

## Introduction to the Special Issue on the Evolution of Transportation Network Infrastructure

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This special issue of *Networks and Spatial Economics* has the theme of the Evolution of Transportation Network Infrastructure. In economics, the short-term is defined by allowing everything to vary except some fixed input, while in the long-term, even fixed inputs may vary. In that light, this issue concerns the long-term, how and why networks change over time, and what are the implications of those changes. The papers presented here span a breadth of methodologies, from empirical, to counter-factual, graph-theoretic, physical, and political economy. These papers all underwent a rigorous peer-review process and we thank the authors for their patience and their reviewers for their meticulousness. By examining these issues with multiple methodologies, by authors from housed in varied disciplines (civil engineering, economics and business, physics, math, informatics, and environmental studies) perhaps new connections can be made and new questions raised.

The first paper (Xie and Levinson 2009a) summarizes and synthesizes the research to date on the topic of the growth of transportation networks. Strands of literature from transport geography, optimization, theoretical and empirical economics, and network science have all approached this issue from different perspectives. The policy implications, of how current investments will shape future choices, are not widely recognized in practice, or understood with confidence in the literature.

Bogart (2009) examines the early English Industrial Revolution, prior to the advent of the railway, to consider how network externalities affected the growth roads, canals, and ports. Historical case studies are important as they allow us to see a complete picture of the birth, growth, maturity, (and ultimately decline) of a type of network infrastructure, and so give us the basis on which to test hypothesized models that just examining the current state of infrastructure would be unable to do. In this case, the author finds that there are positive intermodal network externalities, and that the presence of roads increased (or accelerated) the development of canals, as the necessary local feeder road network may have reduced the risks associated with canal development.

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Casson (2009) follows with an article on the development of the railway network, and considers whether the network, which was built in a very decentralized, piecemeal way was inefficient (it was). The author carefully constructs a more efficient counter-factual network satisfying a number of heuristics, and then compares that with the actual railway, considering the sources of the observed inefficiencies.

Erath et al. (2009) investigate the Swiss road and railway networks for the second half of the twentieth century, showing the increased accessibility provided. They show the freeway network has become less tree-like (and thus more connected) over time, and similarly has become more efficient over this period.

Blumenfeld-Lieberthal (2009) measures the concentration of modern air and rail transportation networks in Germany, Italy, Poland, the United Kingdom, and the United States. The connectivity of the network (measured by a clustering coefficient) is correlated with economic growth and GDP.

Barthelemy and Flammini (2009) develop a model of network growth correlated with development. They show a process that as networks become larger they become less tree-like in topology. They also observe that the resulting network is quite hierarchical, as certain links are much more important than others. Density of development also changes in their model as accessibility varies, and increases when transportation costs rise.

Xie and Levinson (2009b) develop a game-theoretic model of network growth where the expansion of the infrastructure depends on issues of jurisdiction and the different interests of each player. Jurisdictions are allowed to toll, but the toll on non-residents is considered as a benefit, while tolls collected from residents are transfers. The research highlights the problems with incremental myopic decision-making that describes the real infrastructure investment process.

This collection of papers ties together the disparate research to gain a broader understanding of the economic and historical processes driving network growth, and the relationships to network spillovers, land and economic development, and governance issues. These studies may have implications for networks beyond those used in transportation, and help in the shaping of future investments.

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