

Traffic Congestion Effects on Supply Chains: Accounting for Behavioral Elements in Planning and Economic Impact Models



Client

Facts

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Summary of the Book Chapter

The effects of traffic congestion on supply chains are of interest for both public policy and private sector shippers and operators, for differing reasons. From the government and legislative perspective, there is a need to make investment, financing and policy decisions based on an understanding of the public infrastructure needs, costs and broader economic stakes involved. From the perspective of shippers and operators, there is a parallel need to assess opportunities, risks and returns associated with alternative location, production and distribution decisions.

To date, much of the academic literature has focused on theoretical models and simulation to demonstrate how rational firm behavior will change as congestion adds to total transport cost. On the other hand, much of the industry writing has centered on stories about the many ways that businesses change behavior to avoid congestion impacts –by shifting operations, schedules and locations. This article seeks to span the two by providing a structural framework for classifying the different elements of supply chains and how congestion affects each of them. It then identifies the transportation performance measures and cost elements that need to be recognized in economic models of both firm behavior and broader economic development. An example is provided to show how more economic impact modeling can more realistically represent firm behavior and better inform public policy decision-making.

A review of research literature reveals theoretical models which posit that generalized growth of traffic congestion adds to total transport costs for delivered products, causing firms to shift location and shipment size configurations to re-optimize net revenues. However, a review of industry publications reveals a plethora of different responses, with articles focusing on how bottlenecks at specific ports, intermodal facilities and urban districts cause schedule delivery uncertainty, leading to a range of operational responses as a hedge against that uncertainty. The nature of the affected parties, and the form of operational responses, can vary widely by industry. However, the breadth of concerns about supply chain impacts of traffic congestion appears to be sufficiently broad to motivate a number of national industry organizations and local business organizations to take initiatives, focusing attention on the global business competitiveness implications of congestion bottlenecks in supply chains.

To reconcile these different perspectives, it is useful to first develop a taxonomy that systematically classifies the elements of traffic congestion and their impacts on supply chains. The traffic congestion effects include: (a) recurring and predictable speed slowdowns, (b) non-recurring delays due to higher rates of traffic incidents and greater severity of resulting backups, and (c) traffic pattern rerouting. These traffic effects have both time and spatial characteristics which subsequently lead to business impacts. These business impacts fall into seven distinct classes (each of which is explained in the article):

1. Freight Delivery – market size, vehicle/fleet size;
2. Business Scheduling – delivery time shifts, reconfiguration of backhaul operations, use of relief drivers;

3. Business Operations – inventory management, retail stocking, cross-docking;
4. Intermodal Connection Arrangements – access to truck/rail/air/sea interchange terminals;
5. Worker Travel and Compensation – worker time/cost, schedule reliability, “on-the-clock” work travel;
6. Business Relocation Issues – smaller dispersed location strategies, moves outside of major markets, shifts to production elsewhere;
7. Localized Interactions with Other Activities – land use/development and costs passed on to employees.

Each of these seven classes of business impact differentially affects specific parts of the supply chain. These systematic differences are important because they vary by industry, affect the ability of affected industries to mitigate congestion costs through work-around operational changes, and ultimately affect local economic competitiveness in different ways.

The effects on economic competitiveness can be modeled by distilling these supply chain impacts into a manageable set of key changes in delivery market access, labor access, intermodal freight transfers, production scale/dispersion economies and costs of risk avoidance actions. Each of those factors (and the different sensitivity of various industries to them) can then be taken into account in economic impact models. To accomplish this, it is necessary to rely on a relatively new generation of local/regional economic competitiveness and growth models. A brief review is provided of models available to assess regional business competitiveness and growth opportunities associated with local/regional infrastructure investments. An example is provided, using the TREDIS model (Transportation Economic Development Impact System), to illustrate how scenarios to reduce congestion can lead to differential supply chain and regional economic growth impacts.

Finally, need for further research and model improvement are discussed. This focuses on metrics for measuring and monitoring changes in congestion and supply chain responses, and improving model sensitivity to those factors.

SUPPLY CHAIN MANAGEMENT NEW PERSPECTIVES

Edited by Sandra Renko



Contact Persons