t'} \left( \bar{Q}_{od,t'}^c \right)^{\chi-1} \chi$$

Origin $o$’s market share in a destination $d$ is:

$$s_{d,o} = \left( \left( \sum_{t'} \left( \bar{Q}_{od,t}^c \right)^{\chi-1} \chi \right)^{\sigma-1} \sigma \right) / \sum_{o'} \left( \left( \sum_{t'} \left( \bar{Q}_{o'd,t'}^c \right)^{\chi-1} \chi \right)^{\sigma-1} \sigma \right)$$
Stage #3: Competition on a route: Implications

- Trucker $t$’s market share on a route $od$ is:

$$ s_{od,t} = \left( \bar{Q}_{od,t}^c \right)^{\chi^{-1}} / \sum_{t'} \left( \bar{Q}_{od,t'}^c \right)^{\chi^{-1}} $$

- Origin $o$’s market share in a destination $d$ is:

$$ s_{d,o} = \left( \left( \sum_{t'} \left( \bar{Q}_{od,t}^c \right)^{\chi^{-1}} \right)^{\chi \sigma^{-1}} \right)^{\frac{\chi \sigma^{-1}}{\chi \sigma}} / \sum_{o'} \left( \left( \sum_{t'} \left( \bar{Q}_{o'd,t'}^c \right)^{\chi^{-1}} \right)^{\chi \sigma^{-1}} \right)^{\frac{\chi \sigma^{-1}}{\chi \sigma}} $$

- Trucker $t$’s revenue $R_{od,t} \equiv p_{od,t} \bar{Q}_{od,t}^c$ is:

$$ R_{od,t} = s_{od,t} \times s_{d,o} \times E_d $$
Imperfect competition: Overview

Trucker $t$ plays a three stage game:

1. Choose where to live.

2. **Choose the capacity available for each route.**

3. Compete on prices with other truckers on route.
Stage #2: Choice of capacity

- Suppose trucker $t$ can supply capacity at constant marginal cost $p_0 c_{od,t}$. 
Stage #2: Choice of capacity

- Suppose trucker $t$ can supply capacity at constant marginal cost $p^0_{od,t}$.

- Trucker solves:

$$\max_{Q_{od,t}} \sum_{od} R_{od,t} (Q_{od,t}^c) - p^0_{od,t} Q_{od,t}^c$$
Stage #2: Choice of capacity

• Suppose trucker $t$ can supply capacity at constant marginal cost $p^0_{od,t}$.

• Trucker solves:

$$\max_{Q_{od,t}} \sum_{od} R_{od,t} \left( Q_{od,t}^c \right) - p^0_{od,t} Q_{od,t}^c$$

• Solution: trucker’s markup depends on her in-route and in-destination market shares:

$$p_{od,t} = \mu_{od,t} \times c_{od,t} \times p^0_{o}$$

where:

$$\mu_{od,t} \equiv \frac{\chi}{\chi - 1} \left( 1 - s_{od,t} \left( 1 - \frac{\chi}{\chi - 1} \frac{\sigma - 1}{\sigma} (1 - s_{d,o}) \right) \right)^{-1}$$
Stage #2: Choice of capacity: Implications

- Lower cost truckers capture greater market share, charge higher markups:

\[
\frac{s_{od,t}}{s_{od,t'}} = \left( \frac{\mu_{od,t}c_{od,t}}{\mu_{od,t'}c_{od,t'}} \right)^{1-\chi}
\]
Stage #2: Choice of capacity: Implications

- Lower cost truckers capture greater market share, charge higher markups:

\[
\frac{s_{od,t}}{s_{od,t'}} = \left( \frac{\mu_{od,t}c_{od,t}}{\mu_{od,t'}c_{od,t'}} \right)^{1-\chi}
\]

- Trucker \( t \)'s profit on a given route is:

\[
\pi_{od,t} = \left( 1 - \mu_{od,t}^{-1} \right) R_{od,t},
\]

- Note: log-supermodular in trucker \( t \) productivity.

- Endogenous trade costs depends on market concentration:

\[
\tau_{od} = \left( \frac{\chi}{\chi - 1} \right) \left( \sum_{t'} \left( \mu_{od,t}c_{od,t} \right)^{1-\chi} \right)^{\frac{1}{1-\chi}}
\]
Imperfect competition: Overview

Trucker $t$ plays a three stage game:

1. Choose where to live.
2. Choose the capacity available for each route.
3. Compete on prices with other truckers on route.
Stage #1: Choice of residence

• Suppose trucker \( t \) characterized by her type \( k \) and her home \( h \) where:

\[
c_{od,t} = \bar{\tau}_{od} \times \rho_{h,o} \times \rho_{d,h} \times \phi_k
\]
Stage #1: Choice of residence

- Suppose trucker $t$ characterized by her type $k$ and her home $h$ where:

$$c_{od,t} = \bar{\tau}_{od} \times \rho_{h,o} \times \rho_{d,h} \times \phi_k$$

- Intuition:
  - $\bar{\tau}_{od}$ is (standard) iceberg trade cost.
  - $\rho_{h,o}$ and $\rho_{d,h}$ capture cost of getting from home to route and back
  - $\phi_k \geq 1$ is a type shifter.
Stage #1: Choice of residence

- Suppose trucker $t$ characterized by her type $k$ and her home $h$ where:

$$c_{od,t} = \bar{\tau}_{od} \times \rho_{h,o} \times \rho_{d,h} \times \phi_k$$

- Intuition:
  - $\bar{\tau}_{od}$ is (standard) iceberg trade cost.
  - $\rho_{h,o}$ and $\rho_{d,h}$ capture cost of getting from home to route and back.
  - $\phi_k \geq 1$ is a type shifter.

- Trucker $t$ of type $k$ solves:

$$\max_{h} \left( \sum_{od} \pi_{od,h,k} \right) \epsilon_{h,k} (t)$$

where $\epsilon \sim \text{Frechet} (\theta)$ is an idiosyncratic preference shifter.
Stage #1: Choice of residence

- Suppose trucker $t$ characterized by her type $k$ and her home $h$ where:

$$c_{od,t} = \bar{\tau}_{od} \times \rho_{h,o} \times \rho_{d,h} \times \phi_k$$

- Intuition:
  - $\bar{\tau}_{od}$ is (standard) iceberg trade cost.
  - $\rho_{h,o}$ and $\rho_{d,h}$ capture cost of getting from home to route and back.
  - $\phi_k \geq 1$ is a type shifter.

- Trucker $t$ of type $k$ solves:

$$\max_h \left( \sum_{od} \pi_{od,h,k} \right) \varepsilon_{h,k}(t)$$

where $\varepsilon \sim Frechet(\theta)$ is an idiosyncratic preference shifter.

- Solution: $T_{h,k} \propto \Pi^\theta_{h,k}$, where $\Pi_{h,k} \equiv \sum_{od} \pi_{od,h,k}$.
Stage #1: Choice of residence: Implications

- Number of truckers of type $k$ living in home $h$:

$$T_{h,k} = \frac{\Pi_{h,k}^\theta}{\sum_{h'} \Pi_{h',k}^\theta} \bar{T}_k$$

where $\bar{T}_k$ is economy endowment of truckers of type $k$.

- Note: ignoring integer constraints on $T_{h,k}$. 
Stage #1: Choice of residence: Implications

- Number of truckers of type $k$ living in home $h$:

$$T_{h,k} = \frac{\Pi_{h,k}^\theta}{\sum_{h'} \Pi_{h',k}^\theta} \bar{T}_k$$

where $\bar{T}_k$ is economy endowment of truckers of type $k$.

- Note: ignoring integer constraints on $T_{h,k}$.

- More truckers will live near good routes...
Stage #1: Choice of residence: Implications

• Number of truckers of type \( k \) living in home \( h \):

\[ T_{h,k} = \frac{\prod_{h,k}^{\theta}}{\sum_{h'} \prod_{h',k}^{\theta}} \bar{T}_k \]

where \( \bar{T}_k \) is economy endowment of truckers of type \( k \).

• Note: ignoring integer constraints on \( T_{h,k} \).

• More truckers will live near good routes...

• ... but better truckers (lower \( \phi_k \)) especially so.
Equilibrium

• Labor income equal to sales net of markups:

\[ w_o L_o = \sum_d \sum_{h,k} R_{od,h,k} \frac{\mu_{odh,k}}{\mu_{odh,k}} \]
Equilibrium

- Labor income equal to sales net of markups:
  \[ w_o L_o = \sum_d \sum_{h,k} \frac{R_{od,h,k}}{\mu_{odh,k}} \]

- Total expenditure equal to labor income and trucker income:
  \[ E_h = \sum_k T_{h,k} \sum_{od} \pi_{od,h,k} + w_h L_h \]
Equilibrium

- Labor income equal to sales net of markups:

\[ w_o L_o = \sum_d \sum_{h,k} \frac{R_{od,h,k}}{\mu_{odh,k}} \]

- Total expenditure equal to labor income and trucker income:

\[ E_h = \sum_k T_{h,k} \sum_{od} \pi_{od,h,k} + w_h L_h \]

- Implication: trucking redistributes income from \( od \) to \( h \).
Outline of Talk

Introduction

Trucking in Colombia

A spatial model with imperfect competition

The Triple Curse of Remoteness
  The Triple Curse of Remoteness: Theory
  The Triple Curse of Remoteness: Empirical Evidence

Next Steps and Conclusion
The Triple Curse of Remoteness

1. More remote locations face higher marginal costs.

2. More remote locations face higher markups.

3. More remote locations are served by worse truckers.
The Triple Curse of Remoteness

1. More remote locations face higher marginal costs.

2. More remote locations face higher markups.

3. More remote locations are served by worse truckers.
Curse #1: More remote locations face higher marginal costs.

- Combining expression for endogenous trade cost plus assumed marginal cost of capacity yields:

\[
\tau_{od} = \bar{\tau}_{od} \times \left(\frac{\chi}{\chi - 1}\right) \times \left(\sum_{h,k} (\rho_{h,o} \times \rho_{d,h} \times \mu_{od,h,k} \times \phi_k \times T_{h,k})^{1-\chi}\right)^{\frac{1}{1-\chi}}
\]

"remoteness"
Curse #1: More remote locations face higher marginal costs.

- Combining expression for endogenous trade cost plus assumed marginal cost of capacity yields:

\[
\tau_{od} = \bar{\tau}_{od} \times \left( \frac{\chi}{\chi - 1} \right) \times \left( \sum_{h,k} \left( \rho_{h,o} \times \rho_{d,h} \times \mu_{od,h,k} \times \phi_k \times T_{h,k} \right)^{1-\chi} \right)^{\frac{1}{1-\chi}}
\]

"remoteness"

- Recall:
Curse #1: More remote locations face higher marginal costs.

- Combining expression for endogenous trade cost plus assumed marginal cost of capacity yields:

\[ \tau_{od} = \bar{\tau}_{od} \times \left( \frac{\chi}{\chi - 1} \right) \times \left( \sum_{h,k} \left( \rho_{h,o} \times \rho_{d,h} \times \mu_{od,h,k} \times \phi_k \times T_{h,k} \right)^{1-\chi} \right)^{\frac{1}{1-\chi}} \]

- "remoteness"

- Recall:
  - More remote locations trade less.
Curse #1: More remote locations face higher marginal costs.

- Combining expression for endogenous trade cost plus assumed marginal cost of capacity yields:

\[
\tau_{od} = \bar{\tau}_{od} \times \left( \frac{\chi}{\chi - 1} \right) \times \left( \sum_{h,k} \left( \rho_{h,o} \times \rho_{d,h} \times \mu_{od,h,k} \times \phi_k \times T_{h,k} \right)^{1-\chi} \right)^{\frac{1}{1-\chi}}
\]

- "remoteness"  

- Recall:
  - More remote locations trade less.
  - Truckers prefer to live near routes with more trade.
Curse #1: More remote locations face higher marginal costs.

- Combining expression for endogenous trade cost plus assumed marginal cost of capacity yields:

\[ \tau_{od} = \bar{\tau}_{od} \times \left( \frac{\chi}{\chi - 1} \right) \times \left( \sum_{h,k} (\rho_{h,o} \times \rho_{d,h} \times \mu_{od,h,k} \times \phi_k \times T_{h,k})^{1-\chi} \right)^{\frac{1}{1-\chi}} \]

"remoteness"

- Recall:
  - More remote locations trade less.
  - Truckers prefer to live near routes with more trade.

- **Curse #1**: More remote locations are further away from truckers’ residences, incurring additional costs.
Curse #1: More remote locations face higher marginal costs.
Curse #1: More remote locations face higher marginal costs.
Curse #1: More remote locations face higher marginal costs.
Curse #1: More remote locations face higher marginal costs.
The Triple Curse of Remoteness

1. More remote locations face higher marginal costs.

2. More remote locations face higher markups.

3. More remote locations are served by worse truckers.
Curse #2: More remote locations face higher markups.

- Combining expression for endogenous trade cost plus assumed marginal cost of capacity yields:

\[
\tau_{od} = \tilde{\tau}_{od} \times \left( \frac{\chi}{\chi - 1} \right) \times \left( \sum_{h,k} (\rho_{h,o} \times \rho_{d,h} \times \mu_{od,h,k} \times \phi_k \times T_{h,k})^{1-\chi} \right)^{\frac{1}{1-\chi}}
\]

"remoteness"
Curse #2: More remote locations face higher markups.

- Combining expression for endogenous trade cost plus assumed marginal cost of capacity yields:

\[
\tau_{od} = \tau_{od} \times \left( \frac{\chi}{\chi - 1} \right) \times \left( \sum_{h,k} (\rho_{h,o} \times \rho_{d,h} \times \mu_{od,h,k} \times \phi_k \times T_{h,k})^{1-\chi} \right)^{\frac{1}{1-\chi}}
\]

- "remoteness"

- Recall:
Curse #2: More remote locations face higher markups.

• Combining expression for endogenous trade cost plus assumed marginal cost of capacity yields:

\[ \tau_{od} = \bar{\tau}_{od} \times \left( \frac{\chi}{\chi - 1} \right) \times \left( \sum_{h,k} (\rho_{h,o} \times \rho_{d,h} \times \mu_{od,h,k} \times \phi_k \times T_{h,k})^{1-\chi} \right)^{\frac{1}{1-\chi}} \]

"remoteness"

• Recall:
  • More remote locations are further away from (most) truckers’ residences.
Curse #2: More remote locations face higher markups.

- Combining expression for endogenous trade cost plus assumed marginal cost of capacity yields:

\[ \tau_{od} = \bar{\tau}_{od} \times \left( \frac{\chi}{\chi - 1} \right) \times \left( \sum_{h,k} \left( \rho_{h,o} \times \rho_{d,h} \times \mu_{od,h,k} \times \phi_k \times T_{h,k} \right)^{1-\chi} \right)^{\frac{1}{1-\chi}} \]

- "remoteness"

- Recall:
  - More remote locations are further away from (most) truckers’ residences.
  - Markups are increasing in market share.
Curse #2: More remote locations face higher markups.

- Combining expression for endogenous trade cost plus assumed marginal cost of capacity yields:

\[
\tau_{od} = \bar{\tau}_{od} \times \left( \frac{\chi}{\chi - 1} \right) \times \left( \sum_{h,k} (\rho_{h,o} \times \rho_{d,h} \times \mu_{od,h,k} \times \phi_k \times T_{h,k})^{1-\chi} \right)^{\frac{1}{1-\chi}}
\]

- "remoteness"

- Recall:
  - More remote locations are further away from (most) truckers’ residences.
  - Markups are increasing in market share.

- **Curse #2:** More remote locations have fewer nearby truckers, who are more able to exploit their market power by charging higher markups.
Curse #2: More remote locations face higher markups.
Curse #2: More remote locations face higher markups.
Curse #2: More remote locations face higher markups.
Curse #2: More remote locations face higher markups.
The Triple Curse of Remoteness

1. More remote locations face higher marginal costs.

2. More remote locations face higher markups.

3. More remote locations are served by worse truckers.
Curse #3: More remote locations are served by worse truckers.

- Combining expression for endogenous trade cost plus assumed marginal cost of capacity yields:

\[
\tau_{od} = \bar{\tau}_{od} \times \left( \frac{\chi}{\chi - 1} \right) \times \left( \sum_{h,k} (\rho_{h,o} \times \rho_{d,h} \times \mu_{od,h,k} \times \phi_k \times T_{h,k})^{1-\chi} \right)^{\frac{1}{1-\chi}}
\]

"remoteness"
Curse #3: More remote locations are served by worse truckers.

- Combining expression for endogenous trade cost plus assumed marginal cost of capacity yields:

\[ \tau_{od} = \bar{\tau}_{od} \times \left( \frac{\chi}{\chi - 1} \right) \times \left( \sum_{h,k} \left( \rho_{h,o} \times \rho_{d,h} \times \mu_{od,h,k} \times \phi_k \times T_{h,k} \right)^{1-\chi} \right)^{\frac{1}{1-\chi}} \]

- "remoteness"

- Recall:
Curse #3: More remote locations are served by worse truckers.

• Combining expression for endogenous trade cost plus assumed marginal cost of capacity yields:

\[
\tau_{od} = \bar{\tau}_{od} \times \left( \frac{\chi}{\chi - 1} \right) \times \left( \sum_{h,k} \left( \rho_{h,o} \times \rho_{d,h} \times \mu_{od,h,k} \times \phi_k \times T_{h,k} \right)^{1-\chi} \right) \]

"remoteness"

• Recall:
  • Profits are log-super modular in trucker productivity.
Curse #3: More remote locations are served by worse truckers.

- Combining expression for endogenous trade cost plus assumed marginal cost of capacity yields:

$$\tau_{od} = \bar{\tau}_{od} \times \left( \frac{\chi}{\chi - 1} \right) \times \left( \sum_{h,k} \left( \rho_{h,o} \times \rho_{d,h} \times \mu_{od,h,k} \times \phi_{k} \times T_{h,k} \right)^{1-\chi} \right)^{\frac{1}{1-\chi}}$$

- "remoteness"

- Recall:
  - Profits are log-super modular in trucker productivity.
  - Truckers choose residence to maximize profits.
Curse #3: More remote locations are served by worse truckers.

- Combining expression for endogenous trade cost plus assumed marginal cost of capacity yields:

\[
\tau_{od} = \bar{\tau}_{od} \times \left( \frac{\chi}{\chi - 1} \right) \times \left( \sum_{h,k} (\rho_{h,o} \times \rho_{d,h} \times \mu_{od,h,k} \times \phi_k \times T_{h,k})^{1-\chi} \right)^{\frac{1}{1-\chi}}
\]

- "remoteness"

- Recall:
  - Profits are log-super modular in trucker productivity.
  - Truckers choose residence to maximize profits.

- Curse #3: Of the truckers who reside in remote areas, a greater fraction are of worse types.
Curse #3: More remote locations served by worse truckers.
Curse #3: More remote locations served by worse truckers.
Curse #3: More remote locations served by worse truckers.
Curse #3: More remote locations served by worse truckers.
Each curse makes remoteness worse: Curse #1 vs. baseline

(log) Welfare relative to baseline

$\rho = \exp(0 \times \text{distance})$
Each curse makes remoteness worse: Curse #1 vs. baseline

(log) Welfare relative to baseline

\[ \rho = \exp(0.05 \times \text{distance}) \]
Each curse makes remoteness worse: Curse #1 vs. baseline

\[
\text{(log) Welfare relative to baseline} \\
\rho = \exp(0.1 \times \text{distance})
\]
Each curse makes remoteness worse: Curse #1 vs. baseline

(log) Welfare relative to baseline

$$\rho = \exp(0.25 \times \text{distance})$$
Each curse makes remoteness worse: Curse #2 vs. Curse #1

(log) Welfare relative to curse #1
Average trucks per location: 20
Each curse makes remoteness worse: Curse #2 vs. Curse #1

(log) Welfare relative to curse #1
Average trucks per location: 16
Each curse makes remoteness worse: Curse #2 vs. Curse #1

(log) Welfare relative to curse #1
Average trucks per location: 8
Each curse makes remoteness worse: Curse #2 vs. Curse #1

(log) Welfare relative to curse #1
Average trucks per location: 4
Each curse makes remoteness worse: Curse #3 vs. Curse #2

(log) Welfare relative to curse #2

bad trucks: 1x capacity costs
Each curse makes remoteness worse: Curse #3 vs. Curse #2

(log) Welfare relative to curse #2
bad trucks: 1.05x capacity costs
Each curse makes remoteness worse: Curse #3 vs. Curse #2

(log) Welfare relative to curse #2
bad trucks: 1.1x capacity costs
Each curse makes remoteness worse: Curse #3 vs. Curse #2

(log) Welfare relative to curse #2
bad trucks: 1.2x capacity costs
The Triple Curse of Remoteness: Empirical evidence

Fact 1a: Truckers travel further from home to serve more remote routes (Curse 1)
Fact 1b: Truckers market shares are declining with distance from home (Curse 1)
The Triple Curse of Remoteness: Empirical evidence

**Fact 1a:** Truckers travel further from home to serve more remote routes (Curse 1)

**Fact 1b:** Truckers market shares are declining with distance from home (Curse 1)

*And...*

**Fact 2a:** There is less competition on more remote routes (Curse 2)

**Fact 2b:** Routes that became more accessible became more competitive (Curse 2)
The Triple Curse of Remoteness: Empirical evidence

Fact 1a: Truckers travel further from home to serve more remote routes (Curse 1)
Fact 1b: Truckers market shares are declining with distance from home (Curse 1)

And...

Fact 2a: There is less competition on more remote routes (Curse 2)
Fact 2b: Routes that became more accessible became more competitive (Curse 2)

And...

Fact 3a: Truckers that supply more remote routes are worse (Curse 3)
Fact 3b: Better truckers expand relatively more when competition increases (Curse 3)
The Triple Curse of Remoteness: Empirical implications

*Resulting in:*

**Fact 4a:** Lower costs of transit on less remote routes

**Fact 4b:** Decreased costs of transit on routes with more and better truckers
The Triple Curse of Remoteness: Empirical implications

Resulting in:

**Fact 4a:** Lower costs of transit on less remote routes
**Fact 4b:** Decreased costs of transit on routes with more and better truckers

And...

**Fact 5a:** Higher trade flows on less remote routes
**Fact 5b:** Increased trade flows on routes with more and better truckers
Measuring Remoteness

- Theory:

\[
\ln \tau_{od} = c + \ln \bar{\tau}_{od} + \ln \left( \sum_{h,k} (\rho_{h,o} \times \rho_{d,h} \times \mu_{od,h,k} \times \phi_k \times T_{h,k})^{1-\chi} \right)^{1/(1-\chi)}
\]

"remoteness"
Measuring Remoteness

• Theory:

\[
\ln \tau_{od} = c + \ln \bar{\tau}_{od} + \ln \left( \sum_{h,k} \left( \rho_{h,o} \times \rho_{d,h} \times \mu_{od,h,k} \times \phi_k \times T_{h,k} \right)^{1-\chi} \right)^{\frac{1}{1-\chi}}
\]

• Empirical proxy:

\[
Remote_{od} \equiv -\ln \sum_h \left( \frac{1}{\text{dist}_{ho} \times \text{dist}_{dh} \times T_h} \right)
\]

• Assumes \( \phi_k = \mu_{od,h,k} = 1, \rho_{h,o}^{1-\chi} = \frac{1}{\text{dist}_{ho}} \)

• \( \text{dist}_{ho} \) is travel time between \( h \) and \( o \) [Alternatively: great circle distance].

• \( T_h \) is total number of truckers in \( h \) (regardless of type) [Alternatively: total population].
Identification in the cross section: Suggestive evidence

Intuition: Comparing routes that are equally far from $o$ and $d$, do routes which truckers live further from have less competition.
Identification in the panel: Causal evidence

Period 0

- Intuition: generate exogenous shocks to od competition from infrastructure improvements elsewhere, conditioning on od infrastructure improvements

Period 1
Evolution of the Colombian Infrastructure Network
Evolution of the Colombian Infrastructure Network
Evolution of the Colombian Infrastructure Network

Travel Times

- Simple Average
- Weighted Average
The Triple Curse of Remoteness: Empirical evidence

Fact 1a: Truckers travel further from home to serve more remote routes (Curse 1)
Fact 1b: Truckers market shares are declining with distance from home (Curse 1)

Fact 2a: There is less competition on more remote routes (Curse 2)
Fact 2b: Routes that became more accessible became more competitive (Curse 2)

Fact 3a: Truckers that supply more remote routes are worse (Curse 3)
Fact 3b: Better truckers expand relatively more when competition increases (Curse 3)
Fact 1a: Truckers travel further from home to serve more remote routes

$$\ln \text{roundtrip\_distance}_{od} = \beta \ln \text{Remote}_{od} + \sum_k \delta_{ok} + \sum_k \delta_{dk} + \epsilon_{od}$$
Fact 1b: Truckers market shares are declining with distance from home

\[ \ln \text{MarketShare}_{Owner,od} = \beta_1 \ln \text{TravelTimeHomeOrigin}_{h,o} + \beta_2 \ln \text{TravelTimeHomeDestination}_{h,d} + \delta_{Owner} + \delta_{od} + \epsilon_{Owner,od} \]
The Triple Curse of Remoteness: Empirical evidence

Fact 1a: Truckers travel further from home to serve more remote routes (Curse 1)
Fact 1b: Truckers market shares are declining with distance from home (Curse 1)

Fact 2a: There is less competition on more remote routes (Curse 2)
Fact 2b: Routes that became more accessible became more competitive (Curse 2)

Fact 3a: Truckers that supply more remote routes are worse (Curse 3)
Fact 3b: Better truckers expand relatively more when competition increases (Curse 3)
Fact 2a: There is less competition on more remote routes

\[
\ln HHI_{od} = \beta \ln Remote_{od} + \sum_k \delta_{ok} + \sum_k \delta_{dk} + \varepsilon_{od}
\]
Fact 2b: Routes that became more accessible became more competitive

\[
\ln HHI_{od,t} = \beta_1 \ln \left( \sum_h \left( \frac{\hat{Q}_{od,h,t}}{\sum_{h'} \hat{Q}_{od,h',t} \times T_{h',t}} \right)^2 \times T_{h,t} \right) + \beta_2 \ln \text{dist}_{od,t} + \delta_{od} + \delta_{ot} + \delta_{dt} + \varepsilon_{odt}
\]

where \( \hat{Q}_{od,h,t} \) comes from estimating trucker’s capacity:

\[
\ln Q_{od,h,t} = \alpha_1 \ln \text{dist}_{h,o,t} + \alpha_2 \ln \text{dist}_{h,d,t} + \delta_{od,t} + \delta_{h,t} + \varepsilon_{h,od,t}
\]

where we exclude FE and use \( T_{h,pre} \).
Fact 2b: Routes that became more accessible became more competitive

\[
\ln HHI_{od,t} = \beta_1 \ln \left( \sum_h \left( \frac{\hat{Q}_{od,h,t}}{\sum_{h'} \hat{Q}_{od,h',t} \times T_{h',t}} \right)^2 \times T_{h,t} \right) + \beta_2 \ln dist_{od,t} + \delta_{od} + \delta_{ot} + \delta_{dt} + \varepsilon_{odt}
\]
The Triple Curse of Remoteness: Empirical evidence

Fact 1a: Truckers travel further from home to serve more remote routes (Curse 1)
Fact 1b: Truckers market shares are declining with distance from home (Curse 1)

Fact 2a: There is less competition on more remote routes (Curse 2)
Fact 2b: Routes that became more accessible became more competitive (Curse 2)

Fact 3a: Truckers that supply more remote routes are worse (Curse 3)
Fact 3b: Better truckers expand relatively more when competition increases (Curse 3)
Fact 3a: Truckers serving more remote routes are worse

\[ \ln \text{Truckerquality}_{od} = \beta \ln \text{Remote}_{od} + \sum_k \delta_{ok} + \sum_k \delta_{dk} + \epsilon_{od} \]
Fact 3b: Better truckers expand their operations more when competition increases

- Can also explore differential sorting of truckers based on profits

\[ T_{h,t}^{owners,type} = \gamma_1 \Pi_{h,t}^{proxy,type} + \delta_{ht} + \delta_{h,type} + \delta_{t,type} + \varepsilon_{h,t} \]

- Where \( T_{h,t}^{owners,type} \) is number of truckers of given type (good, bad) residing in \( h \) at \( t \)
- \( \delta_{ht} \) ensures we are exploiting variation across trucker types within \( ht \)

\[ \Pi_{h,t}^{proxy,type} = \sum_{od} \left( \frac{1}{T_{od,t}^{type}} \times \left( \frac{\text{Shipments}_{od,t}^{type}}{\text{Shipments}_{od,t}} \right) \right)^2 \times \text{Shipments}_{od,t} \]

\[ \Pi_{h,t} = \sum_{od} \frac{\left( \frac{1}{\text{Type}_{od,t}^{type}} \times \left( \frac{\text{Shipments}_{od,t}^{type}}{\text{Shipments}_{od,t}} \right) \right)^2 \times \text{Shipments}_{od,t} \times \frac{\text{Shipments}_{od,pre}}{\text{Shipments}_{od,pre}}} \text{dist}_{ho,t} \times \text{dist}_{dh,t} \]

- With \( \Pi_{ht}^{IV,type,proxy} = \sum_{od} \frac{\left( \frac{1}{\text{Type}_{od,t}^{type}} \times \left( \frac{\text{Shipments}_{od,pre}^{type, -h}}{\text{Shipments}_{od,pre}^{h}} \right) \right)^2 \times \text{Shipments}_{od,pre}^{h}} \text{dist}_{ho,pre} \times \text{dist}_{dh,pre} \)

(excluding truckers from \( h \)) and \( T_{od,t}^{type} \) as before
### Table: Fact 3b: Better truckers expand their operations more when competition increases

<table>
<thead>
<tr>
<th></th>
<th>Number of Owners(h_t)</th>
<th>Number of Trucks(h_t)</th>
<th>Trucks/Owners(h_t)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Profit(h_t) (logs)</td>
<td>0.504**</td>
<td>0.067</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.250)</td>
<td>(0.142)</td>
<td></td>
</tr>
<tr>
<td>Fixed Effects</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- homeXmonth</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>- monthXtype</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>- homeXtype</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>SW/Cragg-Donald F-stat</td>
<td>186***</td>
<td>669***</td>
<td>186***</td>
</tr>
<tr>
<td>N</td>
<td>30,900</td>
<td>73,780</td>
<td>30,900</td>
</tr>
</tbody>
</table>

* p < 0.1, ** p < 0.05, *** p < 0.01. Standard errors in parentheses.
The Triple Curse of Remoteness: Implications

**Fact 4a:** Lower costs of transit on less remote routes

**Fact 4b:** Decreased costs of transit on routes with more and better truckers

**Fact 5a:** Higher trade flows on less remote routes

**Fact 5b:** Increased trade flows on routes with more and better truckers
Fact 4a: Lower costs of transit on less remote routes

\[ \ln Price_{odc} = \beta \ln Remote_{od} + \sum_k \delta_{okc} + \sum_k \delta_{dkc} + \epsilon_{odc} \]
Fact 4b: Decreased costs of transit on routes with more and better truckers

\[
\ln p_{od,t,c} = \beta_1 \ln dist_{od,t} + \beta_2 \ln HHI_{od,t} + \beta_3 \ln wtd.\avg.\capacity_{od,t} + \delta_{od} + \delta_t + \delta_c + \varepsilon_{od,t},
\]

- where \( \ln HHI_{od,t} \) instrumented with \( \ln \left( \sum_h \frac{(dist_{ho,t})^{\hat{\alpha}_1} (dist_{hd,t})^{\hat{\alpha}_2}}{\sum_{od} (dist_{h\emptyset,t})^{\hat{\alpha}_1} (dist_{h\tilde{d},t})^{\hat{\alpha}_2} \times TruckOwners_{h,pre}} \right) \)

- and \( \ln wtd.\avg.\capacity_{od,t} \) instrumented with \( \ln \sum_{type} \left( \frac{\hat{N}_{od,t}^{type}}{\sum_{\tilde{type}} \hat{N}_{od,t}^{\tilde{type}}} \right) \times capacity_{od,pre}^{type} \)
Table: Fact 4b: Decreased costs of transit on routes with more and better truckers

<table>
<thead>
<tr>
<th>Source of Market Concentration</th>
<th>IV 1st stage: Market concentration_{od,t} (log HHI)</th>
<th>OLS: Price_{od,t,c} (log)</th>
<th>IV 2nd Stage: Price_{od,t,c} (log)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infrastructure-predicted market concentration_{od,t} (log)</td>
<td>2.51*** (0.33)</td>
<td>-0.00*** (0.00)</td>
<td>0.29** (0.12)</td>
</tr>
<tr>
<td>Market concentration_{od,t} (log HHI)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Travel Time_{od,t} (log)</td>
<td>0.03 (0.02)</td>
<td>-0.00 (0.02)</td>
<td>-0.03 (0.02)</td>
</tr>
</tbody>
</table>

**Fixed Effects**
- origin X destination X commodity: X X X
- origin X month X commodity: X X X
- destination X month X commodity: X X X

**Statistics**
- SW F-stat: Market Concentration: 59.3***
- Cragg-Donald F-stat: 59.3*

| N | 715,206 | 715,206 | 715,206 |
| Adjusted within-$R^2$ | 0.00 | |

*p < 0.1, **p < 0.05, ***p < 0.01. Standard errors in parentheses.
t=month, o=origin, d=destination, k = travel time bins
## Table: Fact 4b: Decreased costs of transit on routes with more and better truckers

<table>
<thead>
<tr>
<th></th>
<th>IV 1&lt;sup&gt;st&lt;/sup&gt; stage: Market concentration&lt;sub&gt;od,t&lt;/sub&gt; (log HHI)</th>
<th>IV 1&lt;sup&gt;st&lt;/sup&gt; stage: Quality&lt;sub&gt;od,t&lt;/sub&gt; (log owner avg. capacity)</th>
<th>OLS: Price&lt;sub&gt;od,t,c&lt;/sub&gt; (log)</th>
<th>IV 2&lt;sup&gt;nd&lt;/sup&gt; Stage: Price&lt;sub&gt;od,t,c&lt;/sub&gt; (log)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infrastructure-predicted market concentration&lt;sub&gt;od,t&lt;/sub&gt; (log)</td>
<td>2.52*** (0.33)</td>
<td>3.28*** (0.63)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Infrastructure-predicted change in quality</td>
<td>-0.05*** (0.00)</td>
<td>0.61*** (0.01)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Market concentration&lt;sub&gt;od,t&lt;/sub&gt; (log HHI)</td>
<td>-0.01*** (0.00)</td>
<td></td>
<td>0.19* (0.11)</td>
<td></td>
</tr>
<tr>
<td>Quality&lt;sub&gt;od,t&lt;/sub&gt; (log owner avg. capacity)</td>
<td></td>
<td>0.00*** (0.00)</td>
<td>0.08*** (0.01)</td>
<td></td>
</tr>
<tr>
<td>Travel Time&lt;sub&gt;od,t&lt;/sub&gt; (log)</td>
<td>0.03 (0.02)</td>
<td>0.23*** (0.04)</td>
<td>-0.00 (0.02)</td>
<td>-0.05** (0.02)</td>
</tr>
</tbody>
</table>

**Fixed Effects**
- origin X destination X commodity
- origin X month X commodity
- destination X month X commodity

**SW F-stat:**
- Market Concentration: 68.2***
- Quality: 102***
- Cragg-Donald F-stat: 34*

**N:**
- 715,206

**Adjusted within-R²:**
- 0.00

* p < 0.1, ** p < 0.05, *** p < 0.01. Standard errors in parentheses.

t=month, o=origin, d=destination, k = travel time bins
The Triple Curse of Remoteness: Implications

**Fact 4a:** Lower costs of transit on less remote routes

**Fact 4b:** Decreased costs of transit on routes with more and better truckers

**Fact 5a:** Higher trade flows on less remote routes

**Fact 5b:** Increased trade flows on routes with more and better truckers
Fact 5a: Higher trade flows on less remote routes

\[ \ln Q_{od} = \beta \ln \text{Remote}_{od} + \sum_k \delta_{ok} + \sum_k \delta_{dk} + \varepsilon_{od} \]

(l) Number of shipments  
(m) Tons  
(n) Extensive margin
Table: Fact 5b: Increased trade flows on routes with better truckers

<table>
<thead>
<tr>
<th></th>
<th>IV 1st stage: Market concentration&lt;sub&gt;od,t&lt;/sub&gt; (log HHI)</th>
<th>IV 1st stage: Quality&lt;sub&gt;od,t&lt;/sub&gt; (log owner avg. capacity)</th>
<th>OLS: Tons Shipped&lt;sub&gt;od,t,c&lt;/sub&gt; (log)</th>
<th>IV 2nd Stage: Tons Shipped&lt;sub&gt;od,t,c&lt;/sub&gt; (log)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infrastructure-predicted market concentration&lt;sub&gt;od,t&lt;/sub&gt; (log)</td>
<td>2.52*** (0.33)</td>
<td>3.28*** (0.63)</td>
<td>-0.00 (0.00)</td>
<td>0.14 (0.18)</td>
</tr>
<tr>
<td>Infrastructure-predicted change in quality</td>
<td>-0.05*** (0.00)</td>
<td>0.61*** (0.01)</td>
<td>0.01*** (0.00)</td>
<td>0.12*** (0.02)</td>
</tr>
<tr>
<td>Market concentration&lt;sub&gt;od,t&lt;/sub&gt; (log HHI)</td>
<td>-0.00 (0.00)</td>
<td>0.14 (0.18)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quality&lt;sub&gt;od,t&lt;/sub&gt; (log owner avg. capacity)</td>
<td>0.01*** (0.00)</td>
<td>0.12*** (0.02)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Travel Time&lt;sub&gt;od,t&lt;/sub&gt; (log)</td>
<td>0.03 (0.02)</td>
<td>0.23*** (0.04)</td>
<td>0.02 (0.03)</td>
<td>-0.03 (0.04)</td>
</tr>
</tbody>
</table>

Fixed Effects
- origin X destination X commodity
- origin X month X commodity
- destination X month X commodity

SW F-stat: Market Concentration 68.2***
SW F-stat: Quality 102***
Cragg-Donald F-stat 34*

N 715,206
Adjusted within-R<sup>2</sup> 0.00

* p < 0.1, ** p < 0.05, *** p < 0.01. Standard errors in parentheses.

\[ \ln \text{Shipments}_{odt} = \beta_1 \ln \text{dist}_{od,t} + \beta_2 \ln \text{HHI}_{od,t} + \beta_3 \ln \text{wtd.avg.capacity}_{od,t} + \delta_{od} + \delta_t + \delta_c + \epsilon_{od,t} \]
Outline of Talk

Introduction

Trucking in Colombia

A spatial model with imperfect competition

The Triple Curse of Remoteness

Next Steps and Conclusion
Next Step: Quantify impact of infrastructure improvements

Figure: An example infrastructure improvement
Next Step: Quantify impact of infrastructure improvements

Figure: An example infrastructure improvement: Welfare gains *without* market power
Next Step: Quantify impact of infrastructure improvements

Figure: An example infrastructure improvement: Welfare gains *with* market power
Next Step: How does competition policy shape these impacts?
Next Step: How does competition policy shape these impacts?

**Figure:** Colombia’s new(ly enforced) 1:1 truck scrapping scheme

(a) All Trucks

(b) Big Trucks (Weight>10.5 tons)
Conclusion

- New spatial imperfect competition model, cross-sectional patterns from shipment-level trucking data, and plausibly causal estimates from infrastructure changes highlight the *triple curse of remoteness*:

1. Remoteness $\implies$ higher physical transportation costs
2. Remoteness $\implies$ less competition in transportation sector, higher markups
3. Remoteness $\implies$ transportation services provided by worse firms
Conclusion

- New spatial imperfect competition model, cross-sectional patterns from shipment-level trucking data, and plausibly causal estimates from infrastructure changes highlight the *triple curse of remoteness:*

1. Remoteness $\implies$ higher physical transportation costs
2. Remoteness $\implies$ less competition in transportation sector, higher markups
3. Remoteness $\implies$ transportation services provided by worse firms

- Much still to do:
  - Quantifying the welfare impacts of existing infrastructure improvements in the presence of market power.
  - Quantify the impact of (anti) competitive policies on gains from future infrastructure improvements.
Other Notable Triple Curses

“I stand a wretch, in birth, in wedlock cursed, A parricide, incestuously, triply cursed!” - Oedipus
Other Notable Triple Curses

THE TRIPLE CURSE;

OR, THE

EVILS OF THE OPIUM TRADE

ON

INDIA, CHINA, AND ENGLAND.

BEING THE REPORT OF A SPEECH DELIVERED AT THE

GUILDHALL, BATH,

BY

J. PASSMORE EDWARDS.

LONDON: JUDD AND GLASS, NEW BRIDGE STREET,
AND GRAY'S INN ROAD.

Price 3d.
Other Notable Triple Curses
**Table:** Fact 1a: Truckers travel further from home to serve more remote routes

<table>
<thead>
<tr>
<th>Dep. var: Round Trip Travel Time_{od} (log)</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Remoteness_{od}</td>
<td>1.543***</td>
<td>0.892***</td>
<td>0.692***</td>
</tr>
<tr>
<td></td>
<td>(0.013)</td>
<td>(0.094)</td>
<td>(0.166)</td>
</tr>
</tbody>
</table>

**Fixed Effects**
- origin X destination                          X
- origin X distance bins, destination X distance bins (K=10) X
- origin X distance bins, destination X distance bins (K=25) X

<table>
<thead>
<tr>
<th>Observations</th>
<th>9,754</th>
<th>7,431</th>
<th>5,029</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adjusted within-$R^2$</td>
<td>0.63</td>
<td>0.02</td>
<td>0.01</td>
</tr>
</tbody>
</table>

* p < 0.1, ** p < 0.05, *** p < 0.01. Standard errors in parentheses. o=origin, d=destination, k = bins of travel times, h=home.

Remoteness_{od} $\approx -\ln \sum_h \left( \frac{1}{dist_{ho} \times dist_{dh}} \times \left( \frac{L_h}{\sum_h L_h} \right) \right)$, where dist=travel times and L=truck truckers. o=origin, d=destination, k = bins of travel times, h=home.
Table: Fact 2a: There is less competition on more remote routes

<table>
<thead>
<tr>
<th>Dep. var: Market Concentration_{od} (log HHI)</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Remoteeness measured using travel times &amp; population shares</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Remoteeness_{od}</td>
<td>0.53***</td>
<td>0.69***</td>
<td>0.56***</td>
</tr>
<tr>
<td></td>
<td>(0.01)</td>
<td>(0.05)</td>
<td>(0.10)</td>
</tr>
<tr>
<td>Observations</td>
<td>34,819</td>
<td>34,602</td>
<td>34,744</td>
</tr>
<tr>
<td>Remoteeness measured using travel times &amp; truck owner shares</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Remoteeness_{od}</td>
<td>0.60***</td>
<td>0.66***</td>
<td>0.50***</td>
</tr>
<tr>
<td></td>
<td>(0.01)</td>
<td>(0.05)</td>
<td>(0.09)</td>
</tr>
<tr>
<td>Observations</td>
<td>34,819</td>
<td>34,602</td>
<td>34,744</td>
</tr>
<tr>
<td>Remoteeness measured using straight line distance &amp; population shares</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Remoteeness_{od}</td>
<td>0.33***</td>
<td>0.35***</td>
<td>0.11***</td>
</tr>
<tr>
<td></td>
<td>(0.01)</td>
<td>(0.03)</td>
<td>(0.06)</td>
</tr>
<tr>
<td>Observations</td>
<td>33,818</td>
<td>33,530</td>
<td>33,726</td>
</tr>
<tr>
<td>Remoteeness measured using straight line distance &amp; truck owner shares</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Remoteeness_{od}</td>
<td>0.33***</td>
<td>0.26***</td>
<td>0.06</td>
</tr>
<tr>
<td></td>
<td>(0.01)</td>
<td>(0.03)</td>
<td>(0.05)</td>
</tr>
<tr>
<td>Observations</td>
<td>33,818</td>
<td>33,530</td>
<td>33,726</td>
</tr>
</tbody>
</table>

Fixed Effects
origin X destination                               X   X   X
origin X distance bins, destination X distance bins (K=10)   X
origin X distance bins, destination X distance bins (K=25)   

*p < 0.1, ** p < 0.05, *** p < 0.01. Standard errors in parentheses.

Remoteeness_{od} ≈ -ln \sum_{h} \left( \frac{1}{dist_{ho} \times dist_{dh}} \times \left( \frac{L_{h}}{L_{h}} \right)^{k} \right), where dist={travel times, straight line distance} and L={population, truck owner share}, o=origin, d=destination, k = bins of travel times or straight line distances, h=home.

Note: If od had 0 trips, HHI was not calculated.
Table: Fact 2b: Routes that became more accessible became more competitive

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Market Concentration</strong>&lt;sub&gt;od,t&lt;/sub&gt; (log HHI)</td>
<td><strong>0.15</strong>*</td>
<td><strong>0.15</strong>*</td>
</tr>
<tr>
<td>Infrastructure-predicted market concentration&lt;sub&gt;od,t&lt;/sub&gt; (log)</td>
<td>(0.00)</td>
<td>(0.00)</td>
</tr>
<tr>
<td>Travel Time&lt;sub&gt;od,t&lt;/sub&gt; (log)</td>
<td>-0.09***</td>
<td>(0.02)</td>
</tr>
</tbody>
</table>

**Fixed Effects**
- origin X destination  | X       | X       |
- origin X month        | X       | X       |
- destination X month   | X       | X       |

**Observations** | 548,776 | 548,776 |
**Adjusted within-<i>R</i><sup>2</sup>** | 0.16    | 0.16    |

* p < 0.1, ** p < 0.05, *** p < 0.01. Standard errors in parentheses.

Remoteness<sub>od</sub> ≈ \(-\ln \sum_h \frac{1}{\text{dist}_{ho} \times \text{dist}_{dh}} \times \left( \frac{L_h}{\sum_h L_h} \right)\), where \(\text{dist} = \{\text{travel times, straight line distance}\}\) and \(L = \{\text{population, truck owner share}\}\).  \(o = \text{origin}, d = \text{destination}, k = \text{bins of travel times or straight line distances}, h = \text{home}\).

**Note:** If od had 0 trips, HHI was not calculated.
Table: Fact 3a: There are worse truck owners on more remote routes

<table>
<thead>
<tr>
<th>Dep. var: Trucks/Owners&lt;sub&gt;od&lt;/sub&gt; (logs)</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Remoteeness measured using travel times &amp; population shares</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Remoteeness&lt;sub&gt;od&lt;/sub&gt;</td>
<td>-0.26***</td>
<td>-0.86***</td>
<td>-0.73***</td>
</tr>
<tr>
<td></td>
<td>(0.02)</td>
<td>(0.09)</td>
<td>(0.16)</td>
</tr>
<tr>
<td>Observations</td>
<td>34,819</td>
<td>34,602</td>
<td>34,744</td>
</tr>
<tr>
<td>Remoteeness measured using travel times &amp; truck owner shares</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Remoteeness&lt;sub&gt;od&lt;/sub&gt;</td>
<td>-0.31***</td>
<td>-0.86***</td>
<td>-0.66***</td>
</tr>
<tr>
<td></td>
<td>(0.02)</td>
<td>(0.09)</td>
<td>(0.16)</td>
</tr>
<tr>
<td>Observations</td>
<td>34,819</td>
<td>34,602</td>
<td>34,744</td>
</tr>
<tr>
<td>Remoteeness measured using straight line distance &amp; population shares</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Remoteeness&lt;sub&gt;od&lt;/sub&gt;</td>
<td>-0.17***</td>
<td>-0.19***</td>
<td>-0.03</td>
</tr>
<tr>
<td></td>
<td>(0.01)</td>
<td>(0.05)</td>
<td>(0.09)</td>
</tr>
<tr>
<td>Observations</td>
<td>33,818</td>
<td>33,530</td>
<td>33,726</td>
</tr>
<tr>
<td>Remoteeness measured using straight line distance &amp; truck owner shares</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Remoteeness&lt;sub&gt;od&lt;/sub&gt;</td>
<td>-0.17***</td>
<td>-0.18***</td>
<td>-0.03</td>
</tr>
<tr>
<td></td>
<td>(0.01)</td>
<td>(0.05)</td>
<td>(0.08)</td>
</tr>
<tr>
<td>Observations</td>
<td>33,818</td>
<td>33,530</td>
<td>33,726</td>
</tr>
<tr>
<td>Fixed Effects</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>origin X destination</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>origin X distance bins, destination X distance bins (K=10)</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>origin X distance bins, destination X distance bins (K=25)</td>
<td></td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>

* p < 0.1, ** p < 0.05, *** p < 0.01. Standard errors in parentheses.

Remoteeness<sub>od</sub> ≈ −ln ∑ₙ (1 / distₖₙ × distₖₙ) × (Lₖ / Lₙₖ), where dist=[travel times, straight line distance] and L=[population, truck owner share], o=origin, d=destination, k = bins of travel times or straight line distances, h=home.
**Table:** Fact 3a: There are worse truck owners on more remote routes

<table>
<thead>
<tr>
<th>Dep. var: Capacity/Owners_{od} (logs)</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Remoteness measured using travel times &amp; population shares</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Remoteness_{od}</td>
<td>-0.15***</td>
<td>-0.90***</td>
<td>-0.72***</td>
</tr>
<tr>
<td></td>
<td>(0.03)</td>
<td>(0.11)</td>
<td>(0.21)</td>
</tr>
<tr>
<td>Observations</td>
<td>34,819</td>
<td>34,602</td>
<td>34,744</td>
</tr>
<tr>
<td><strong>Remoteness measured using travel times &amp; truck owner shares</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Remoteness_{od}</td>
<td>-0.17***</td>
<td>-0.91***</td>
<td>-0.66***</td>
</tr>
<tr>
<td></td>
<td>(0.03)</td>
<td>(0.12)</td>
<td>(0.20)</td>
</tr>
<tr>
<td>Observations</td>
<td>34,819</td>
<td>34,602</td>
<td>34,744</td>
</tr>
<tr>
<td><strong>Remoteness measured using straight line distance &amp; population shares</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Remoteness_{od}</td>
<td>-0.12***</td>
<td>-0.23***</td>
<td>-0.01</td>
</tr>
<tr>
<td></td>
<td>(0.02)</td>
<td>(0.07)</td>
<td>(0.12)</td>
</tr>
<tr>
<td>Observations</td>
<td>33,818</td>
<td>33,530</td>
<td>33,726</td>
</tr>
<tr>
<td><strong>Remoteness measured using straight line distance &amp; truck owner shares</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Remoteness_{od}</td>
<td>-0.12***</td>
<td>-0.20***</td>
<td>0.02</td>
</tr>
<tr>
<td></td>
<td>(0.02)</td>
<td>(0.06)</td>
<td>(0.10)</td>
</tr>
<tr>
<td>Observations</td>
<td>33,818</td>
<td>33,530</td>
<td>33,726</td>
</tr>
<tr>
<td><strong>Fixed Effects</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>origin X destination</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>origin X distance bins, destination X distance bins (K=10)</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>origin X distance bins, destination X distance bins (K=25)</td>
<td></td>
<td>X</td>
<td></td>
</tr>
</tbody>
</table>

* p < 0.1, ** p < 0.05, *** p < 0.01. Standard errors in parentheses.

Remoteness_{od} \approx -\ln \sum_{h} \left( \frac{1}{\text{dist}_{oh} \times \text{dist}_{dh}} \times \left( \frac{L_{oh}}{L_{dh}} \right) \right), \text{ where dist}=[\text{travel times, straight line distance}] \text{ and } L=[\text{population, truck owner share}], o=\text{origin}, d=\text{destination}, k=\text{bins of travel times or straight line distances}, h=\text{home}.
**Table: Fact 3a: There are worse truck owners on more remote routes**

<table>
<thead>
<tr>
<th>Dep. var: Age of Owner’s Trucks&lt;sub&gt;od&lt;/sub&gt; (logs)</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Remoteness measured using travel times &amp; population shares</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Remoteness&lt;sub&gt;od&lt;/sub&gt;</td>
<td>-0.44***</td>
<td>-0.34***</td>
<td>-0.30***</td>
</tr>
<tr>
<td></td>
<td>(0.01)</td>
<td>(0.04)</td>
<td>(0.08)</td>
</tr>
<tr>
<td>Observations</td>
<td>34,815</td>
<td>34,598</td>
<td>34,740</td>
</tr>
<tr>
<td>Remoteness measured using travel times &amp; truck owner shares</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Remoteness&lt;sub&gt;od&lt;/sub&gt;</td>
<td>-0.49***</td>
<td>-0.24***</td>
<td>-0.14*</td>
</tr>
<tr>
<td></td>
<td>(0.01)</td>
<td>(0.04)</td>
<td>(0.07)</td>
</tr>
<tr>
<td>Observations</td>
<td>34,815</td>
<td>34,598</td>
<td>34,740</td>
</tr>
<tr>
<td>Remoteness measured using straight line distance &amp; population shares</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Remoteness&lt;sub&gt;od&lt;/sub&gt;</td>
<td>-0.25***</td>
<td>-0.22***</td>
<td>-0.26***</td>
</tr>
<tr>
<td></td>
<td>(0.01)</td>
<td>(0.02)</td>
<td>(0.04)</td>
</tr>
<tr>
<td>Observations</td>
<td>33,814</td>
<td>33,526</td>
<td>33,721</td>
</tr>
<tr>
<td>Remoteness measured using straight line distance &amp; truck owner shares</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Remoteness&lt;sub&gt;od&lt;/sub&gt;</td>
<td>-0.25***</td>
<td>-0.16***</td>
<td>-0.17***</td>
</tr>
<tr>
<td></td>
<td>(0.01)</td>
<td>(0.02)</td>
<td>(0.04)</td>
</tr>
<tr>
<td>Observations</td>
<td>33,814</td>
<td>33,526</td>
<td>33,721</td>
</tr>
</tbody>
</table>

**Fixed Effects**
- origin X destination: X X X
- origin X distance bins, destination X distance bins (K=10): X
- origin X distance bins, destination X distance bins (K=25): X

* p < 0.1, ** p < 0.05, *** p < 0.01. Standard errors in parentheses.

Remoteness<sub>od</sub> ≈ − ln \( \sum_h \left( \frac{1}{\text{dist}_{ho} \times \text{dist}_{dh}} \times \left( \frac{L_h}{L_h + L_d} \right) \right) \), where dist = {travel times, straight line distance} and L = {population, truck owner share}. o = origin, d = destination, k = bins of travel times or straight line distances, h = home.
**Table: Fact 4a: Prices are higher on more remote routes**

<table>
<thead>
<tr>
<th>Dep. var: Price (logs)</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Remoteness measured using travel times &amp; population shares</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Remoteness$_{od}$</td>
<td>1.29***</td>
<td>2.15***</td>
<td>2.69***</td>
</tr>
<tr>
<td></td>
<td>(0.01)</td>
<td>(0.03)</td>
<td>(0.05)</td>
</tr>
<tr>
<td>Observations</td>
<td>106,009</td>
<td>104,466</td>
<td>105,026</td>
</tr>
<tr>
<td>Remoteness measured using travel times &amp; truck owner shares</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Remoteness$_{od}$</td>
<td>1.36***</td>
<td>2.02***</td>
<td>2.64***</td>
</tr>
<tr>
<td></td>
<td>(0.01)</td>
<td>(0.03)</td>
<td>(0.05)</td>
</tr>
<tr>
<td>Observations</td>
<td>106,009</td>
<td>104,466</td>
<td>105,026</td>
</tr>
<tr>
<td>Remoteness measured using straight line distance &amp; population shares</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Remoteness$_{od}$</td>
<td>0.71***</td>
<td>0.78***</td>
<td>0.64***</td>
</tr>
<tr>
<td></td>
<td>(0.00)</td>
<td>(0.02)</td>
<td>(0.03)</td>
</tr>
<tr>
<td>Observations</td>
<td>79,978</td>
<td>77,475</td>
<td>78,558</td>
</tr>
<tr>
<td>Remoteness measured using straight line distance &amp; truck owner shares</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Remoteness$_{od}$</td>
<td>0.70***</td>
<td>0.66***</td>
<td>0.53***</td>
</tr>
<tr>
<td></td>
<td>(0.00)</td>
<td>(0.02)</td>
<td>(0.03)</td>
</tr>
<tr>
<td>Observations</td>
<td>79,978</td>
<td>77,475</td>
<td>78,558</td>
</tr>
<tr>
<td>Fixed Effects</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>origin X destination X commodity</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>origin X commodity X distance bins, destination X commodity X distance bins (K=10)</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>origin X commodity X distance bins, destination X commodity X distance bins (K=25)</td>
<td>X</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* \( p < 0.1, \ ** p < 0.05, \ *** p < 0.01. \) Standard errors in parentheses.

\[
\text{Remoteness}_{{od}} \approx - \ln \left( \sum_h \left( \frac{1}{\text{dist}_h \times \text{dist}_h} \times \left( \frac{L_h}{L} \right) \right) \right), \text{ where dist}=\{\text{travel times, straight line distance}\} \text{ and } L=\{\text{population, truck owner share}\}.
\]

\( o = \text{origin}, \ d = \text{destination}, k = \text{bins of travel times or straight line distances}, h = \text{home}. \)
### Table: Fact 4a: Prices are higher on more remote routes

<table>
<thead>
<tr>
<th>Dep. var: Price/Ton_{\text{od},c} (logs)</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Remote Mesurement using Travel times &amp; Population Shares</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Remote Mesurement_{\text{od}}</td>
<td>0.93***</td>
<td>1.64***</td>
<td>2.13***</td>
</tr>
<tr>
<td></td>
<td>(0.01)</td>
<td>(0.04)</td>
<td>(0.06)</td>
</tr>
<tr>
<td>Observations</td>
<td>106,009</td>
<td>104,466</td>
<td>105,026</td>
</tr>
<tr>
<td>Remote Mesurement using Travel times &amp; Truck Owner Shares</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Remote Mesurement_{\text{od}}</td>
<td>0.98***</td>
<td>1.49***</td>
<td>2.01***</td>
</tr>
<tr>
<td></td>
<td>(0.01)</td>
<td>(0.04)</td>
<td>(0.07)</td>
</tr>
<tr>
<td>Observations</td>
<td>106,009</td>
<td>104,466</td>
<td>105,026</td>
</tr>
<tr>
<td>Remote Mesurement using Straight Line Distance &amp; Population Shares</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Remote Mesurement_{\text{od}}</td>
<td>0.53***</td>
<td>0.69***</td>
<td>0.62***</td>
</tr>
<tr>
<td></td>
<td>(0.01)</td>
<td>(0.03)</td>
<td>(0.05)</td>
</tr>
<tr>
<td>Observations</td>
<td>79,978</td>
<td>77,475</td>
<td>78,558</td>
</tr>
<tr>
<td>Remote Mesurement using Straight Line Distance &amp; Truck Owner Shares</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Remote Mesurement_{\text{od}}</td>
<td>0.52***</td>
<td>0.55***</td>
<td>0.46***</td>
</tr>
<tr>
<td></td>
<td>(0.01)</td>
<td>(0.03)</td>
<td>(0.05)</td>
</tr>
<tr>
<td>Observations</td>
<td>79,978</td>
<td>77,475</td>
<td>78,558</td>
</tr>
</tbody>
</table>

**Fixed Effects**
- origin X destination X commodity
- origin X commodity X distance bins, destination X commodity X distance bins (K=10)
- origin X commodity X distance bins, destination X commodity X distance bins (K=25)

* p < 0.1, ** p < 0.05, *** p < 0.01. Standard errors in parentheses.

 skirm

$Remote_{\text{od}} \approx - \ln \sum_h \left( \frac{1}{\text{dist}_{\text{ho}} \times \text{dist}_{\text{dh}}} \times \left( \frac{1}{L_h \times L_h} \right) \right)$, where $\text{dist} = \{\text{travel times, straight line distance}\}$ and $L = \{\text{population, truck owner share}\}$. 

o=origin, d=destination, k=bins of travel times or straight line distances, h=home. 
<table>
<thead>
<tr>
<th>Model</th>
<th>Dep. var: Number of Shipments_{od} (logs)</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Remoteeness measured using travel times &amp; population shares</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Remoteeness_{od}</td>
<td>-2.34***</td>
<td>-3.75***</td>
<td>-3.35***</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.03)</td>
<td>(0.13)</td>
<td>(0.25)</td>
</tr>
<tr>
<td></td>
<td>Observations</td>
<td>34,819</td>
<td>34,602</td>
<td>34,744</td>
</tr>
<tr>
<td></td>
<td>Remoteeness measured using travel times &amp; truck owner shares</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Remoteeness_{od}</td>
<td>-2.69***</td>
<td>-3.51***</td>
<td>-2.78***</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.04)</td>
<td>(0.14)</td>
<td>(0.23)</td>
</tr>
<tr>
<td></td>
<td>Observations</td>
<td>34,819</td>
<td>34,602</td>
<td>34,744</td>
</tr>
<tr>
<td></td>
<td>Remoteeness measured using straight line distance &amp; population shares</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Remoteeness_{od}</td>
<td>-1.43***</td>
<td>-1.58***</td>
<td>-0.73***</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.02)</td>
<td>(0.08)</td>
<td>(0.14)</td>
</tr>
<tr>
<td></td>
<td>Observations</td>
<td>33,818</td>
<td>33,530</td>
<td>33,726</td>
</tr>
<tr>
<td></td>
<td>Remoteeness measured using straight line distance &amp; truck owner shares</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Remoteeness_{od}</td>
<td>-1.44***</td>
<td>-1.26***</td>
<td>-0.48***</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.02)</td>
<td>(0.08)</td>
<td>(0.12)</td>
</tr>
<tr>
<td></td>
<td>Observations</td>
<td>33,818</td>
<td>33,530</td>
<td>33,726</td>
</tr>
<tr>
<td></td>
<td>Fixed Effects</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>origin X destination</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>origin X distance bins, destination X distance bins (K=10)</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>origin X distance bins, destination X distance bins (K=25)</td>
<td></td>
<td>X</td>
<td></td>
</tr>
</tbody>
</table>

* p < 0.1, ** p < 0.05, *** p < 0.01. Standard errors in parentheses.

Remoteeness_{od} \approx -\ln \sum_{h} \left( \frac{1}{\text{dist}_{ho} \times \text{dist}_{dh}} \times \left( \frac{L_{h}}{\sum_{h} L_{h}} \right) \right), where dist={travel times, straight line distance} and L={population, truck owner share}, o=origin, d=destination, k = bins of travel times or straight line distances, h=home.
**Table: Fact 5a: Trade is lower on more remote routes**

<table>
<thead>
<tr>
<th>Dep. var: Tons Shipped(_{od,c}) (logs)</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Remoteness measured using travel times &amp; population shares</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Remoteness(_{od})</td>
<td>-0.23***</td>
<td>-0.78***</td>
<td>-0.62***</td>
</tr>
<tr>
<td></td>
<td>(0.01)</td>
<td>(0.07)</td>
<td>(0.10)</td>
</tr>
<tr>
<td>Observations</td>
<td>112,150</td>
<td>111,023</td>
<td>111,481</td>
</tr>
<tr>
<td><strong>Remoteness measured using travel times &amp; truck owner shares</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Remoteness(_{od})</td>
<td>-0.24***</td>
<td>-0.75***</td>
<td>-0.55***</td>
</tr>
<tr>
<td></td>
<td>(0.01)</td>
<td>(0.08)</td>
<td>(0.10)</td>
</tr>
<tr>
<td>Observations</td>
<td>112,150</td>
<td>111,023</td>
<td>111,481</td>
</tr>
<tr>
<td><strong>Remoteness measured using straight line distance &amp; population shares</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Remoteness(_{od})</td>
<td>-0.20***</td>
<td>-0.29***</td>
<td>-0.13*</td>
</tr>
<tr>
<td></td>
<td>(0.01)</td>
<td>(0.05)</td>
<td>(0.08)</td>
</tr>
<tr>
<td>Observations</td>
<td>78,666</td>
<td>76,181</td>
<td>77,264</td>
</tr>
<tr>
<td><strong>Remoteness measured using straight line distance &amp; truck owner shares</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Remoteness(_{od})</td>
<td>-0.19***</td>
<td>-0.25***</td>
<td>-0.11</td>
</tr>
<tr>
<td></td>
<td>(0.01)</td>
<td>(0.05)</td>
<td>(0.07)</td>
</tr>
<tr>
<td>Observations</td>
<td>78,666</td>
<td>76,181</td>
<td>77,264</td>
</tr>
</tbody>
</table>

| Fixed Effects                           |          |          |          |
| origin X destination X commodity        | X        | X        | X        |
| origin X commodity X distance bins, destination X commodity X distance bins (K=10) | X        |          |          |
| origin X commodity X distance bins, destination X commodity X distance bins (K=25) |          | X        |          |

\[ Remoteness\(_{od}\) \approx -\ln \sum_h \left( \frac{1}{\text{dist}_{oh} \times \text{dist}_{dh}} \times \left( \frac{1}{L_h} \right) \right), \] where \( \text{dist} = \{\text{travel times, straight line distance}\} \) and \( L = \{\text{population, truck owner share}\} \).

\( o = \text{origin}, d = \text{destination}, k = \text{bins of travel times or straight line distances}, h = \text{home}. \)

\* \( p < 0.1 \), \** \( p < 0.05 \), \*** \( p < 0.01 \). Standard errors in parentheses.
**Table: Fact 5a: Trade is lower on more remote routes**

<table>
<thead>
<tr>
<th>Remoteness measured using travel times &amp; population shares</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Remoteness(\text{od})</td>
<td>-0.14***</td>
<td>-0.12***</td>
<td>-0.02***</td>
</tr>
<tr>
<td></td>
<td>(0.00)</td>
<td>(0.00)</td>
<td>(0.00)</td>
</tr>
<tr>
<td>Observations</td>
<td>1,110,916</td>
<td>1,110,863</td>
<td>1,110,691</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Remoteness measured using travel times &amp; truck owner shares</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Remoteness(\text{od})</td>
<td>-0.17***</td>
<td>-0.16***</td>
<td>-0.08***</td>
</tr>
<tr>
<td></td>
<td>(0.00)</td>
<td>(0.00)</td>
<td>(0.00)</td>
</tr>
<tr>
<td>Observations</td>
<td>1,110,916</td>
<td>1,110,863</td>
<td>1,110,691</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Remoteness measured using straight line distance &amp; population shares</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Remoteness(\text{od})</td>
<td>-0.08***</td>
<td>-0.11***</td>
<td>-0.05***</td>
</tr>
<tr>
<td></td>
<td>(0.00)</td>
<td>(0.00)</td>
<td>(0.00)</td>
</tr>
<tr>
<td>Observations</td>
<td>1,110,916</td>
<td>1,110,840</td>
<td>1,110,477</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Remoteness measured using straight line distance &amp; truck owner shares</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Remoteness(\text{od})</td>
<td>-0.09***</td>
<td>-0.10***</td>
<td>-0.06***</td>
</tr>
<tr>
<td></td>
<td>(0.00)</td>
<td>(0.00)</td>
<td>(0.00)</td>
</tr>
<tr>
<td>Observations</td>
<td>1,110,916</td>
<td>1,110,840</td>
<td>1,110,477</td>
</tr>
</tbody>
</table>

**Fixed Effects**
- origin X destination: X X X
- origin X distance bins, destination X distance bins (K=10): X
- origin X distance bins, destination X distance bins (K=25): X

\( p < 0.1, ** p < 0.05, *** p < 0.01.\) Standard errors in parentheses.

\( Remoteness_{\text{od}} \approx -\ln \sum_{h} \left( \frac{1}{\text{dist}_{h} \times \text{dist}_{h}} \times \left( \frac{L_{h}}{\sum_{h} L_{h}} \right) \right), \) where \( \text{dist}=[\text{travel times, straight line distance}] \) and \( L=[\text{population, truck owner share}] \). \( o=\text{origin}, d=\text{destination}, k=\text{bins of travel times or straight line distances}, h=\text{home}. \)