



# State of the Art in Transportation Contracts: Moving towards Transportation Portfolio Management

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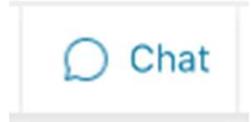
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## Rules of the Road

- This is a webinar with three panelists (David, Angi, and me).
- All other attendees should remain on mute with cameras off.
- Questions can be entered in the chat (lower right corner).
- Feel free to enter questions at any time and we will try to answer them as they are relevant and at the end.
- There will be polling questions throughout – all anonymous.
- We will be recording this event.
- Slides are available to all who request updates at [freightlab.mit.edu](https://freightlab.mit.edu)

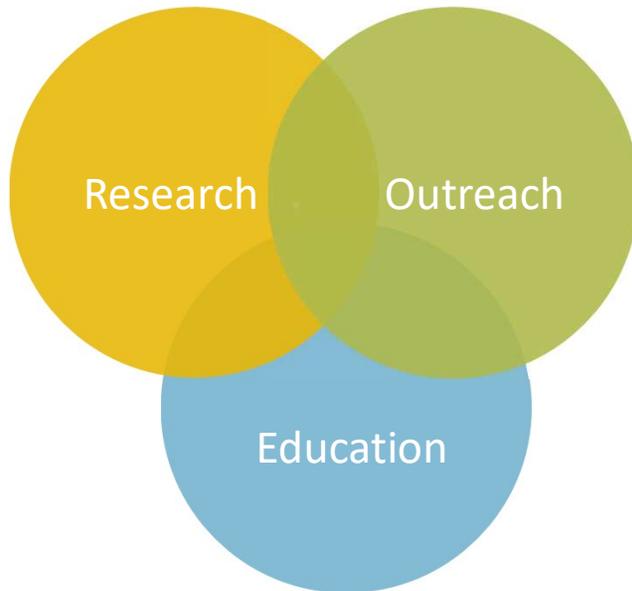


# The Plan for Today

- Introduction to MIT CTL & FreightLab
- Overview of Shipper-Carrier Relations Research (Chris)
  - Procurement Practices
  - Transportation Portfolio Management
- Building a Freight Index – Lessons from BDI (David)
- Index Based Pricing (Angi)
- Wrap up and Final Questions

# WHAT IS MIT CTL

We create supply chain innovation and drive it into practice.



- \$15M Research Budget
- 15 Full-Time Researchers
- 20+ Active Research Projects
- 60+ Faculty & Researchers Across MIT

- 4-Tier Partnership Model
- 50+ Member Companies
- Industry-Driven Workshops & Symposia

- Supply Chain Management Program
- MicroMasters in Supply Chain Management
- Executive Education
- PhD in Logistics

# MIT CTL Corporate Partners



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Waters  
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WHAT'S POSSIBLE

wayfair

xylem



<https://freightlab.mit.edu/>



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Shraddha Rana



### Freight contract performance & portfolio strategies

Current Projects

Freight contract performance & portfolio strategies Research publicationsResearch TeamContact TeamIn the U.S. truckload (TL) industry, shippers and motor carriers face major challenges as a result of uncertainties in the amount and timing of demand for...  
[read more](#)



### Modeling Effects of Natural Disasters on The US Truckload Market

Current Projects

Modeling Effects of Natural Disasters on The US Truckload Market Research TeamContact TeamWe analyze shipment data for assessing the impact of natural disasters on freight movement. Our focus is on North-Atlantic hurricanes that make landfall in the contiguous...  
[read more](#)



### The Driver Initiative

Current Projects

The Driver Initiative Research publicationsResearch TeamContact TeamThe Driver Initiative looks to uncover new insights and identify specific opportunities to improve the effectiveness, efficiency, and quality of life of American over-the-road truck drivers...  
[read more](#)



### Forecasting Long Haul Truckload Spot Market Rates

Previous Projects

The project aims at predicting long haul truckload spot market rates in continental USA for the near future. Accurate forecasting of transportation costs is a key step in logistical planning. It helps buyers and sellers of transportation services make better decisions at all stages of a supply chain.



### Freight Rate Impacts & Influences

Previous Projects

Freight Rate Impacts & Influences Research publicationsResearch PartnersResearch TeamContact TeamThis continuing project examines how truckload transportation rates are impacted by different policies, procedures, and network characteristics. Various...  
[read more](#)



### Future Freight Flows

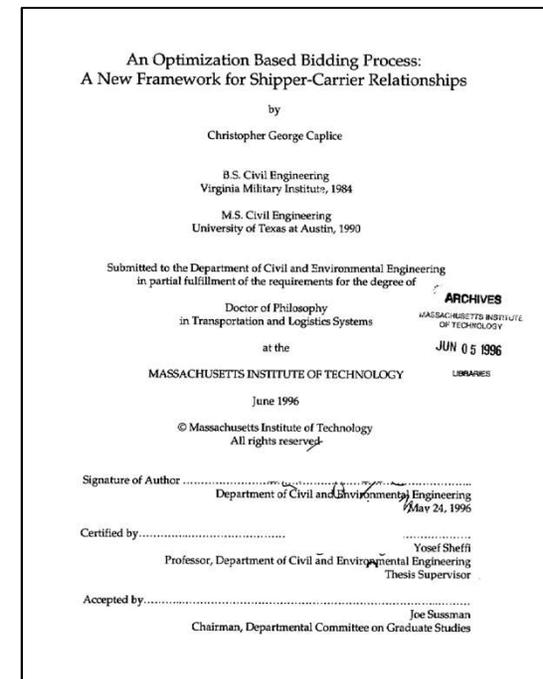
Previous Projects

Future Freight Flows Research publicationsResearch PartnersResearch TeamContact TeamThe future rarely moves in predictable, incremental ways. Often seemingly small changes in technology, demographics, regulations, economics, or a myriad of other factors have...  
[read more](#)

# Shipper-Carrier Relations Research

# CTL Freight Transportation Research

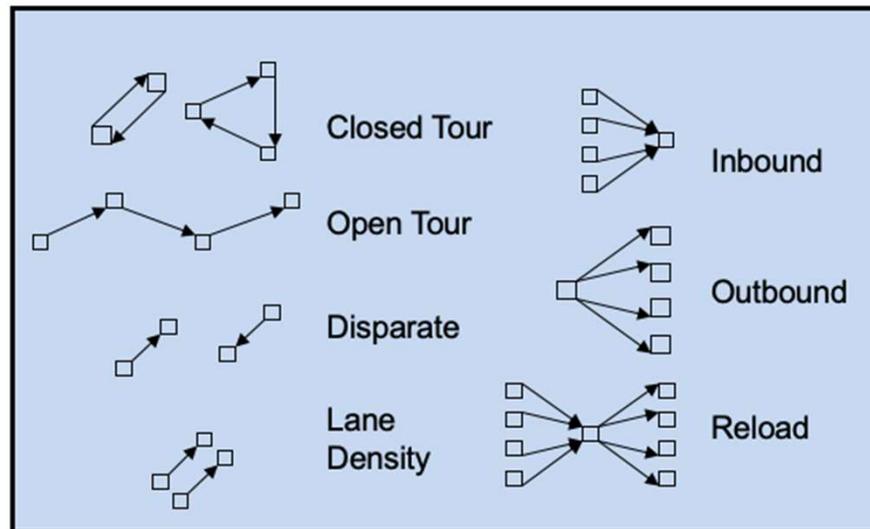
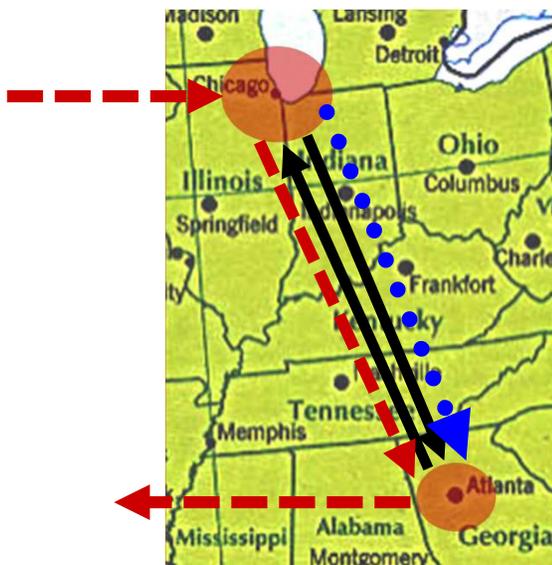
- 1980's – early 1990's
  - Focus on applying Operations Research techniques to trucking
  - Papers published & software developed to improve LTL & TL operations
- Mid-1990's – 2000's
  - Shifted focus to Shipper-Carrier Relationship
  - Published initial work on Optimization-based procurement for annual truckload auctions.
  - Developed software and delivered services for shippers to run their transportation auctions.
  - Objective was to improve relations between shippers and carriers.



# Shipper-Carrier Relations Research

## Key Insights:

Truckload carriers have strong economies of scope. Therefore the carriers should be able to select packages (bundles) of lanes rather than lane by lane when bidding to leverage their internal synergies.



Type	% of Packages
Inbound	9%
Outbound	6%
Reload	5%
Closed Tour	52%
Open Tour	15%
Disparate	6%
Lane Density	3%
Short Haul	4%

# Optimization Based Procurement – In Practice

## Required Optimization Tools:

Solving for lowest cost assignment with packaged (multiple lane) bids requires the use of sophisticated Mixed Integer Linear Programming (MILP) optimization models.

$$\begin{aligned}
 \min \quad & \sum_c \sum_k \left[ \left( \sum_{\forall i,j \in k} c_{i,j}^k \delta_{i,j}^k \right) c y^k + \sum_{i,j} (c_{i,j}^k c x_{i,j}^k) \right] \\
 \text{subject to:} \quad & \sum_c \sum_k (c x_{i,j}^k + c \delta_{i,j}^k c y^k) = x_{i,j} \quad \forall i,j \\
 & -c M_{i,j}^k c y^k + c x_{i,j}^k \leq 0 \quad \forall c,k,i,j \\
 & -c L B_{i,j}^k c y^k + c x_{i,j}^k \geq 0 \quad \forall c,k,i,j \\
 & -c U B_{i,j}^k c y^k + c x_{i,j}^k \leq 0 \quad \forall c,k,i,j \\
 & -c P L^k c y^k + \sum_{ij} c x_{i,j}^k \leq 0 \quad \forall c,k,i,j \\
 & c x_{i,j}^k \geq 0 \quad \forall i,j,c,s,k \\
 & c y^k = [0,1] \quad \forall c,k
 \end{aligned}$$

## Using a MILP enabled the shipper to:

1. Include constraints in the assignment,
2. Make trade-offs with non-financial metrics, and
3. Create multiple scenarios with different carrier assignments.



# Optimization Based Procurement – In Practice

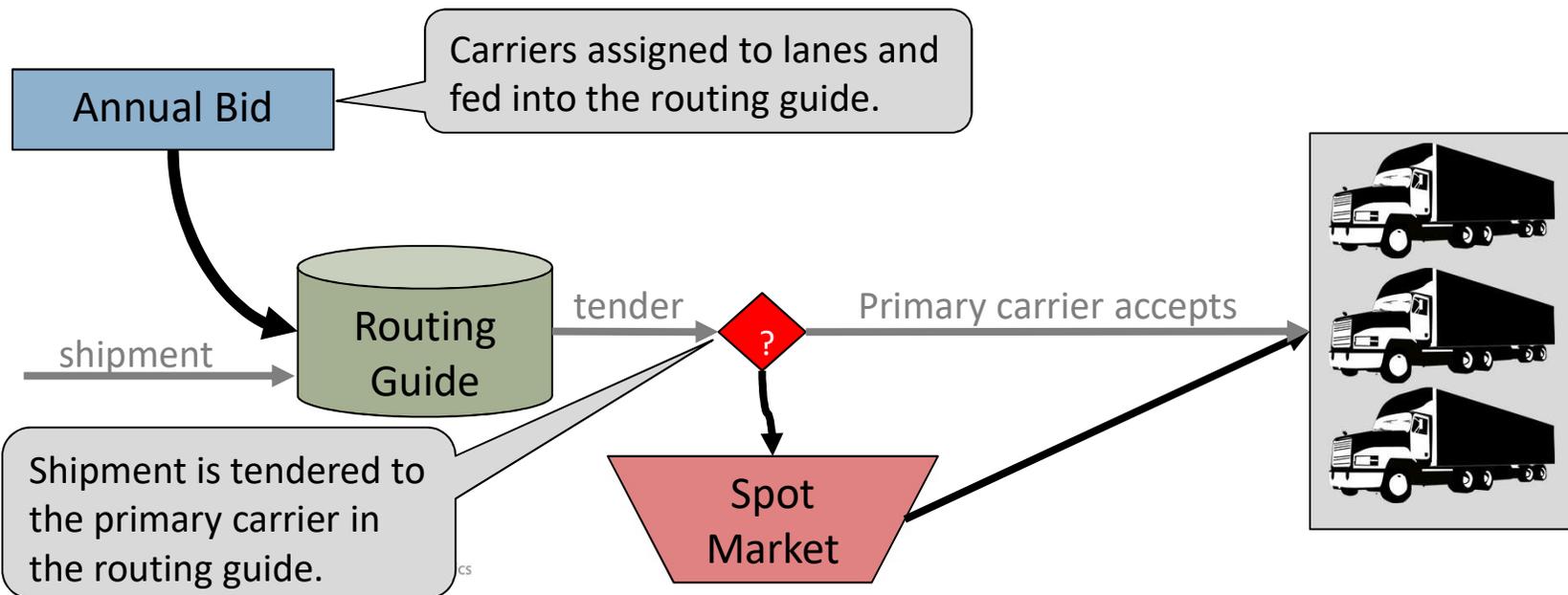
## Results in Practice:

Optimization based procurement for transportation is now common practice. However, package or bundled bids are not nearly as widespread as was expected.

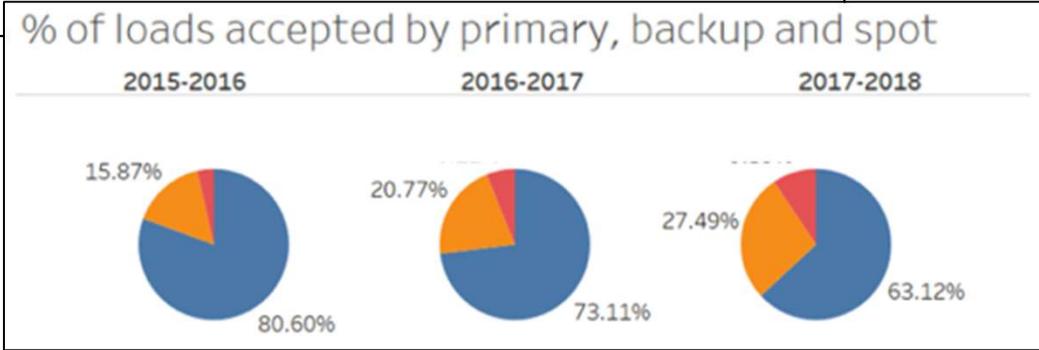
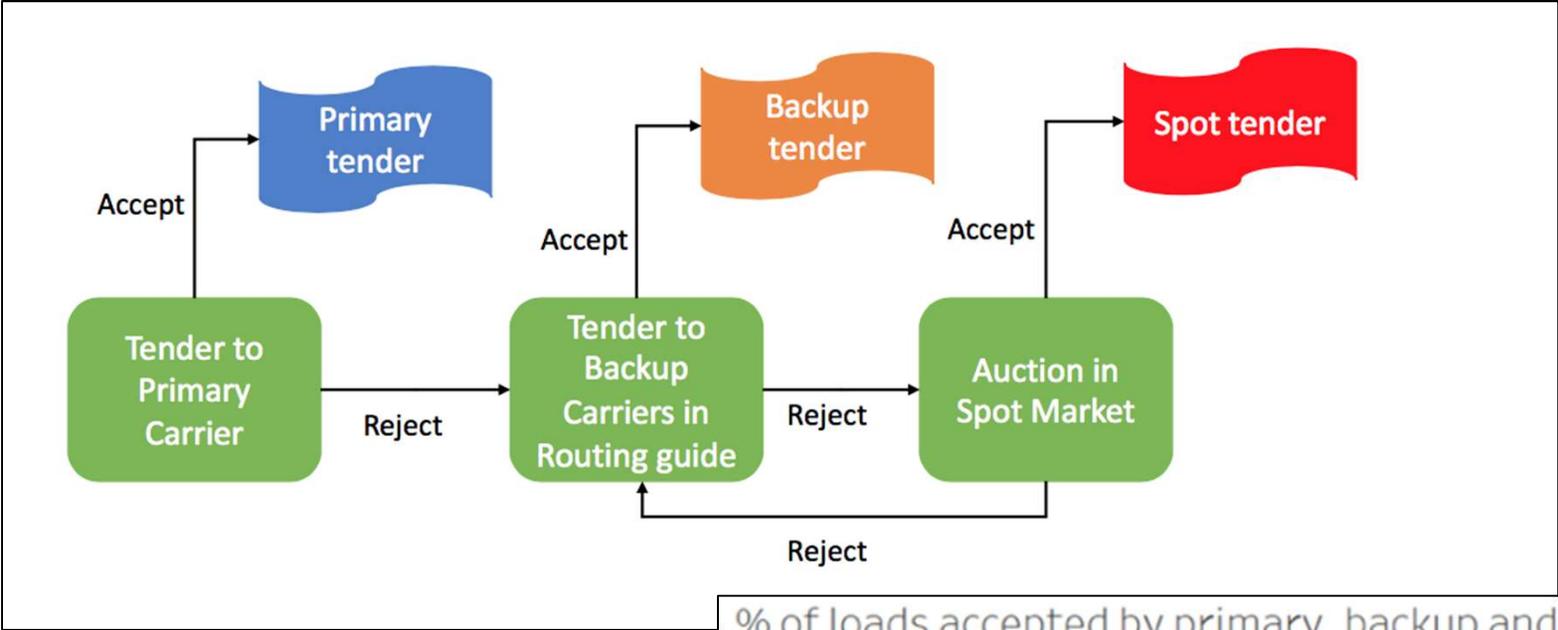
## Key Oversight:

We ignored the Two Moments of Procurement for Transportation!

1. Awarding of the business
2. Tender of the shipment

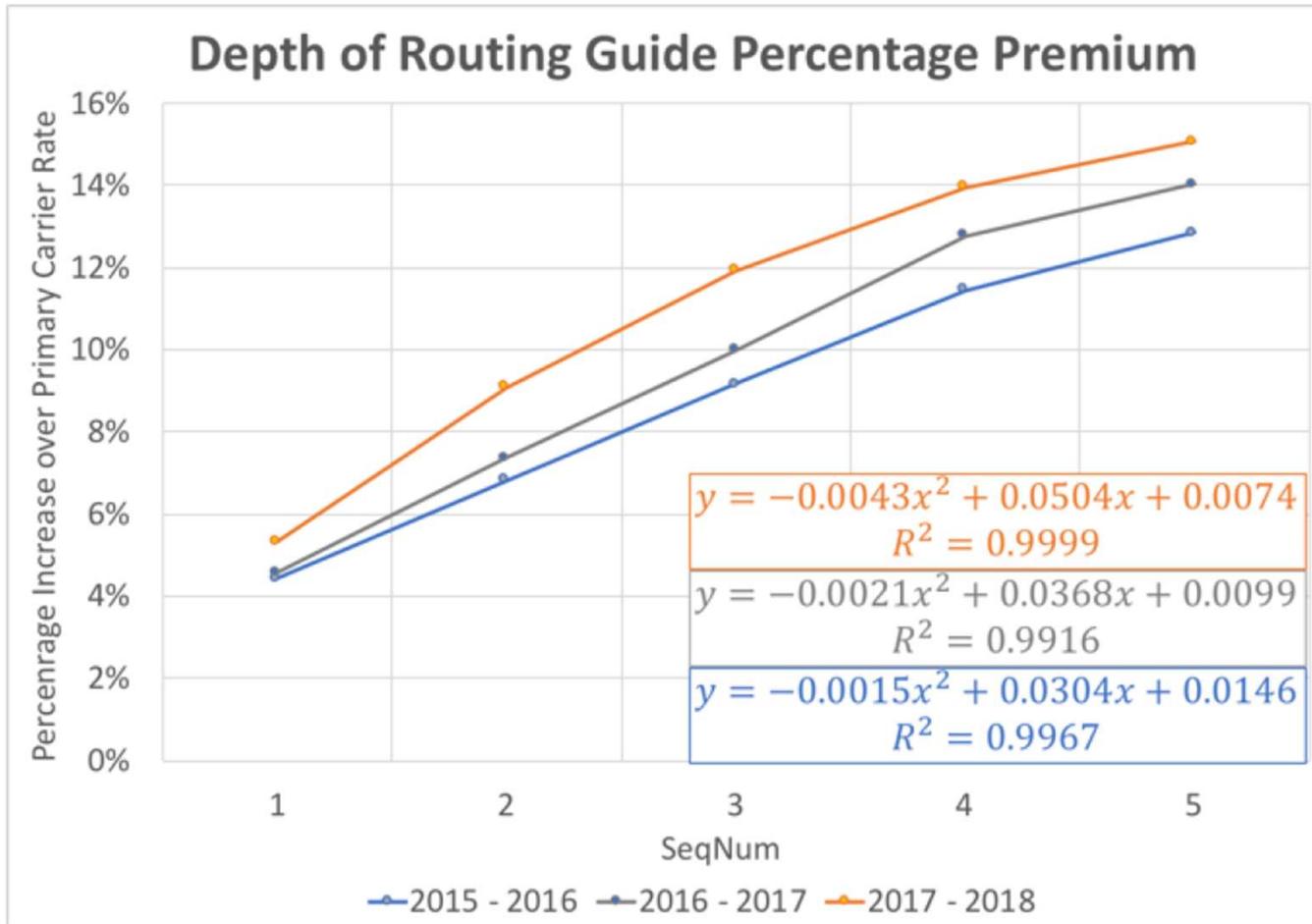


# Standard Waterfall Tendering Process

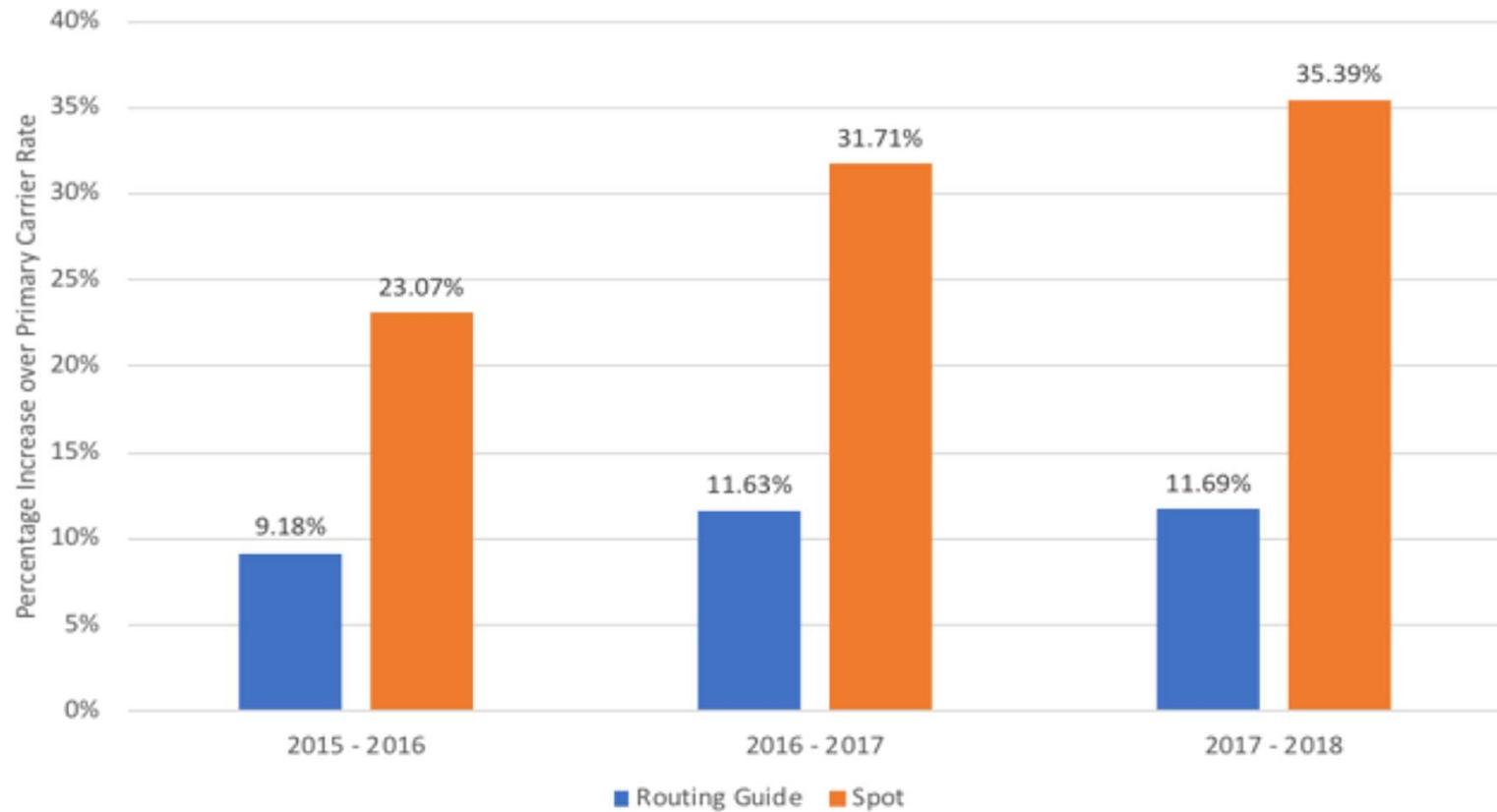


Source: Aemireddy & Yuan (2019) SCM Capstone Project with CH Robinson & TMC

**Carrier Category**  
 ■ Primary Carrier  
 ■ Backup Carrier  
 ■ Spot

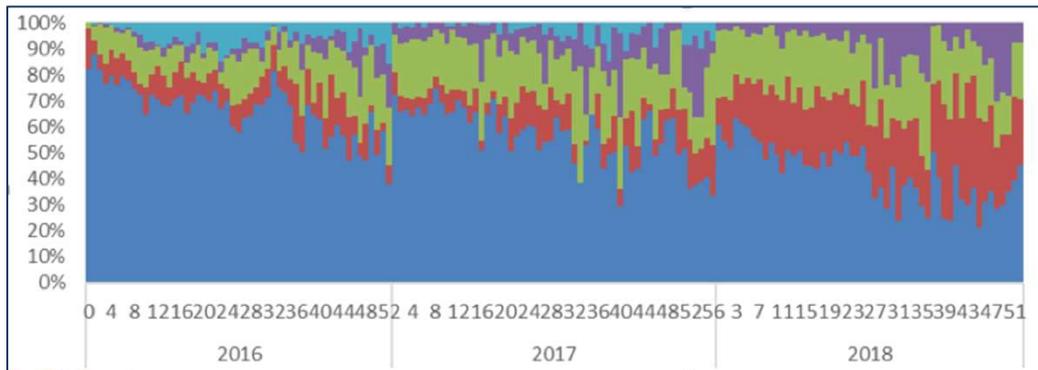
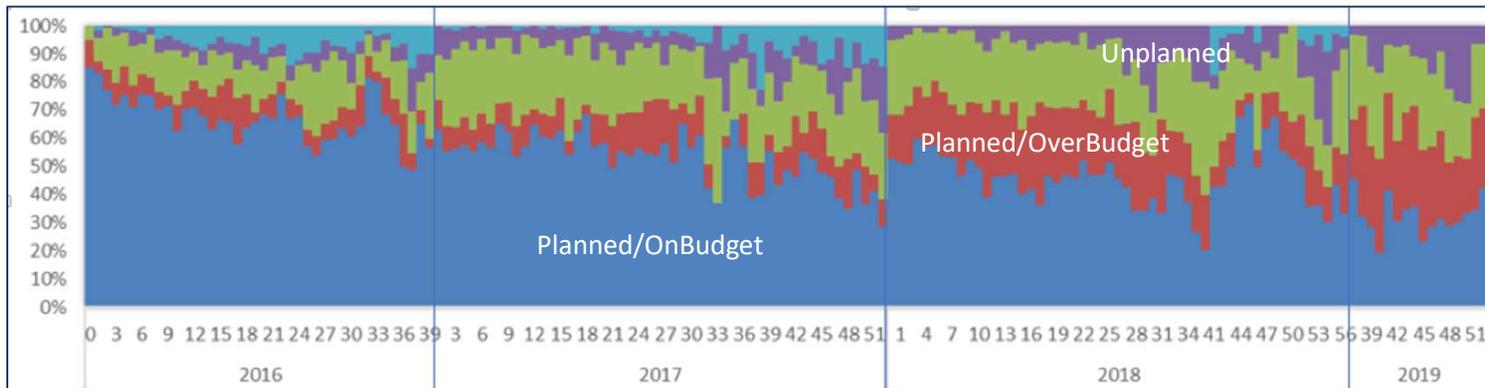


## Routing Guide & Spot Percentage Premium



# So how do routing guides actually perform?

## Comparing what you bid to what you did

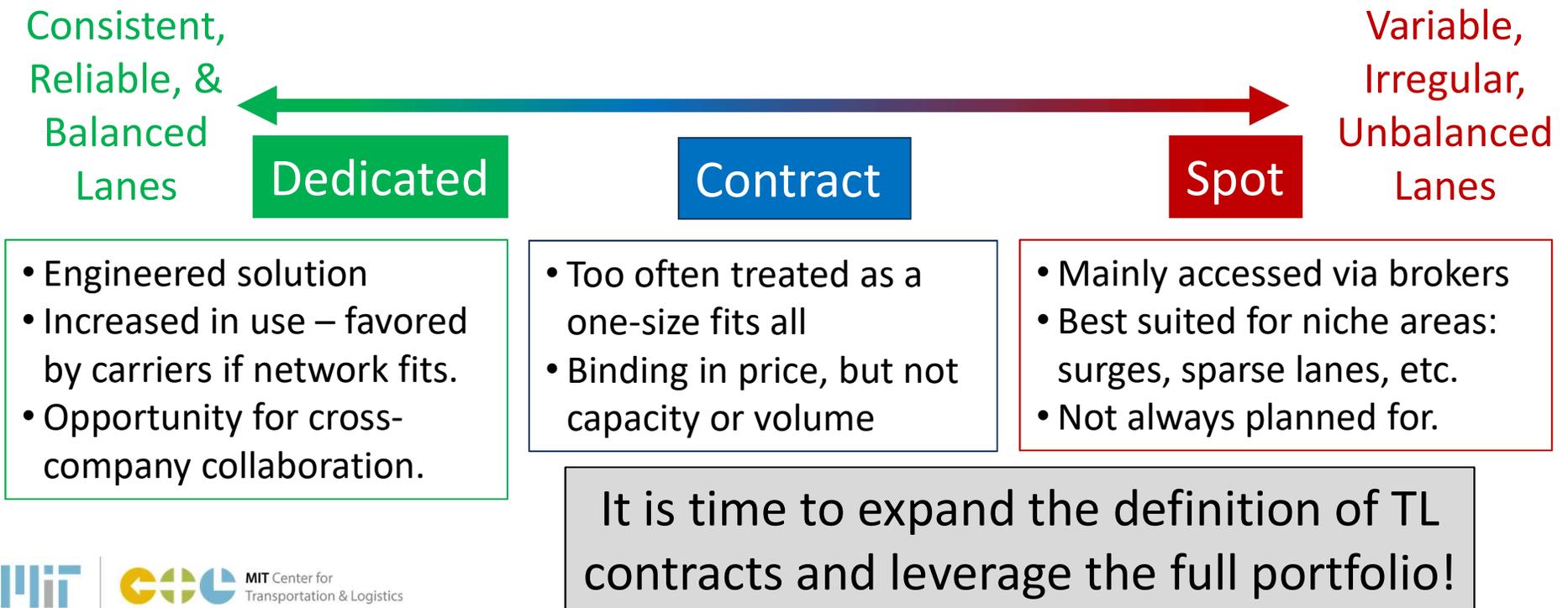


- Routing guides degrade over time
- Every shipper is a little different
- Biggest challenge is collecting data
- Analysis misses ghost freight
- Can we predict which lanes fail?

Source: Acocella, Bandaru, & Dolci (2020)

# Transportation Portfolio Management

Not all lanes are equal – so why treat them the same?



# Portfolio of Different Contracts / Relationships

- Guaranteed Volumes (Take or Pay)
  - Shipper guarantees number of loads per day/week, pays penalty if not occurring.
- Guaranteed Service Lanes
  - Carrier guarantees 100% acceptance at rate, but has brokerage rights.
- Tiered Based Pricing
  - Shipper pays different set prices based on volume level on lane per day/week.
- Short Term Performance Based Contracts
  - Shipper established short (<90 day) contracts with primary over ordinary rates.
- Index Based Pricing
  - Shipper pays a rate based on how an index changes.

## Bottom Line Recommendations

- Annual bids are a necessary evil, but planned procurement should not happen just once a year.
- ‘Continuous Procurement’ should include scheduled periodic mini-bids as well as the use of spot market.
- Routing guides degrade over time – but mostly due to shipper’s business changing – not carrier performance.
- Shippers need the capability to track, monitor, and analyze carrier and network behavior – and use this in procurement decisions.
- Shippers should design, procure, and manage their transportation as a portfolio and expand the use of different contractual forms.
- Market-driven contracts should be considered where demand patterns and market dynamics make primary carrier acceptance difficult.

# Questions, Comments, Suggestions?



Gidget (left) and Wilson (right) hoping that there will be food in the revolution.

Slides are available to all who request updates at [freightlab.mit.edu](https://freightlab.mit.edu)

For information on researching any of these topics, please contact us.

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# Typical Annual Procurement Event

## Pre-Bid

What business to bid?

- Extensive data collection, cleaning, and forecasting.
- Invite incumbents & potential new entrants.

- Effort required to collect data is massive.
- Volume forecasts made 15 months out are worthless.
- Volumes can be gamed.

## Bid

What info to share & collect?

- Either very detailed or very vague descriptions of business.
- Carriers submit rates & cap's
- 1+ to 3 rounds of bidding

- Few carriers can efficiently or effectively process detailed information
- Carriers will always over bid – tend to win less than  $\frac{1}{4}$  of business they bid, and only  $\sim\frac{2}{3}$  of what they 'win' materializes.

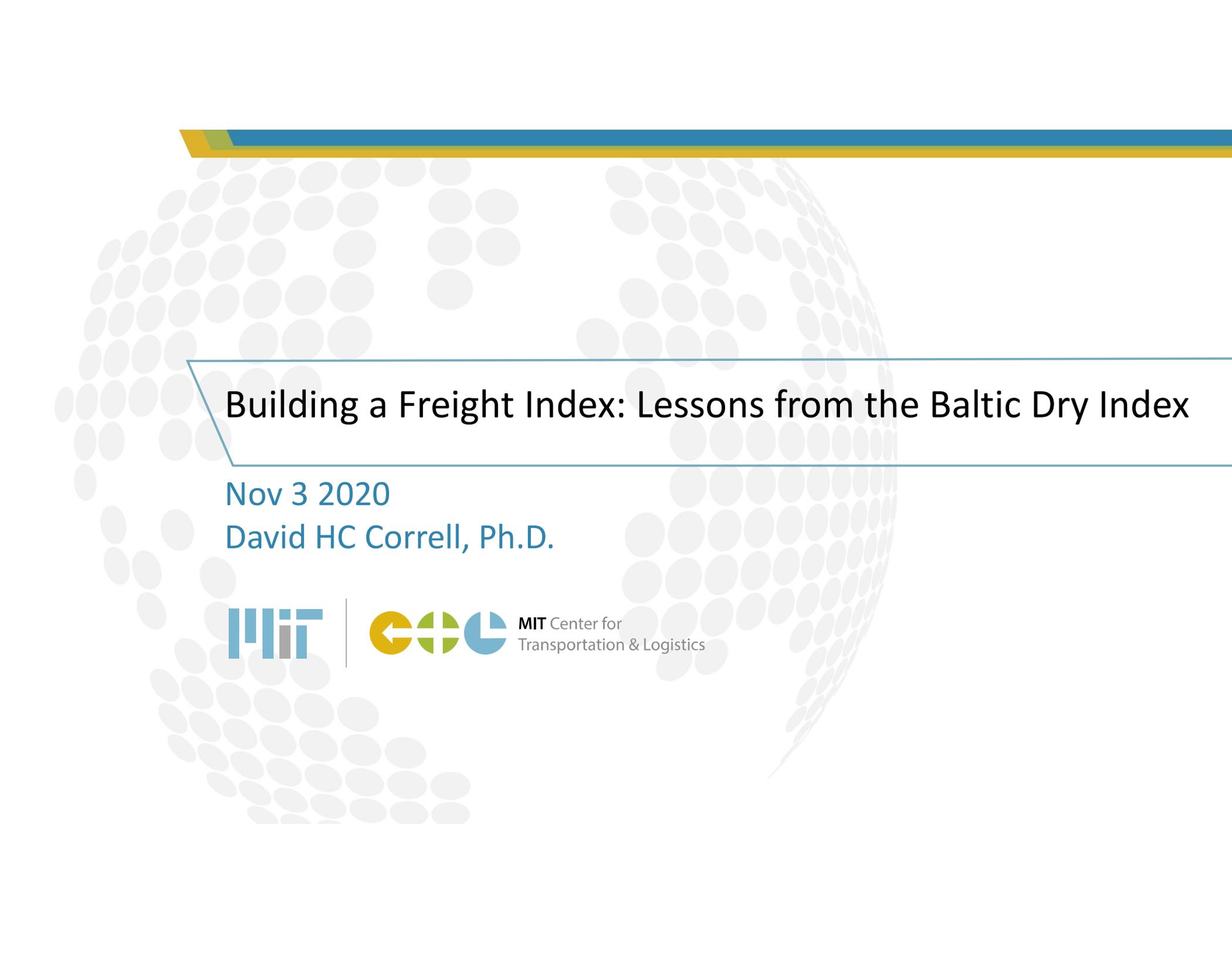
## Post-Bid

Which carriers win what?

- Optimization software minimizes cost s.t. level of service etc.
- Dozens to hundreds of scenarios
- Lane assignments fed into TMS

- Routing guides rarely capture detailed conditions of scenarios (Scalpel to Hatchet)
- Time from bid to implement makes many rates already obsolete





# Building a Freight Index: Lessons from the Baltic Dry Index

Nov 3 2020

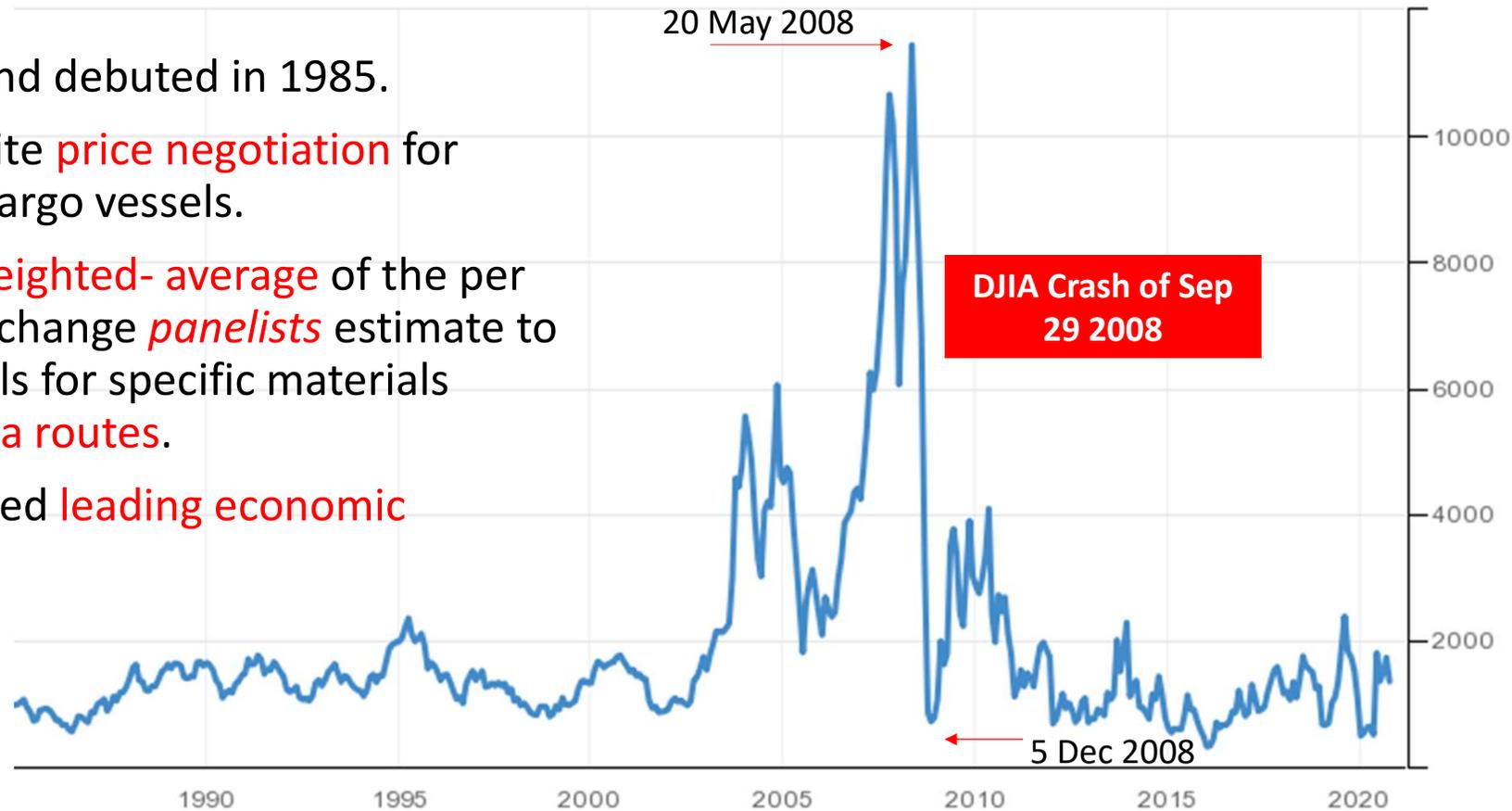
David HC Correll, Ph.D.



MIT Center for  
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# What is the Baltic Dry Index?

- Based in London and debuted in 1985.
- Intended to expedite **price negotiation** for chartering ocean cargo vessels.
- A daily **adjusted weighted- average** of the per day rates Baltic Exchange **panelists** estimate to time-charter vessels for specific materials **across 23 global sea routes**.
- A globally recognized **leading economic indicator**.



The Baltic Dry Index: 1985 to present

SOURCE: TRADINGECONOMICS.COM

## The Baltic Exchange and the BDI

The Baltic Exchange is a for-profit subsidiary of the Singapore Exchange Limited that makes its revenue from membership fees and data subscriptions.



The Baltic Exchange is an organization of 3,000 global maritime professionals from ~600 companies, **50 are surveyed panelists.**

Baltic Exchange members receive the results of daily panelist surveys packaged as **130 different data points.**

The publicly available BDI is an **aggregated selection** of those 130 data points.

## Panelist Surveys

- Panelists are **brokers**, not principals.
- Panelists are vetted for requisite **experience and expertise**.
- Panelists are given standard **operating costs and conditions** to assume specific to each route and ship class.
- Panelists use a custom web interface to input their assessments during pre-set and **common 15-min open windows**. Algorithms then aggregate the data and release aggregated numbers 15 min after window close (for daily figures).
- Panelists are **3<sup>rd</sup> party audited** quarterly for conflict of interest or evidence of manipulation.



International Organization of Securities  
Commissions' Principals for Financial  
Benchmarks (IOSCO PFB)

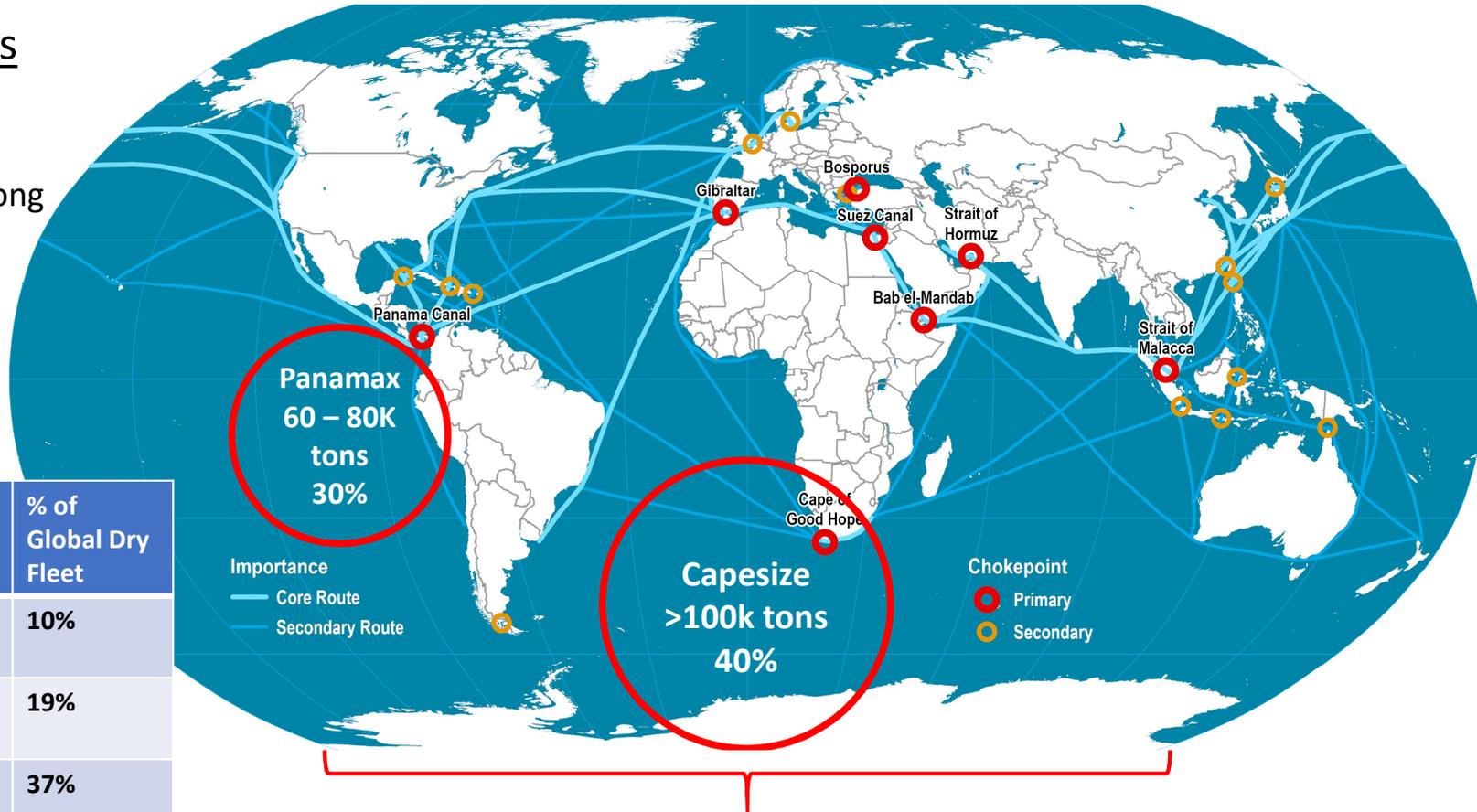


European Securities and  
Markets Authority

# BDI Weighting & Selection

The BDI weighting is based on:

- Daily price estimations along **23** shipping routes
- A weighted average of **3** different ship sizes.



Ship Size	BDI Weight	% of Global Dry Fleet
Capesize (100k+ tons)	40%	10%
Panamax (60k – 80k tons)	30%	19%
Supramax (49 – 59k tons)	30%	37%

This reflects the March 2018 re-weighting

**Supramax 49 -59k tons  
30%**

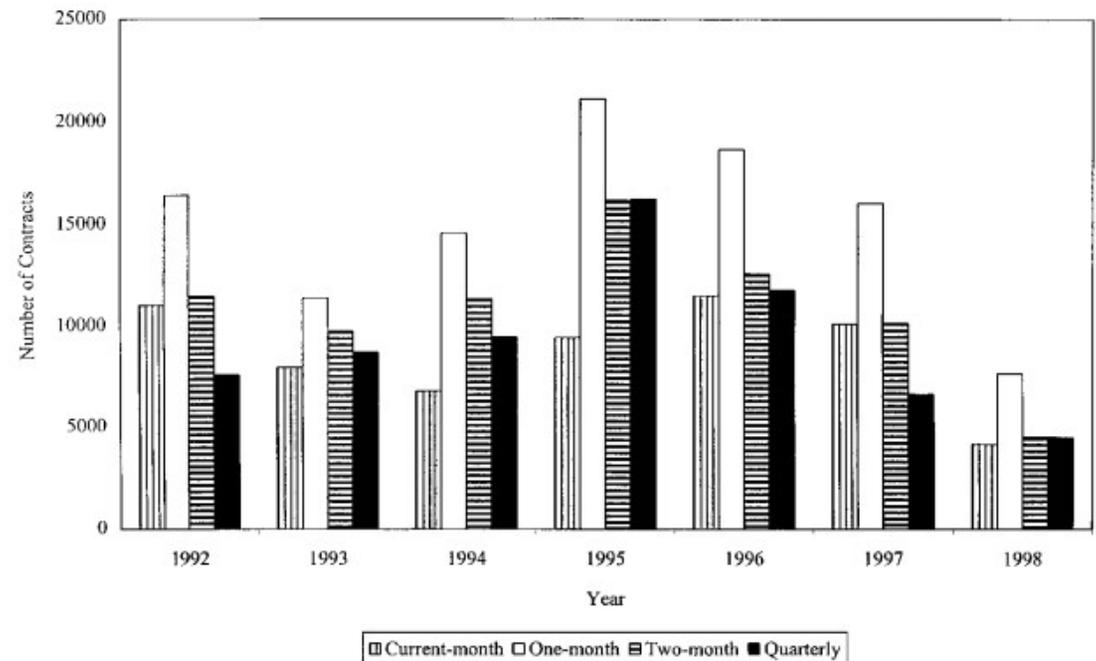
## BIFFEX Futures Derivatives

The Baltic Exchange simultaneously introduced a **derivative instrument**, the Baltic International Freight Future Exchange (BIFFEX).

Among the first **service-based** derivative instruments.

BIFFEX trades enabled price hedging of shipping rates on **one-month**, and **two-month, quarterly and later annual** forward contracts.

Trading volume disappointed some. It operated for **~15 years**, until 2002.



**FIGURE 1**  
Volume of Trading by Contract Month: 1992–1998.

Haigh, Michael S. "Cointegration, unbiased expectations, and forecasting in the BIFFEX freight futures market" *The Journal of Futures Markets*; Jul 2000; 20, 6;

## Select pros and cons of the Baltic Dry Index

Successfully facilitated price agreement in a volatile international marketplace.

Successfully enabled price hedging and risk management in maritime shipping.

A globally recognized real-time indicator of global trade, and thereby a leading economic indicator.

**BDI =**

$((\text{Capesize 2014 TCavg} * 0.4 + \text{PanamaxTCavg} * 0.3 + \text{Supramax10TCavg} * 0.3) * 0.1)$

Where TCavg = Time charter average.

The multiplier was first applied when the BDI replaced BFI, and has changed over the years as the contributing indices and the methods of calculation have been modified. The multiplier was last updated on 01 March 2018.

## The Baltic Dry Index and Today's Mission

Ocean dry bulk shipping **comparatively illiquid**.

- Lesser traffic and 'stickier' commitments.
- Price discovery is more important than incentive alignment.

Ocean dry bulk shipping is **comparatively capital intensive and supply inelastic**.

- Shipbrokers are connecting a high quantity of shippers to a limited quantity of vessels and crews
- Truck freight brokers are connecting shippers to large quantity of small trucking companies.
- The role of brokers is different. Do brokers know the market best?

Creating an index that addresses incentive alignment in a differently organized industry may necessitate a **unique path**.

- Should only brokers be surveyed?
- Which are the representative lanes?
- What is the most helpful release cadence?

## Lessons for candidate freight indices

1

The path to an industry-wide index, and from an index to a derivative financial instrument, **is paved with trust in an institution.**

2

The aggregation **formula matters.**

3

The **aggregation formula needs updating** as the world changes.

4

But **who updates the formula** and how matters.

# Discussion



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# Selecting alternative freight contracts: potential for index-based pricing

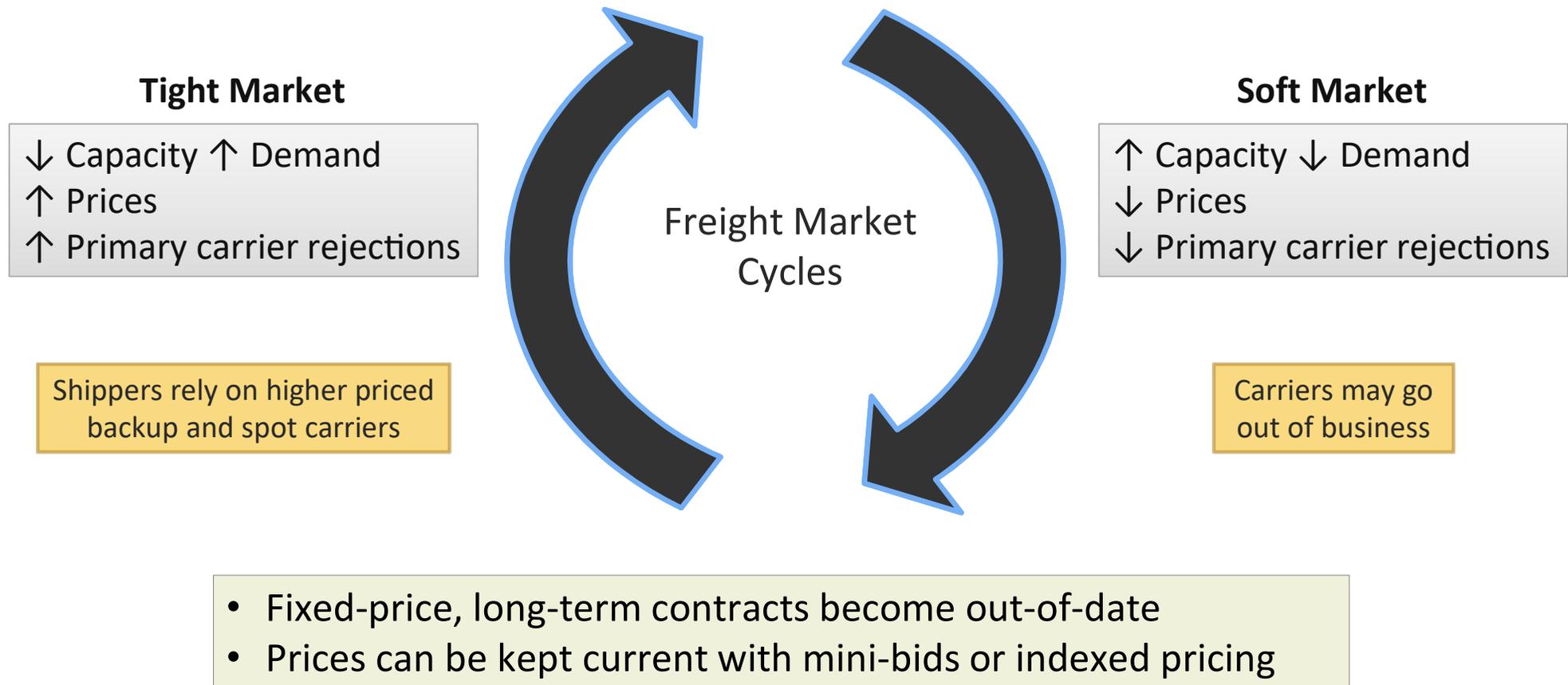
Nov. 3, 2020

Angi Acocella, PhD Candidate



MIT Center for  
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# Market conditions impact freight acceptance



## Carrier Type



## Network & Demand Patterns



## Market Expectations



## Carrier Type

## Network & Demand Patterns

## Market Expectations

- Non-asset primary carriers are more sensitive to the market
- Brokers/3PLs more likely to respond to indexed pricing than asset-based carriers.

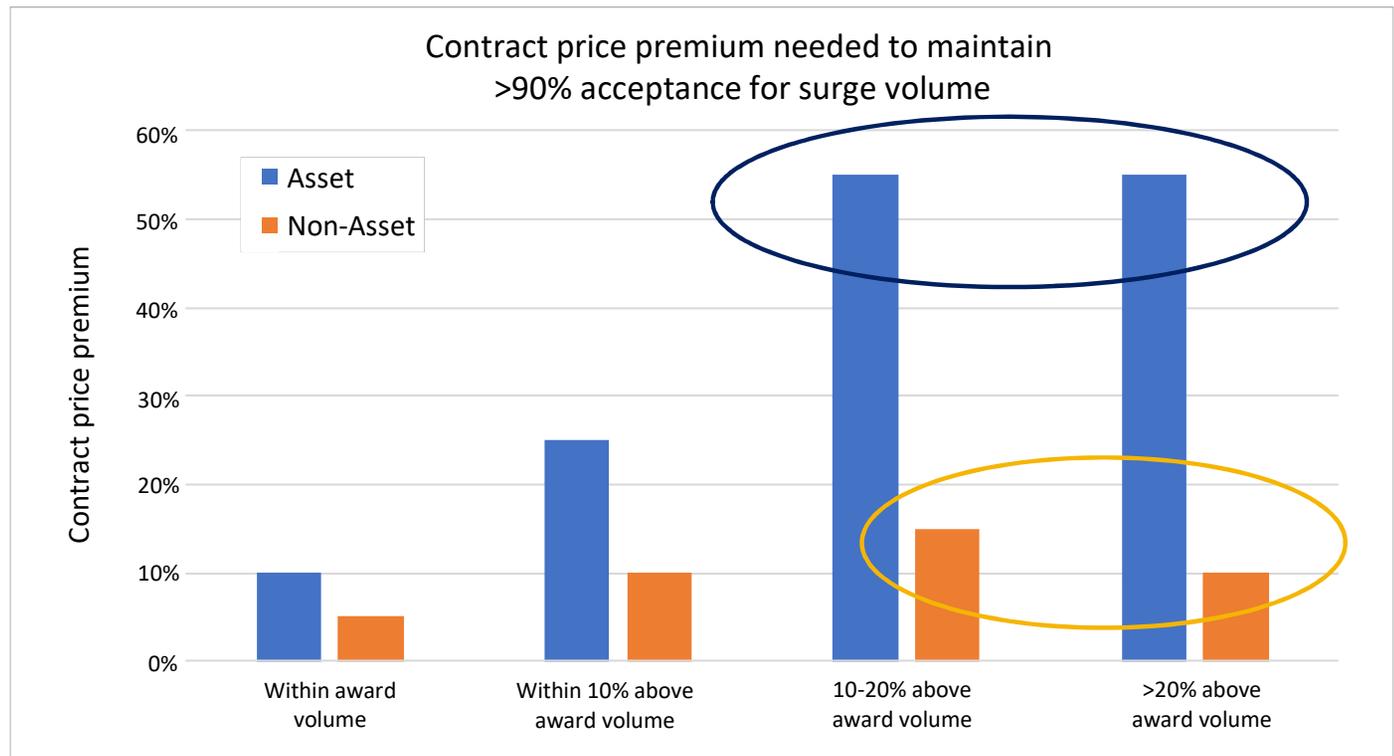


## Carrier Type

## Network & Demand Patterns

## Market Expectations

- Asset carriers require higher prices to accept surge volume
- Brokers/3PLs more willing to accept surge volume at all price points
- Indexed pricing could improve surge acceptance



Carrier Type

Network & Demand Patterns

Market Expectations

%Δ in Primary Acceptance Ratio

W/W%Δ in tendered volume: ≤ 10%

Increasing tendering volatility

W/W%Δ in tendered volume: 200%

Increasing contract price relative to spot

0%	-7%	-10%	-12%	-15%	-16%	-16%	-19%	-18%
-1%	-9%	-13%	-15%	-18%	-20%	-20%	-23%	-22%
-3%	-14%	-19%	-22%	-26%	-28%	-28%	-32%	-30%
-3%	-13%	-18%	-22%	-25%	-28%	-27%	-32%	-29%
-4%	-17%	-23%	-26%	-30%	-33%	-32%	-37%	-35%
-8%	-25%	-32%	-36%	-41%	-44%	-43%	-48%	-46%
-10%	-30%	-37%	-42%	-47%	-50%	-49%	-54%	-51%
-11%	-32%	-39%	-44%	-48%	-51%	-51%	-56%	-53%

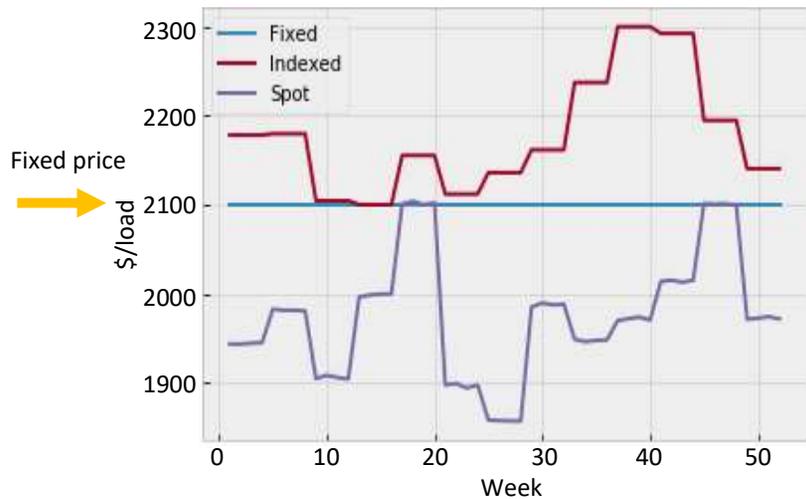
Index-based pricing may improve primary acceptance for lanes where tendering volatility cannot be reduced

## Carrier Type

## Network & Demand Patterns

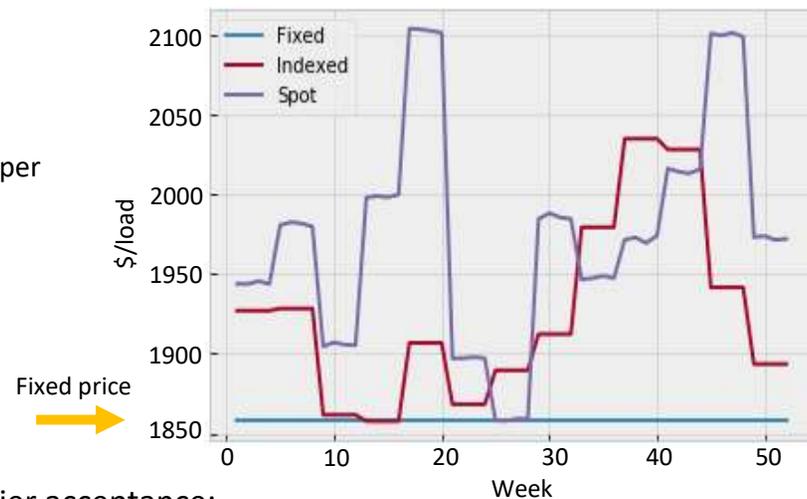
## Market Expectations

Weekly price per load



Primary carrier acceptance:  
84-86%

Weekly price per load



- Setting fixed price low and indexing could outperform 'set it and forget it' fixed pricing that is too high for shipper.
- Contract design choice depends on many sources of uncertainty.

Carrier Type



Network & Demand Patterns



Market Expectations

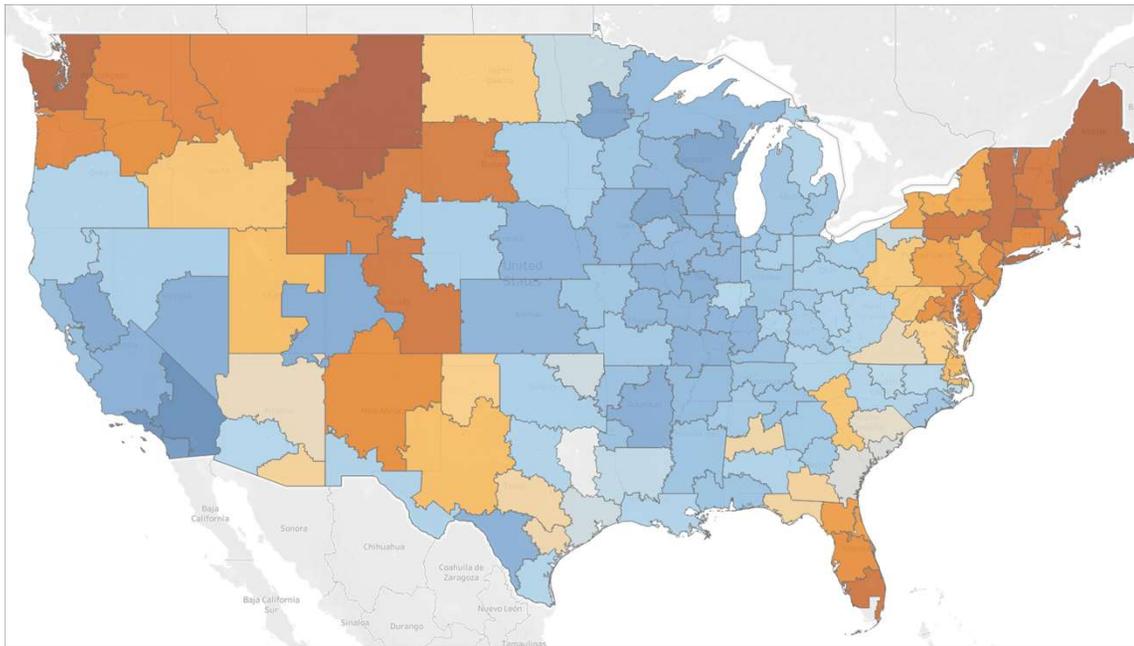


Index-based contract design choices

1. Index selection?
2. Updating frequency?
3. Symmetric pricing or rate escalator?
4. Upper/lower limit; collar?

# Design choice: index selection

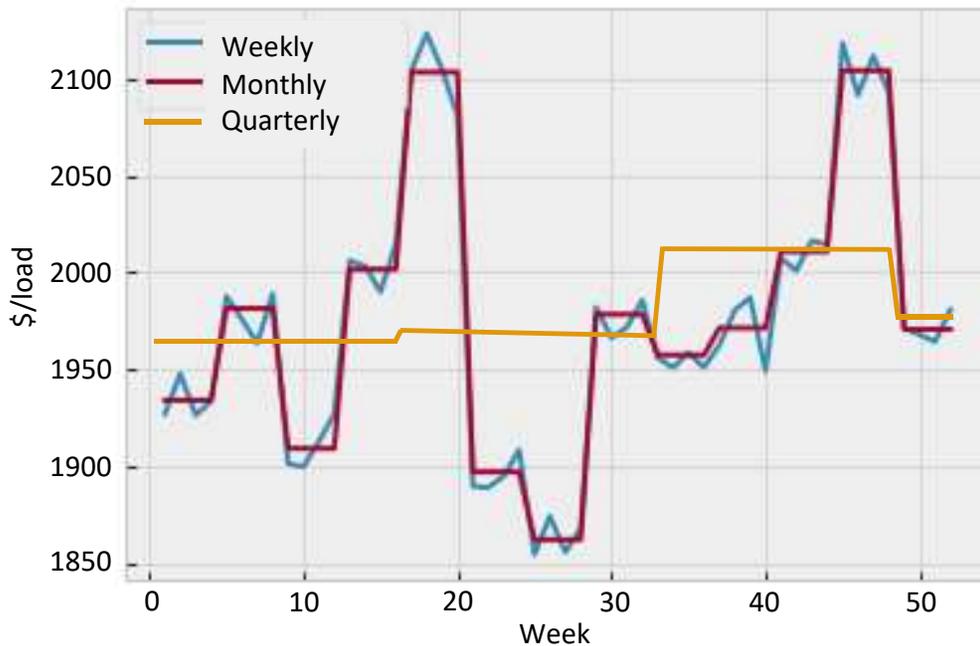
Inbound regional price premiums



- DAT, Cass, Morgan Stanley; composite
  - Spot vs. contract composition
  - Characteristics of freight index is applied to
- National vs. regional
  - Must appropriately capture general market trends
  - Must appropriately represent specific regional dynamics
- How to peg to the index

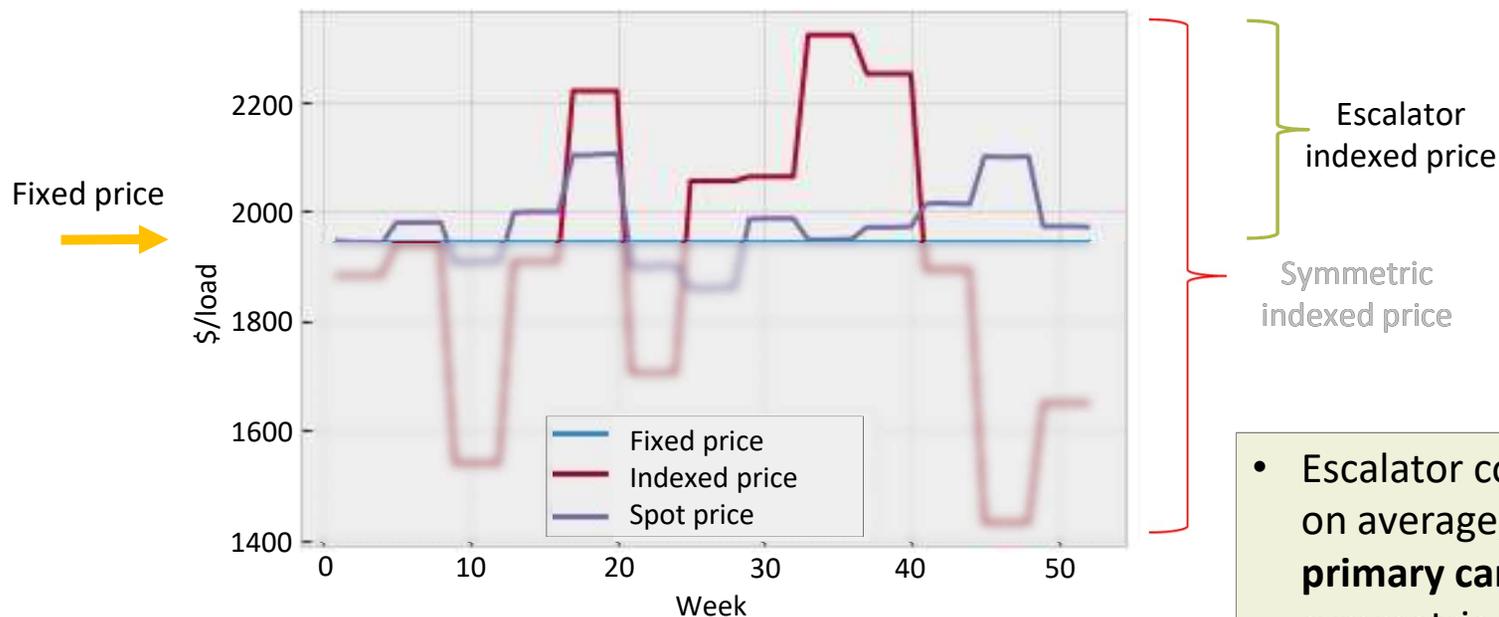
Source: Acocella, Caplice, Sheffi (2020)

# Design choice: update frequency



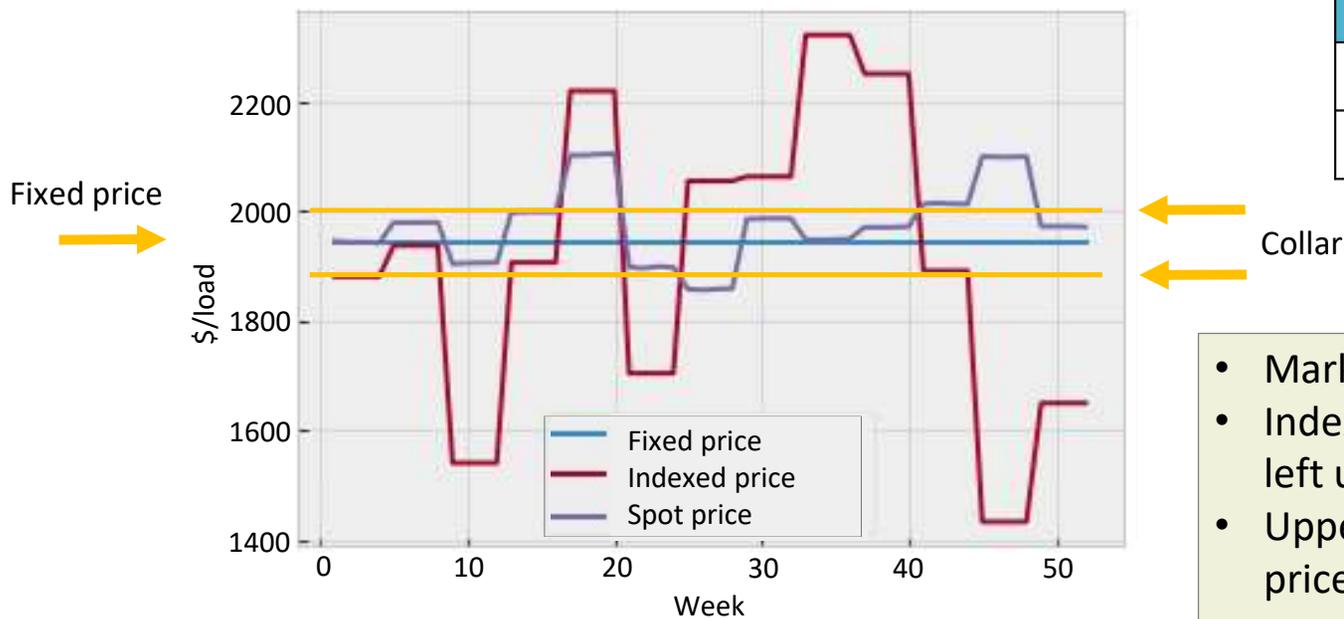
- Commonly use previous period index value applied to upcoming period.
- Too frequent may be cumbersome to implement or result in undesirable price fluctuations.
- Too infrequent may not appropriately represent market dynamics.
- Depends on index choice.

# Design choice: symmetric vs. escalator



- Escalator costs more than symmetric on average, but **consistently higher primary carrier acceptance** than both symmetric or fixed designs
- Internal tolerance to cost vs. performance will dictate design choice

# Design choice: unbound vs. collar



	Backup Premium	Spot Premium
Soft	1-10%	23%
Tight	11-18%	35%

- Market can swing widely in short time.
- Indexed prices can fluctuate too much if left unbound.
- Upper and lower limits on indexed prices will reduce exposure to unexpected price surges or drops.
- Backup and spot premiums can inform collar limits.

Source: Aemireddy and Yuan (2019) | Acocella, Caplice, Sheffi (2020)

# Recommendations

## Potential applications

- Index-based contracts should be considered where annual contract results in stale rates but frequent, continuous procurement is too cumbersome.
- Indexed pricing has high potential benefit with non-asset carriers most exposed to market swings, and for surge volume, and on inconsistent lanes with asset-based carriers.

## Design choices

- Index chosen should reflect demand patterns and price volatility of freight and lanes it is applied to.
- Shippers and carriers should determine their tolerance to rate spikes and dips during contract design stage.



# Discussion

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