**Title**: Roadside Infrastructure, Spatial Complementarities, and Transportation Efficiency
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## Introduction

The modern industrial and consumer economy relies on the movement of goods. An efficient freight transportation network depends not only on direct inputs such as roads and trucks, but also complementary inputs such as real estate, refueling facilities, and parking infrastructure. Under-provision of these inputs – resulting in capacity constraints, suboptimal routes, and delays – may create costs that spread through the transportation network and affect all parts of the economy.

In this project, we study the provision of complementary infrastructure for freight transportation, focusing on the example of truck parking. Trucking freight relies on the availability of parking spaces for mid-day and end-of-day rest breaks, as mandated by labor and safety regulations, and time spent searching for parking directly leads to underutilization of trucking capital. Parking spaces are provided by a mix of public and private sector entities. Insights from interviews with individuals in the trucking industry have suggested that existing infrastructure is already underprovided and has contributed to higher transportation costs. Indeed, the Federal Highway Administration found that 75 percent of truckers regularly have trouble finding parking at night, and the American Trucking Research Institute has ranked “Managing Critical Truck Parking” as its most important research topic (ATRI 2016).

We build a structural model of trucker preferences over truck stops and private truck stop entry to study several research questions: In selecting routes, how do truck drivers value route efficiency relative to access to complementary infrastructure such as parking? In what ways does the current infrastructure network deviate from the network that minimizes transportation costs? Given private entry incentives of infrastructure providers, which policy regimes most closely approximate the optimal infrastructure network?

Our analysis focuses on three economic forces which are fundamental to addressing these research questions: strategic complementarities in spatial infrastructure provision, market power among private infrastructure providers, and regulatory costs. When strategic complementarities are present, infrastructure providers see limited returns to entry unless enough providers enter to

provide a sufficient level of provider density. As a result, equilibria may exist with both high and low levels of infrastructure provision. Large providers with market power may open fewer locations for fear of competing with their existing locations. Regulatory barriers, such as lack of industrial zones, raise entry costs. These forces have been cited as causes for the existing undersupply of truck parking, and as a result are relevant to any future refueling infrastructure.

**Data**

We have constructed and assembled a rich collection of data on diesel stations, truck parking, high-frequency truck location information, aggregate trucking traffic, and shipping requirements. To capture information on truck stop characteristics, including refueling, parking, and other amenities, we digitized annual editions of the industry periodical *Trucker's Friend*. Used by truck drivers to plan routes and stopping decisions, this directory aimed to include all (private) diesel stations that could serve 18-wheeler trucks, providing details about truck stop address, refueling hours, and availability of various driver and vehicle services, including overnight parking. Crucially the panel dataset allows us to infer entry and exit from changes in truck stops from year to year. We also supplement this information about privately owned truck stops with the US Department of Transportation's surveys of publicly owned truck parking.

To model driver preferences over routes and truck stops, we rely on a combination of high-frequency truck location information, aggregate trucking traffic, and shipping requirements. High-frequency telemetrics data, purchased from the data provider INRIX, allows us to identify individual truck trips, including economic origin and destination, date and time, speed along the route, and any stops. This data covers a majority of truck trips taken in California, Arizona, Utah, and Nevada for one week in May 2019. We combine this data with aggregate traffic information at the highway segment level across the entire United States from the Department of Transportation's Highway Performance Monitoring System (HPMS). We also observe total trucking demand from DAT RateView by origin and destination market.

**Model**

We build a model of truckers' route choices in the vein of Allen and Arkolakis 2022, to estimate trucker demand for roadside infrastructure. In our model, truck drivers choose routes given a fixed origin and destination, in order to serve exogenous commodity flows between the origin and destination. Each route consists of a sequence of segments from origin to destination, and average trade costs for a route are an aggregate of segment-level costs.

We extend Allen and Arkolakis 2022 by parameterizing segment-level costs as a function of characteristics. In addition to distance, which we use as the metric, we include characteristics like the density of diesel stations, the density of parking spots, and proxies for typical traffic congestion.

This model allows infrastructure along different routes and edges to be either substitutes or complements depending on the network structure and pattern of freight demand. For example, an increased number of parking spots along a stretch of highway may steer traffic towards "upstream" and "downstream" segments and away from alternate routes.

We then build a model of private truck stop entry, building on the predicted demand effects of entry. In our preliminary results, we use a simple free entry condition with atomistic truck stops. Using truck stop brand data from the *Trucker's Friend* and other sources, we will extend the model to allow firms to internalize spillovers from entrants they are affiliated with, and allow heterogeneous entry costs due to variation in local real estate prices and municipality characteristics.

**Preliminary Results**

In our preliminary estimates[1], we find that truckers prefer routes which feature a higher density of diesel stations and truck parking. In economic terms, a trucker is indifferent between taking a detour of 33 miles (0.68 miles) and taking a route with an additional diesel station (parking spot) per mile. Given the $1.65 marginal cost per mile estimate in Yang 2022, this suggests a value of $54 ($1.10) per additional diesel station (parking spot) per mile.

Our preliminary results capture intuitive features of the transportation network. For example, the following figure plots the predicted change in traffic when the travel cost on a single segment (in yellow) decreases by one percent. Naturally, the upstream and downstream segments observe an increase of traffic flows (blue segments), while alternate routes to the east of the yellow segment show a decrease in traffic flows (red segments).

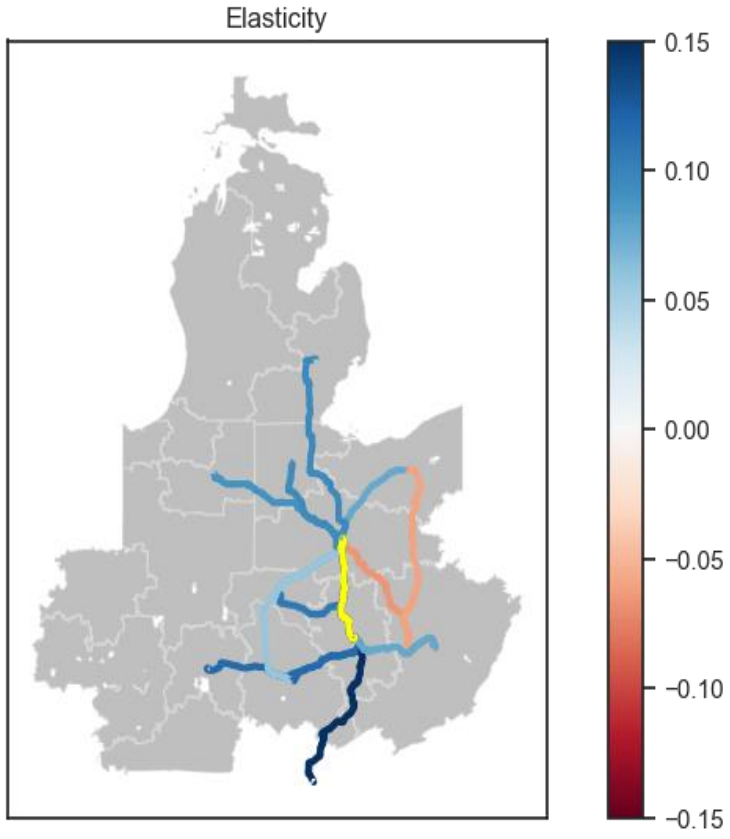



Figure 1: Traffic Elasticities with respect to Travel Cost

*Notes*: This figure shows the elasticity of traffic with respect to a fall in travel cost along a treated edge (in yellow). Blue edges indicate an increase in traffic, while red edges indicate a decrease in traffic. Darker values represent larger magnitudes. This figure only plots edges with elasticities greater than 0.05 in magnitude.

## References

[1] Preliminary estimates rely on aggregate traffic data only. The purchase of high-frequency location information was completed during the last week of June, and we are now re-estimating the model with this micro data.

[1] ATRI. Managing Critical Truck Parking Case Study. Technical Report December, 2016.

[2] Treb Allen and Costas Arkolakis. The Welfare Effects of Transportation Infrastructure Improvements. *The Review of Economic Studies*, 2022.

[3] Ron Yang. (Don't) Take Me Home: Home Preference and the Effect of Self-Driving Trucks on Interstate Trade. page 74, September 2022.