CONCRETE SUSTAINABILITY REPORT
NATIONAL READY MIXED CONCRETE ASSOCIATION CSR08—SEPTEMBER 2011

MIT Research: Effects of Inflation and Volatility on Construction Alternatives

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Life-Cycle Cost Analysis (LCCA) is used to determine the most cost effective design alternative for assets such as buildings, roads and other infrastructure. Costs are calculated in terms of the Net Present Value (NPV), accounting for initial construction costs and future costs, including maintenance, rehabilitation and salvage. Within the LCCA framework, it is important to account for the time value of money so that the NPV of future activities can be determined. In the construction industry the time value of money is typically determined based on the real discount rate which is a function of the anticipated market interest rate less the rate of inflation over the anticipated life of a project. Using the real discount rate implies that the inflation rate of all construction materials matches the general rate of inflation, inferring that the real costs are fixed over time for all building materials.

Recent research at the Massachusetts Institute of Technology (MIT) examined historical data on real prices and found that the assumption of constant real costs is inconsistent with historical experience. MIT investigated the historical inflation rates of several construction materials (wood, steel, concrete and asphalt) and demonstrated that the historical inflation rates for these materials has been quite different (See Figure 1) and in the case of asphalt has been highly volatile (See Figure 2).

Methodology

To demonstrate the effect of variable inflation rates, MIT performed a LCCA for an assumed 10-mile, four-lane highway project. A concrete and asphalt alternative were analyzed using standard North Carolina DOT pavement designs and maintenance/rehabilitation strategies. MIT performed a stochastic simulation of 1,000 different LCCA outcomes using a Monte-Carlo simulation and historical inflation rates which generated a variety of different random possible outcomes. The results of the simulation found:

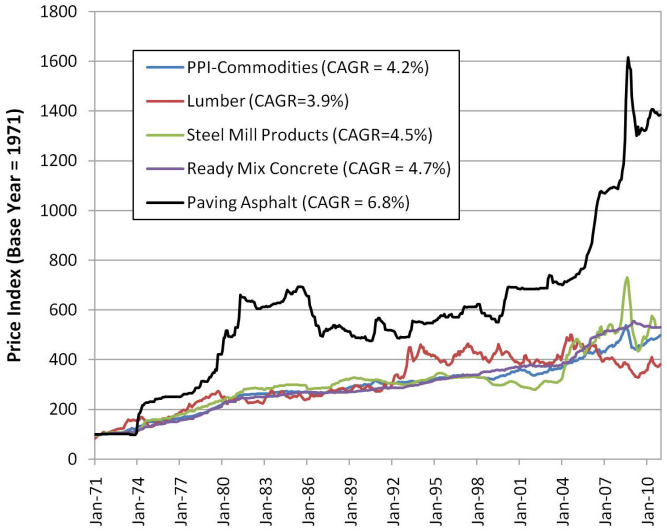

Figure 1. Bureau of Labor Statistics Price Indexes from 1971 to 2010. (CAGR = Compound Annual Growth Rate)

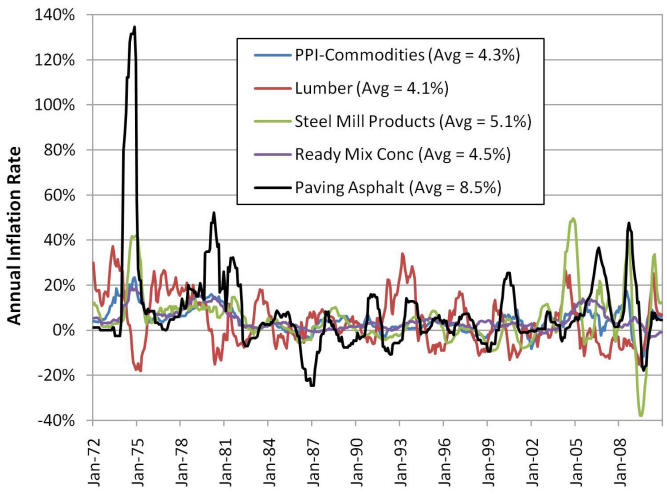

Figure 2. Bureau of Labor Statistics Annual Inflation Rates from 1972 to 2010.

- It is likely that the actual costs for concrete maintenance would be lower than those assuming constant real costs (as in a typical LCCA)—in 86% of the simulations the real price of concrete fell over the maintenance period;
- Asphalt inflation is likely to outstrip overall inflation, meaning that an LCCA assuming constant real costs will exaggerate asphalt's price competitiveness—in 85% of the simulations asphalt's real price rose over the course of 40 years; and
- Based on this analysis, the cost surprise exceeded 4% of the initial projected cost (on a NPV basis) in half the cases, usually because the asphalt construction turned out to be relatively more expensive than concrete construction.

MIT analyzed the real price behavior of wood, steel, concrete and asphalt using data from the Bureau of Labor Statistics (BLS) for a period of more than 30 years and found:

- Asphalt has risen 1.25% per year on average;
- Concrete has declined nearly 0.20% in real terms over the same time frame;
- Concrete's real price volatility is low at 2.9% while asphalt's volatility is substantially higher at 6.3%; and
- Lumber and steel's real price volatility is even higher at three times more than concrete.

To account for the variable inflation rate of various construction materials, analysts could use an escalation rate to account for the difference in inflation between building materials and the general rate of inflation. MIT conducted another stochastic simulation for 1,000 real cost paths for the four basic construction materials over a period of 50 years and found:

- If the real prices of lumber, steel, and concrete continue to decline as they have historically, their real prices could fall to 56%, 72% and 80% of their current costs, respectively;
- Asphalt's real cost would rise by nearly 95%; and
- The mean annual real escalation rate of concrete is –0.5% while asphalt's rate is +1.1%.

Impacts and Recommendations

LCCA for road construction is used to determine which pavement design is most cost effective over the analysis period. For LCCA to be reliable, both the engineering inputs and the economic inputs need to accurately reflect the future performance and the time value of money. Current practice assumes that the inflation rate for all materials is the same; however, MIT has demonstrated that this is not the case and determined:

- Asphalt's 40-year historical inflation rate is 2% to 4% higher than that of concrete; and
- There is sufficient historical and forecasting evidence that demonstrates this difference will continue in the future.

Recommendations for improving LCCA for construction material selection include:

- Continue use of the Office of Management and Budget (OMB) recommended real discount rates in LCCA;
- For pavements it is recommended to use the 30-year real discount rate;
- For other structures it is recommended to use the 50-year real discount rate (or other appropriate timeframe); and
- Account for differences in inflation among materials and the general rate of inflation by using an appropriate escalation rate applied at the year(s) of rehabilitation.

More Information

The full report titled *The Effects of Inflation and Its Volatility on the Choice of Construction Alternatives* can be downloaded from the MIT Concrete Sustainability Hub Web site at http://web.mit.edu/cshub. The Concrete Sustainability Hub is a research center at MIT that was established by the Ready Mixed Concrete (RMC) Research & Education Foundation and the Portland Cement Association (PCA). Both organizations are committing significant effort and resources with the goal of accelerating emerging breakthroughs in concrete science and engineering and transferring that science into practice. NRMCA is providing technical input to the research program and helping transfer the research results into practice.

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