Improving Pavement Network Conditions Through Competition

CSHub Research Brief | Volume 2020, Issue 8 | By Fengdi Guo | guofd@mit.edu

MIT CONCRETE SUSTAINABILITY HUB

Solving An Infrastructure Crisis

Departments of transportation across the United States face inadequate funding: According to the 2017 ASCE Infrastructure Report Card, the backlog for highway repairs is about $420 billion. This is one of the reasons why 21% of the nation's highways are in poor condition.

The consequences of America's ailing infrastructure are numerous. Besides causing uncomfortable ride quality, they can impose higher maintenance costs and even increase fuel consumption. Annually, poor roads in the U.S. cause vehicles to consume an extra 0.5 billion gallons of diesel and 1.6 billion gallons of gasoline. This extra fuel consumption amounts to 6.2 tons of greenhouse gas (GHG) emissions per mile.

To improve the nation's inadequate roads and mitigate the consequences associated with them, it is important to effectively select and time preservation, overlay, and reconstruction (POR) actions as part of the pavement management process. CSHub researchers have proposed a budget allocation model called probabilistic treatment path dependence (PTPD) that incorporates both the future cost and deterioration uncertainties and their influence on the future treatment path into the decision-making process.

Key Takeaways:

- An increase in competition between paving materials decreases unit POR cost.
- The increase in competition between paving materials has a larger impact on high-traffic roads in Missouri. For those roads, the effect lowers the annual average network roughness by 11% and GHG emissions by 8%.
- The effect is smaller for low-traffic roads in Missouri, which see a 6% reduction in GHG emissions.

High-traffic Roads in Missouri

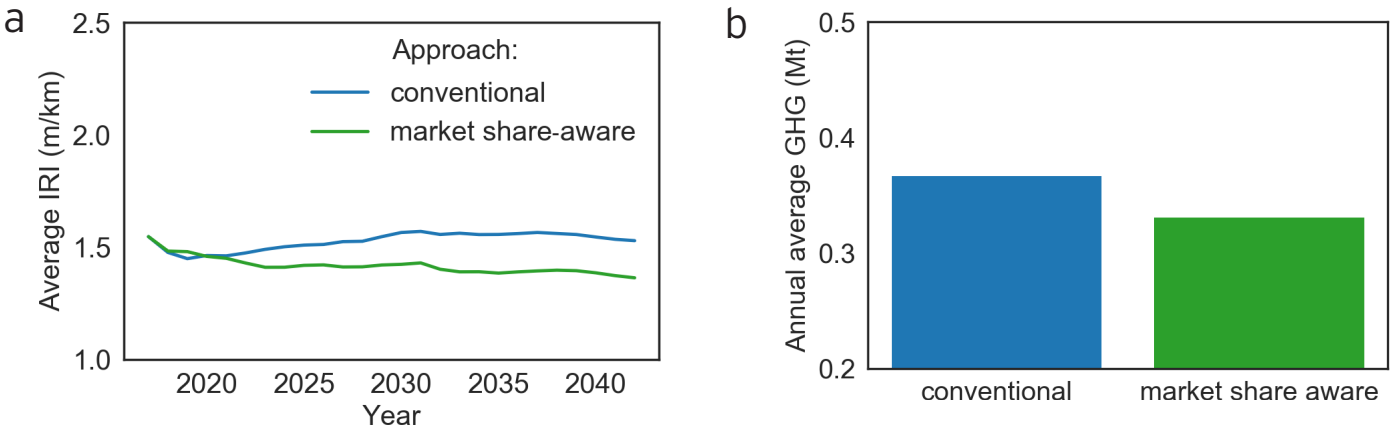

Figure 1. The impact of incorporating competition on (**a**) annual average IRI (International Roughness Index) and (**b**) annual average GHG emissions for **high-traffic roads** in Missouri.

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In addition to implementing a robust allocation model, it is also necessary to find ways to reduce the unit costs of paving materials. Past CSHub research has shown that increased competition among paving material substitutes is correlated with lower unit prices for both asphalt and concrete. Thus, there is potential for increased competition to increase the amount of paving that can be done in a network for the same amount of investment.

In this brief, researchers present results of an analysis showing how increased paving competition and a sophisticated budget allocation model can improve pavement network condition and reduce GHG emissions.

Planning with Competition

Researchers explore the impacts of incorporating competition into the budget allocation process using the PTPD model, which is based on a framework where the segment-level and network-level problems are analyzed separately. POR actions and timing are selected at the pavement segment-level (e.g., a specific mile of pavement in the network) and the allocation of funds to segments and POR actions occurs at the network-level based on the constraints of a limited budget and performance thresholds. The effect of competition is considered in the segment-level analyses where the market share and its effect on paving material prices affect which POR actions are selected. GHG emissions due to excess fuel consumption in vehicles driving on rough roads is also calculated.

The case of Missouri is shown in this brief using data from the Federal Highway Administration (FHWA), the Oman database, and pavement engineers. Projections of pavement network performance and vehicle excess fuel consumption are made over a 25-year analysis period.

Low-traffic Roads in Missouri

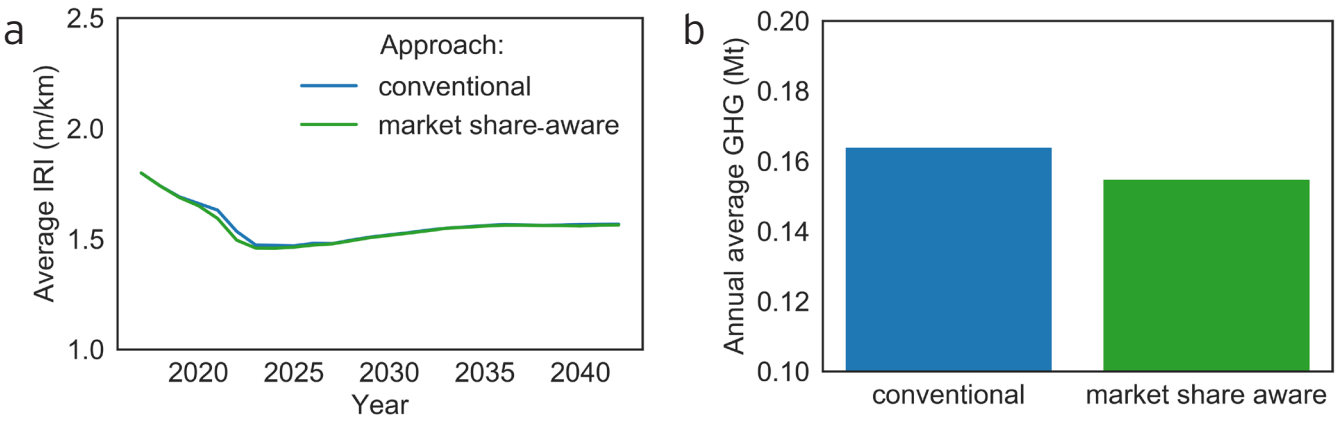

Figure 2. The impact of incorporating competition on (**a**) annual average IRI (International Roughness Index) and (**b**) annual average GHG emissions for **low-traffic roads** in Missouri.

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Competition and Network Improvements

The network analyses show that the lower costs of paving materials due to increased competition would lower the annual average roughness (IRI) on high-traffic Missouri roads by 11% and reduce GHG emissions by 8% (**See Figure 1**). This is in part due to increased usage of concrete on those roads in the model: The slower deterioration rate of concrete is well suited to high-traffic volumes where it sunstains better surface conditions and, therefore, better fuel economy.

Low-traffic roads, however, make more use of asphalt pavements in the model because of the material's lower initial cost. While the impact of competition on asphalt costs is smaller than that of concrete, the incorporation of competition is still able to decrease GHG emissions by 6% on low-traffic roads (**See Figure 2**).

Related Links:

- CSHub Pavements Research
- CSHub Network Asset Management Research
- CSHub Pavement LCA Research
- Topic Summary: Industry Competition and Paving Material Unit Costs
- Journal Article: "Incorporating cost uncertainty and path dependence into treatment selection for pavement networks," Transportation Research Part C: Emerging Technologies.

Citation:

Guo, F., Gregory, J., Kirchain, R. (2020). "Improving Pavement Network Conditions Through Competition", Topic Summary Volume 2020, Issue 3.

This research was carried out by CSHub with sponsorship provided by the Portland Cement Association and the Ready Mixed Concrete Research & Education Foundation. CSHub is solely responsible for content.

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