Valuing Domestic Transport Infrastructure: A View from the Route Choice of Exporters

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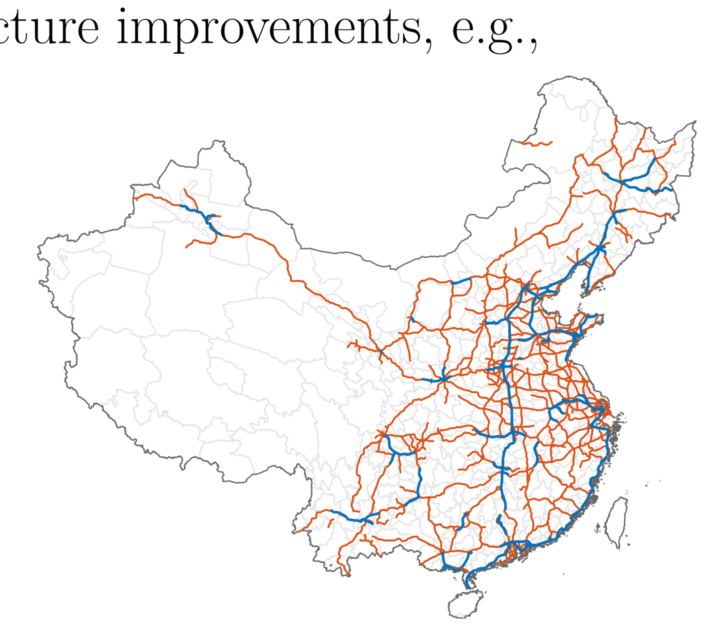
Abstract

A key input to quantitative evaluations of transport infrastructure projects is their impact on transport costs. This paper proposes a new method of estimating this impact relying on the widely accessible customs data: by using the route choice of exporters. We combine our method with a spatial equilibrium model to study the aggregate effects of the massive expressway construction in China between 1999 and 2010. We find that the construction brings 5.1% welfare gains, implying a net return to investment of 150%. Our analysis also produces some intermediate output of independent interest, for example, a time-varying IV for city-sector export.

Introduction

Goal: evaluate welfare effects of domestic transport infrastructure improvements, e.g.,



Expressway Expansion in China, 1999 (blue)-2010 (orange)

Key step: estimate how transport networks map to city-to-city trade costs

Existing methods: freight rates; infer from price gaps of goods; infer from shipment flows

Challenges: lack of shipment flow data *over time* in many countries

Our approach

- Exploit over-time variations from exogenous expressway expansion
- Estimate using changes in exporting firm's port choice from easily accessible customs data
- Combine a routing and spatial equilibrium model to estimate parameter and conduct counterfactual

Data and Reduced-form Evidence

$$\ln(v^t_{(o,RoW),d}) = \beta_{od} + \beta^t_o + \beta^t_d + \gamma \cdot \text{dist}^t_{od} + \epsilon^t_{od}$$

- $v^t_{(o,RoW),d}$: value of export from city o via port d in year $t \in \{1999, 2010\}$; from Chines customs data
- dist^t_{od}: regular-road equivalent length of the shortest route; maps from Baum-Snow et al. (2016)

Estimated results

	Effective Length		By Road Type
dist^t_{od}	-0.384***	-0.174***	
	(0.011)	(0.045)	
-on express			-0.088**
			(0.038)
-on regular			-0.174***
			(0.045)
City-port FE	no	yes	yes

Notes: All columns control for origin-time and dest.-time fixed effects. Standard errors are clustered at city-port level.

Takeaways

- Using cross-section variations alone (i.e., no city-port FE) overstates the elasticity by 100%
- The distance elasticity for expressway is lower

The Spatial Equilibrium Model

Setup

- 323 prefectures+RoW, 25 sectors (2-digit)
- Mobile workers with Cobb-Douglas preference over housing and sectoral final goods
- Intermediate good production: combine labor and sectoral final goods with Cobb-Douglas
- Final good production: combine sectoral intermediate inputs across regions a la Armington
- Prefectures differ in sectoral productivity and amenity, calibrated to match regional specialization and population distribution

Key parameters estimated

Parameters	Descriptions	Value	s.e.
θ	Routing elasticity	111.5	35.4
κ_H	Expressway route cost	0.034	0.002
κ_L	Regular route cost	0.042	0.008

- Elasticity of substitution of routing is high
- Expressway offers about 20% cost saving

Results - Evaluate Mega Projects

14 projects that incur 60% of total cost

—colored based on rank of investment return

ID	Welfare Gains (%)	Net return to investment	% Change in dom. trade	% Change in Export
G1	0.40	567.19%	1.16	0.56
G3	0.49	354.10%	1.05	1.86
G10	0.02	-22.92%	0.09	0.02
G30	0.39	129.32%	1.34	-0.10
...				
Total	3.47		8.76	6.48

- Substantial heterogeneity in impacts on welfare, domestic/int'l trade, and investment return

Highlights

- Use over-time variations in express network and export routing choice to estimate route cost elasticity
- Combine routing and spatial equilibrium model to estimate structural parameters and evaluate welfare
- 100 km on expressway and regular roads increases trade cost by 3.4% and 4.2%, respectively
- Expressway expansion in China during 1999-2010 brings 5.1% welfare gains and a net return of 150%

The Routing Model

- Extend Allen and Arkolakis (2019) with two co-existing networks and transshipment
- Derive trade costs and route choices as analytical and differentiable functions of the road network structure
- Derive structural equation that can be used to estimate route cost parameters with customs data
- Flexible enough to incorporate alternative transport mode and port choice

Results - Aggregate Impacts

Counterfactual: change 2010 expressway to 1999

Aggregate Impacts

Change in	Value	s.e.
Aggregate welfare (%)	0.051	0.025
Log(Domestic trade)	0.136	0.052
Log(Exports)	0.097	0.080

Perspective

- Account for 14% of TFP increase for this period
- Generate a 150% net return to investment, combining estimated cost and required return

Additional Results

- Ignoring regional specialization, int'l trade, or intermediate good trade understates welfare gains and could turn investment return to negative
- Model-implied shipment flows and export align well with data. Model-produced domestic trade and export growth useful in other research
- Derive a 2nd-order sufficient statistic formula for welfare evaluation that takes into account nonlinearity due to the routing block

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