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New Developments in Cost-Benefit Analysis Applications to Transportation

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Introduction

- There has been a significant increase in the use of benefit cost analysis (BCA) to guide transportation planning in the United States
- In 2005 the Government Accountability Office found inconsistent application of BCA, however the use of standardized frameworks has expanded:
  - At the federal level BCA increasingly required for projects seeking discretionary funding (e.g., TIGER grants, FTA grants, FAA)
  - Regional and state transportation agencies increasingly develop and apply BCA models (Port Authority of New York and New Jersey, Virginia Department of Rail and Public Transportation)

Introduction (cont.)

- There has been substantial expansion in the scope of BCA from the traditional framework of user benefits
- The traditional user benefits measured are travel time, safety, and privately-borne vehicle operating costs
- There are at least three major areas where BCA practice has expanded:
  - Environmental benefits and costs
  - Wider economic benefits
  - Applying BCA to “State of Good Repair” projects

Environmental Costs: Health Impacts of Emissions

- Transportation projects may increase (or decrease) pollution, through vehicle emissions or emissions associated with power plants
- These changes lead to measurable health impacts that should be incorporated into a BCA to measure the full welfare impact of a transportation project
- For example, a transportation project that shifts passengers from auto to transit may lead to a net decrease in harmful pollutants (nitrous oxide, sulfur dioxide, particulate matter)
- Essential components of such an analysis are:
  - Emissions models that estimate the emissions profile of specific vehicles
  - Estimates of localized health impacts to link emissions to quantifiable damages

Environmental Costs: Health Impacts of Emissions (cont.)

- BCA must consider a variety of nuances
- The emissions profile of different vehicle types are changing over time, and BCA for a transportation project has time horizons of 20 – 30 years or more
- Health impacts for a given level of emissions vary greatly by location, as affected by:
  - Exposure: How many people will be directly exposed to the pollutants before dispersal
  - Existing ambient levels: Health impacts non-linear and marginal impacts known to increase with starting levels
- For example, in the New York region 1 million miles of auto emissions has a far greater health impact in Bronx County than in the relatively rural Suffolk County

Environmental Costs: Health Impacts of Emissions (cont.)

- At present emissions models are widely available, detailed and account for technological change in the vehicle types over time.
- Studies of emissions health impacts have become commonplace, and meta-analyses have led to estimates of quite localized effects
- As a result, incorporation of pollution health costs is increasingly become a common component of BCA practice: Federal guidance on completing BCA in the United States usually requires incorporating these heath impacts

Environmental Costs: Carbon and Climate Change

- Climate change is widely expected to have some grave economic impacts, be it through sea level rise or on agricultural productivity
- Of the greenhouse gases produced by transportation, carbon has been the primary focus
- Integrated assessment models measure the economic costs of carbon's atmospheric concentration on biological and physical systems
- This rapidly evolving field of research is summarized in various sources including the *Stern Review on the Economics of Climate Change* (2006) or William Nordhaus' *A Question of Balance* (2008)
- The economic impacts of marginal increases in carbon rely on estimates of sequential impacts that cannot be estimated with certainty

Wider Economic Benefits

- It has long been known that the same worker as measured by education and experience is 10-20 percent more productive in an urban setting than outside one
- Wider economic benefits (WEBs) account for the fact that a transportation investment may facilitate an urban environment, leading to increases in productivity
  - Increased accessibility within a region allows for firms to draw on a larger labor market
  - Especially for higher skilled, specialized occupations this improves the "match" between the needs of firms and the skills/ability of a worker
  - A large and dense labor market reduces the risk in becoming highly specialized in a particular skill (more employment options)
  - A larger concentration of firms and workers locating near each other facilitates exchange of ideas, technology and leads to innovation
  - Accessibility improves the choice of non-labor inputs

Wider Economic Benefits (cont.)

- The importance of accessibility in fostering greater productivity dates back to Adam Smith, and the idea that a larger effective market allows workers to become more specialized and productive
- Urban Economics (in particular the New Economic Geography) has provided a detailed theoretical basis for the agglomeration economies
- What was needed was a link between transportation investment, accessibility and productivity
- Two approaches are suggested by research and guidance (e.g., UK Department for Transport):
  - Calculate the improvement in *generalized transportation cost* from a transportation investment and then infer increase in "effective density" and productivity
  - Estimate WEBs as a proportion of direct user benefits (travel time savings)

Wider Economic Benefits (cont.)

- Effective density calculations are preferred as they take into account project specifics including
  - The type of user affected (i.e., business versus leisure)
  - The existing degree of accessibility
- In practice the calculations require detailed data and can be involved, leading to the use of mark-ups of user benefits
- In general, WEBs tend to be in the range of 10% to 25% of user benefits

State of Good Repair

- In 2013, the FTA estimated that more than 40% of buses and 25% of rail transit assets were in marginal or poor condition
- Estimates from the *National State of Good Repair Assessment* identified an backlog of over $85 billion in deferred maintenance and replacement needs, a backlog that has continued to grow
- Such a large backlog of projects necessitates project prioritization given the limited budgets available to many transit agencies
- Traditionally BCA has been difficult to apply to State of Good Repair (SGR) projects as they provide few new benefits and instead maintain the existing levels of service

State of Good Repair (cont.)

- There are two main areas where SGR projects tend to generate benefits
  - minimizing decreases in the level of service due to routine limited failures
  - protecting against infrequent catastrophic failures.
- To identify these types of benefits it is essential that a realistic base case or "do-nothing" scenario is identified
- Unfortunately this is the biggest hurdle when identifying the benefits of SGR project as it requires extensive analysis and data collection

State of Good Repair (cont.)

- What is the base case?
- The base case must reflect the most realistic situation where the asset is not replaced or refurbished
- Determining the effects of not bringing the asset to a state of good repair requires analysis of the asset's failure rates
- Identifying the failure rates for both routine and severe failures is quite difficult and requires either detailed and digitized maintenance logs or extensive manufacturer testing of the asset
- When it's not possible to maintain detailed logs, even simple digital logs of type of repair and asset downtime can be invaluable in assessing SGR projects

State of Good Repair (cont.)

- In addition to reducing failures rates, SGR projects tend to have another benefit, hazard mitigation
- Many SGR projects include modernization of an asset that bring it up to today's safety standards which take into account increased rates of severe weather events
- In today’s funding environment it is important to recognize the hazard mitigation benefits of SGR projects as it opens them up to additional funding sources
- Hazard mitigation benefits can include the following
  - Keeping the asset from being destroyed
  - Reducing the amount of time a key piece of infrastructure is out of service following an severe event
  - Reducing the need for expensive repairs needed to recover from the event.

Conclusion

- The use of BCA is expanding in transportation;
- It has long suggested that environmental issues were important, WEBs has been a more recent arrival
- Prioritizing SGR has always been a concern of those in the trenches
- Environmental benefits and WEBs research has permitted inclusion in BCA as measurement of benefits and costs– but there is still work to be done;
- SGR is area with the most to be done to permit more generalized use of BCA

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Questions

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