Long-Term Relationships and the Spot Market: Evidence from US Trucking*

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1 Research team

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2 Research question

With the Motor Carrier Act of 1980, the US trucking industry began a dramatic transformation from a highly concentrated industry subject to strict price and entry regulation to the highly competitive, fragmented, and decentralized industry of today.

Today, 80% of transactions in the US truckload freight market occur within long-term shipper-carrier relationships, while the remaining 20% occur as spot arrangements. Both modes of transaction are decentralized. Yet over the last decade, digital marketplaces like Uber Freight and Convoy have sought to re-centralize the market around privately-controlled spot platforms. The idea is not without merit, as centralization and algorithmic matching may improve efficiency. For example, Uber demonstrated the efficacy of this model in the ridehail industry, where Uber and similar platforms have largely replaced the previous decentralized taxi model. Thus far, however, efforts to re-centralize trucking have failed.

This failure is explained by the fact that, unlike the taxi industry, trucking is dominated by long-term relationships. On the one hand, these relationships may provide shippers and carriers with large intrinsic benefits (e.g., stability, reliability, quality assurance). On the other hand, the fact that so many transactions occur within long-term relationships means that too little activity occurs in the spot market, which makes search frictions large. The result is that the incentive for any *individual* shipper or carrier to switch to the spot market is low. *Socially*, however, it might be optimal for all shippers and carriers to coordinate on a switch to the spot market, maximizing spot market thickness and efficiency. How do relationships' intrinsic benefits compare to the potential improvements in efficiency from spot platforms?

*__Conflict of interest statement__: No member of the research team has any financial or other interest in the transportation industry. Both Harris and Nguyen are working on other transportation-related research projects, but none of these creates a conflict of interest with the project described in this proposal.

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Are relationships merely an obstacle to progress and greater efficiency, or are the benefits of relationships sufficient to justify their continued dominance?

3 Data

Interactions between relationships and the spot market are central to our research question. Our analysis therefore combines data on both of these modes of transaction.

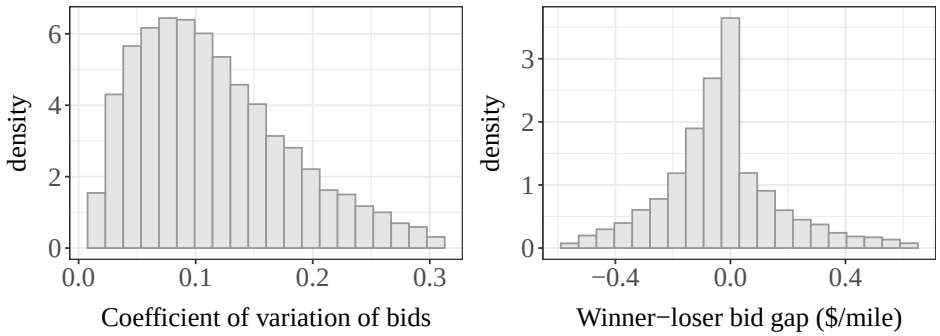
We have obtained transaction-level data on shipper-carrier relationships from TMC, a division of C.H. Robinson, the largest logistic firm in the US. For each relationship in our data, we observe the details of all shipment requests, including origins and destinations, timestamps, carriers' identities, contract rates, and carriers' accept/reject decisions. While such data on shipper-carrier relationships has been used in the transportation and logistics literature to study how to improve these relationships (e.g., Acocella et al., 2022), we are the first to use this data to analyze the welfare implications of this industry's market structure.

We have obtained market-level data on spot rates and volumes from DAT Solutions, the dominant freight marketplace platform in the US and the leading vendor of spot market data. This data provides us with weekly spot rates and volumes for each KMA-KMA lane.[1]

4 Suggestive evidence

We aim to quantify the tradeoff between relationships' intrinsic benefits and the potential for scale efficiency in the spot market. In this section, we present suggestive empirical evidence on relationships' benefits (Fact 1), the spot market's scale efficiencies (Fact 2), and the interactions between relationships and the spot market (Fact 3).

Figure 1: Within-auction variation in carriers' bids



Fact 1. Non-price factors matter in relationships A relationship is formed through an auction in which carriers bid rates and the shipper selects the winning carrier. Behavior by both shippers and carriers in these auctions reveals that both have preferences over non-price factors. First, the left-hand panel of Figure 1 shows that, within any given auction, there is often substantial heterogeneity in carriers' bids, suggesting substantial differences in carriers' payoffs from relationships. Second, the right-hand panel of Figure 1 shows that the shipper does not always select the carrier with the lowest bid; on the contrary, in one-third of the auctions, the winning carrier is not the carrier offering the lowest rate. This strongly suggests that shippers value other characteristics that are heterogenous across carriers. These characteristics

[1]DAT partitions the US into 135 Key Market Areas (KMAs).

can be thought of as dimensions of quality that are superior when transactions occur within relationships, rather than as spot transactions.[2]

Fact 2. Spot market exhibits scale efficiency We demonstrate the existence of spot market scale efficiencies by showing that as the total number of loads going from state s to state s' increases, the share of these loads transacted in the spot market also increases.

We estimate the following regression on the relative share of spot to relationship volumes,

$$\ln\left(\frac{\text{Volume}_{ss'}^{\text{spot}}}{\text{Volume}_{ss'}^{\text{LT}}}\right) = \beta_0 + \beta_1 \ln(\text{Volume}_{ss'}^{\text{total}}) + \text{controls} + \epsilon_{ss'},$$

where for each state-to-state lane, $\text{Volume}_{ss'}^{\text{spot}}$ is the average weekly load posts in the spot market, $\text{Volume}_{ss'}^{\text{LT}}$ is the average weekly loads transacted within long-term relationships, and $\text{Volume}_{ss'}^{\text{total}}$ is the total for-hire truckload volume in 2017 taken from the Commodity Flow Survey.[3] We instrument for total volume with a demand shifter—the predicted trade flows across different states of the US from Caliendo et al. (2018). We find that $\beta_1 = 0.345 > 0$ (SE $= 0.045$). That is, on lanes with higher total market volume—and thus, higher potential for a thick spot market—the spot market takes a larger share of all transactions. This suggests that spot market thickness increases the relative attractiveness of spot transactions. This further implies that relationships exert an externality on the spot market; by forming a relationship, a shipper and carrier withhold their demand/supply from the spot market, thus reducing spot market efficiency.

Fact 3. The spot market undermines relationship performance Figure 2 shows that, during the boom period of 2017-2018, a period in which spot rates frequently exceeded relationships' fixed contract rates, carriers frequently rejected the offers they received within their long-term relationships. This illustrates that the spot market undermines relationships' performance by creating the temptation for carriers to behave opportunistically.

In Harris and Nguyen (2021), a paper which studies the nature of shipper-carrier relationships, we show that the carrier (agent) faces a moral hazard problem from spot temptation and the shipper (principal) uses a punishment scheme to mitigate this temptation. In particular, the shipper uses the threat of relationship termination to induce more acceptances by carriers.

Together, Facts 2 and 3 speak to the intricate interplay between relationships and the spot market, an interplay that is central to our research question.

5 Methods

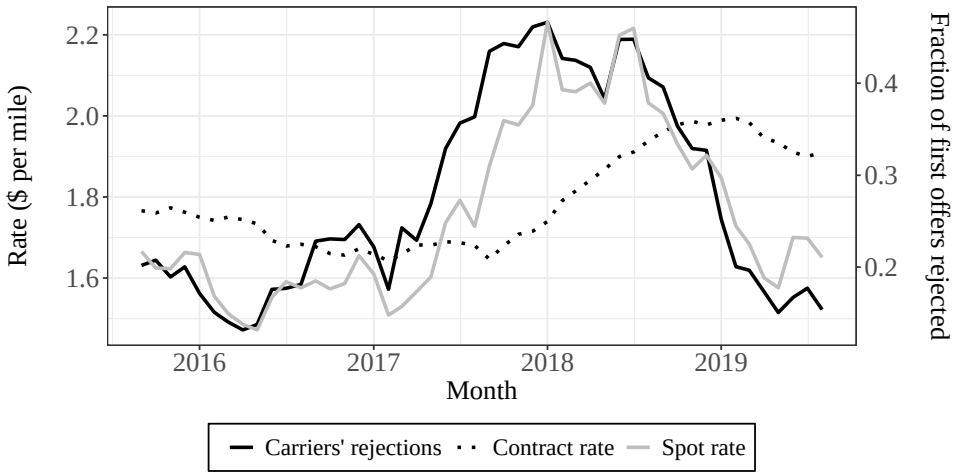
Motivated by this suggestive evidence, we develop a framework that captures relationships, the spot market, and the interplay between the two.[4] Within this framework, there may be mulitple equilibria. Some of these equilibria may be suboptimal because they have too high a share of spot transactions, so that relationships' benefits are not realized; others may be suboptimal because they have too low a share of spot transactions, making the spot market

[2]Comparing the performance of carriers in relationships with shippers versus those whose interactions with shippers are mediated by a broker (very similar to a spot transaction), we see that the former perform better along multiple dimensions of observable quality: they are 10pp more likely to deliver goods on time and spend 31 fewer minutes in detention time on average (baseline of 124 minutes).

[3]We run a log-regression to avoid scaling issues between different data sets.

[4]To understand this interplay, we build on the theoretical insights of Kranton (1996), who hypothesized the existence of two-way crowding out effects in settings where relationships and spot coexist.

Figure 2: Aggregate movements in relationships and the spot market



thin and inefficient. Which of these categories the current equilibrium falls into is an empirical question; answering this question requires quantifying the relationships' intrinsic benefits and the spot market's scale efficiencies, both of which we will estimate from the data.

To recover these primitives, we use a variety of empirical industrial organization tools. To estimate the intrinsic benefits of relationships, we exploit both the formation of relationships via auctions (Guerre et al., 2000) and the fact that shippers and carriers interact repeatedly under varying spot conditions (Rust, 1994). To estimate the potential scale efficiency of the spot market, we exploit variation in trade volumes across regions of the US to instrument for variation in spot market volume.

Using the estimated model, we evaluate counterfactuals that speak to the welfare implications of various market institutions which allocate transactions differently between between relationship and spot. Market efficiency under each of these institutions depends on (i) allocative cost efficiency and (ii) the balance between realizing more of relationships' match-specific gains versus maintaining a thicker spot market with lower search costs.

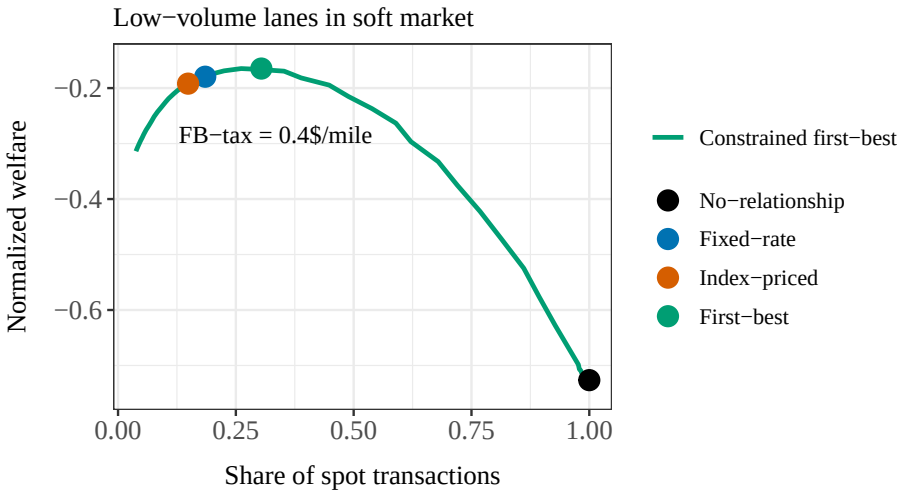
6 Policy implications

Preliminary findings We derive the market-level first-best institution by combining the optimal contracts for relationships (*index-priced*) with the optimal *corrective tax* on relationship transactions.[5] Figure 3 plots, for one subset of lanes, how the welfare level and the share of spot transactions change as we vary this corrective tax. The case where this tax goes to infinity corresponds to the ideal scenario for spot efficiency, where all transactions are centralized in the spot market (*no-relationship*). As the figure shows, the current institution (*fixed-rate*) has far better market-level performance than this *no-relationship* scenario.

Informing DOT research and policy Our preliminary findings highlight the importance of relationships in the US truckload freight industry. If upstart digital platforms were to succeed in completely replacing these relationships, substantial welfare losses would result. Nevertheless, policies to encourage local improvements to the spot market—for example, by encouraging the adoption of algorithmic matching to reduce search frictions or algorithmic pricing to reduce bargaining costs—could still have substantial welfare benefits. Such improvements would not only directly benefit spot carriers, who are often owner-operators, but would also have the

[5]Intuitively, this tax makes shippers and carriers internalize relationships' externalities on the spot market.

Figure 3: Comparison to the market-level first-best



indirect effect of moving the equilibrium split between relationship and spot transactions toward the first-best.

Looking ahead This proposed project is part of our broader research agenda seeking to understand the role of relationships in trucking, an industry critical to the US economy. Because these relationships and their interplay with the spot market are so fundamental to trucking, they help determine the economic effects of a variety of shocks that might affect the industry. To understand the economic effects of, for instance, a technological change or a supply/demand shock affecting trucking, one must first understand these relationships. This proposed project will therefore serve as a foundation for future work on additional policy-relevant questions. In particular, in the next project in this research agenda, we plan to study the role of shipper-carrier relationships and spatial externalities in shaping supply chain resilience.

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