New Jersey Link to the 21st Century: Maximizing the Impact of Infrastructure Investment

Working Paper No. 1

Outlining Objectives, Approach and Structure of Study

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Preface

The University Transportation Research Center (UTRC), as part of the *New Jersey's Links to the 21st Century* project, has requested the different members of the research team to produce working papers on the different facets of the analysis. These working papers are intended to provide an initial basis for discussion and analyses of ideas, and to stimulate discussion and analysis on the part of both team members and New Jersey Department of Transportation representatives.

In this context, rather than being an official expression of the research team, the working papers represent a starting point for discussion. The research team is extremely interested in receiving comments and suggestions from the readers and reviewers. Constructive comments and suggestions will enhance the quality of the final product, ensuring the New Jersey Department of Transportation receives a product of the highest quality representing the state of the art of transportation science.

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Introduction

The overall goal of this project is to assess the impact of planned transport infrastructure investment projects on travel behavior and economic development in New Jersey. The proposal for this research project discusses 5 main objectives for this study. The purpose of this working paper is to review these objectives, provide basic definitions, highlight key issues and suggest methodologies to accomplish these objectives. In addition this paper suggests a general structural framework and outlines the main tasks and phases to follow. It should be understood that while each objective is stated separately in the proposal, they all are interconnected in that they focus on the relationship between infrastructure investment and transportation, land use and economic development. For presentation purposes we will discuss each objective individually.

This paper is the first in a series of working papers to be written by members of the research team, as the work progresses. Ultimately, these working papers will serve as a means of providing NJDOT and others continuous information about the status of the project and about major results and findings.

The Structure of this working paper is as follows. Section 2 presents and discusses the hypothesized relationships between transport investment and economic development. The subsequent section (3) elaborates and expands on the specific objectives of this study as described in the proposal. Section 4 elaborates on some key underlying premises of this study. Section 5, lists tasks to be done next.

1. Overview of the Relationships between Transport Investment and Economic Development

The fundamental assertion of this study is that planned and in progress transportation infrastructure investment projects in New Jersey have the potential to engender economic development in the state. This economic development will be manifested primarily in the form of land use activity changes, improved environment, and increased employment. These effects, in turn, will transpire mainly from improved accessibility and from the non-transportation impacts of the investments. For this study the key question then is how to define and quantify these impacts and how to model the functional links between the investment projects and the resultant economic development.

Figure 1 shows a general framework for the study of the relationships between the major variables involved. In what follows WEcall these relationships the "causality linkage" as it indicates the way transportation infrastructure investment projects potentially influence changes in land use and economic decisions by households and firms, which jointly can result in economic growth.

Figure 1 Here

As this figure shows it is conjectured that the main results from a transport investment project are changes in accessibility and in non-transportation factors. The latter include factors such as industrial and commercial agglomeration, labor market conditions, investment multiplier, supply of land, and environmental conditions. Given present and future policies on transportation, land use, social, environmental and economics, accessibility changes, in turn, will affect land use patterns and the economic behavior of households and firms. Combined, these latter effects will determine the potential path and rate of expected economic growth.

Obviously, the relationships depicted in Figure 1, describing the causality linkages between transport investment and economic growth, require careful definition, modeling and interpretation. For example, Figure 1 asserts that travel behavior and conditions affect land use distribution, which, in turn, affects travel patterns. To actually determine how changes in accessibility from infrastructure investments effectuate new land use equilibrium patterns, it is necessary to carefully model and analyze the interrelationships between accessibility changes and location decisions. Such an analysis will be a key task for future work. Next we discuss the 5 main objectives of this study.

3.   Discussion of the Study's Objectives

In this section each of the project's objectives underlying premises and implications for the study are introduced.

First Objective: *To describe, quantify and assess the nature and impact of current and proposed transportation infrastructure investments upon accessibility and economic development.*

While the diagram in Figure 1 constitutes the general interpretation of this objective it is necessary to elaborate on the objective's components. First, we need to characterize infrastructure investment projects in terms of money outlay, implementation time (year start and end), type of project (rail, highway), capacity (new facility or expansion of existing one) and location. Secondly, we need to evaluate, measure and model the impact of such investment on economic development (or the demand for such investment in response to economic development).

Work to be carried out for this objective:

1.   Define the geographical boundaries of the study area. This can be done by
     a. Counties
     b. Population density
     c. Accessibility contours
     d. Commuting patterns
     e. Problem areas
     f. Others

2. Prepare a list of current and proposed infrastructure investment projects relative to the characteristics mentioned above.

2. Define accessibility meaningful to travel behavior and land-use analysis. These include
     a.   Actual travel time by mode
     b.   Location opportunities
     c.   Weighted combination of travel time and distance
     d.   Network accessibility (e.g., minimum travel time)
     e.   Corridor travel time
     f.   appropriate combinations of above

3. Define economic development. This can be done in terms of:
     a.   Employment by category
     b.   Land use changes within the major counties in NJ
     c.   New business establishments
     d.   Income per capita in NJ

Second Objective: *To review and quantify recent and proposed land-use changes and developments, and evaluate such changes as a response to investment and accessibility.*

Whereas the first objective was to propose how improved accessibility from infrastructure projects can affect land-use, this objective aims at reviewing land use changes and ascertaining the degree to which they were caused or affected by accessibility changes. To that end the following should be carried out:

1. Survey of land use development plans in terms of
     a.   Type (commercial, residential, recreational, industrial)
     b.   Location
     c.   Magnitude (land requirement, number of units, density, capital expenditures)

2. Contact county planning boards and other agencies to obtain necessary information

3. Survey firms (commercial and industrial) that have recently moved to ascertain the key motives for their relocation.

4. Develop tools to assess whether these plans were indeed influenced by accessibility considerations and if so, to what degree. These tools need to be considered within the overall modeling activities of this study. See next objective.

Third Objective: *To develop analytical tools to assess the ties of investment to accessibility to assist in policy decisions concerning future infrastructure investments and development projects. These tools will be especially useful to assess New Jersey's potential for growth within the highly competitive region*

Here we focus on the linkages between transport infrastructure investment and accessibility changes. In general, such investments are undertaken primarily (though not exclusively) to ease traffic conditions and, therefore, improve accessibility. Yet, improved accessibility is not guaranteed, especially not if we consider some major short and long-term effects. One such change is mode choice. Improved highway accessibility due to a capacity expansion project can draw transit passengers to switch to highway use, thereby causing congestion back to previous levels. Second, improved travel time can induce latent demand, again causing additional use, thus congestion. Third, in anticipation or in response to the infrastructure investment, activity relocation might cause additional traffic to ensue. Fourth, considering the network, capacity development in one location may worsen conditions elsewhere. Hence the tools to be developed should be able to account for these effects. A battery of analytical tools will be proposed. In a subsequent working paper the exact nature of these models will be discussed. The main ones are:

1. Accessibility models, whose aim is to link capacity improvement (or upgrading) to changes in travel times, travel volumes, travel distances and O-D changes. Accessibility models must also be sensitive to strong changes in activities (the attractions). As some of these attractions are correlated with economic activity, economic trends, including simple measures such as income, job type and employment will be tracked and modeled. Mode choice models should also be employed.

2. Investment evaluation models. Even if infrastructure investments can be shown to improve accessibility one key question still needs to be answered. That is, how much accessibility an additional dollar of investment "buys". Our attempt is not to assess, in a cost-benefit fashion, current of planned projects but rather, to characterize transport infrastructure investment projects in New Jersey relative to their ability to gain *additional* accessibility.

3.   Land-Use-travel models. It will be very useful to employ such a model. However, the main problems are:

> First, major efforts are needed to install such a model and fully understand its capabilities and limitations
>
> Second, uncertainty regarding the availability of pertinent data
>
> Third, the time and efforts needed to calibrate the model
>
> Fourth, the results might be at the end too general (in geographical terms) to be useful for policy analysis at specific locations.

UTRC suggests that a preliminary investigation will be conducted with respect to the availability and usefulness of such a model and the time and costs resources needed for its implementation.

Fourth Objective: *To conduct the above assessment looking at all modes, freight and passenger, understanding that both are essential for economic well being and that investment strategies must examine means of providing both.*

The focus of this objective is the assessment of freight transport on the economic well being of New Jersey. Freight movement is unique in a number of ways. First, it imposes a disproportionate traffic congestion level on passenger and other traffic. Second, while perceived as a major cause for the wear and tear of highway facilities, its level is a direct function of total economic activity in the region. Fourth, insufficient capacity of freight vehicles and facilities is a real constraint on the potential economic development of the region. We therefore propose the following approach.

1. Review the major freight systems in New Jersey, including rail and truck and ports, relative to their routes, key facilities and annual movement of goods by type.

2. Assess the costs of freight movement in New Jersey, in terms of shipping costs, wear and tear, and externality costs including environmental and accident costs.

3. Develop a freight demand model to be specified in terms of macro-economic variables like Gross State Product (GSP), income per capita, and US manufacturing output indices.

Fifth Objective: *To study the above in a joint academic -NJDOT setting, providing training and education for the professionals who will eventually be responsible for*

infrastructure and land use planning and implementation. Some may be agencies and firms today; others may be students, soon to be employed by agencies.

This objective is of particular importance since it calls for efficient dissemination of information to those agencies and individuals that eventually will have to use the methods developed in this study and its main results. We propose the establishment of an information dissemination mechanism to attain this objective.

In summary, the prime goal of this study is to provide decision makers and planners in New Jersey working tools to assess the contribution of transportation infrastructure investment projects to the state's economic well-being and development. To that end, we need to assess how such projects affect accessibility in the locale in which they are implemented. Subsequently, we need to examine how improved accessibility affects land use distribution and economic general development in the state, given developments in adjacent states.

4.   Key Premises that Underlie the Proposed Approach View

The general approach to the study of the impact of transportation infrastructure investment projects on accessibility and economic development in New Jersey is depicted by Figure 1. Underlying this approach are four major premises that also should serve as a guideline in carrying out the various tasks of this study (see next section).

The first premise contends that the state of New Jersey is part of a larger region including New York city metropolitan area parts of Pennsylvania and Connecticut. Hence, transportation and economic developments in New Jersey affect and are being affected by trends, investments and economic developments in other parts of this region. It is for this reason that major trends and transportation investment projects in neighboring areas should be examined as part of this study.

The second premise is that we need to take a long-term view of the main issues under study. Often economic development factors (e.g., land use changes) transpire long after infrastructure investments are made. Therefore, we need to consider historical trends to correctly ascertain the relationships between the variables involved. We also need to choose a horizon year for our predictions, which will allow sufficient time to evolve for capturing all of the impacts from the investments.

While we do not propose to carry out cost-benefit analysis of any single infrastructure project, it still may become necessary to consider groups of benefits and costs such as increase in total employment or total time spent in travel.

The third premise of this study is that we evaluate infrastructure projects using a welfare approach where *total* benefits and costs *and* their distribution by location or population type are regarded.

The fourth major premise of this study is that some transportation facilities have a disproportionate impact on the economy of the state and the region than others do. Major examples are the seaport, the airport and some key rail facilities. Obviously, infrastructure developments at, say, the seaport will have very large impact on the highway system on freight movements and on employment. For this reason we propose that present and planned investments in these facilities will be studied with special attention and that attempts would be made to examine the overall impact of these facilities on the economy of the state.

5.   Work to be done

In this section we first elucidate the major phases in the overall analysis and then suggest the formation of working teams to cover these phases.

5.1 Major Phases in the Study

Major phases of the study are shown in figure 2.

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 Figure 2 Here
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Phase I is to examine data sources and availability relative to transportation infrastructure projects and travel patterns, population and key population indicators (income, HHCO, etc.) employment and land use distribution and density. Key attributes of these data study are geographical location, years for which the data are available, degree of disaggregation (e.g., SIC code or household level), and form of data coding.

Phase II is a set of trend analyses. In many cases economic development takes place as a result of "natural" trends in population, employment and land use. Key trends in adjacent states should also be examined. In general, before we can attribute economic growth impact to transportation projects (under way or planned) it is necessary to examine present trends in these key variables. Forecasted effects will be compared and contrasted with these trends.

Phase III is accessibility analysis where the main objective is to develop accessibility models (see Section 3, first objective) and then determine empirically the relationships between transport infrastructure projects and changes in accessibility.

Phase IV of the study calls for the adoption of a land use model from the few models available commercially. The use of such a model, mainly its calibration and use for prediction analysis, is certainly a difficult and a time consuming activity which requires careful planning and team work. It is imperative that the users of a land use model would fully understand its theoretical underpinnings as well as its limitations. A key question is whether the data necessary for such a model is available and part of the efforts in phase I should be targeted to that end. In general, the availability of a working and analytically sound land use model can greatly facilitate the analysis of this study. Therefore, a careful investigation of all the issues concerning the adoption of a land use model should be undertaken soon.

The goal of Phase V of the study is to analyze how changes in land use, in improved accessibility and in other factors germane to transport infrastructure investment (e.g., the investment multiplier and environmental externalities) collectively, affect economic development. This is rather a difficult task, which requires in-depth theoretical and analytical analysis[1]. The main result from the empirical analysis that follows, should be a clear understanding of the contribution of transportation capital investment projects to the economic development of the state of New Jersey, by investment type, time and location.

The final phase VI aims at bringing together all the pieces from this lengthy analysis in a coherent strategic policy statement pertaining to two main issues. First, the type of transportation infrastructure projects, which will have the greatest impact on accessibility and economic development in New Jersey. Second, the conditions, which are necessary for these impacts to ensue. These conditions pertain to land use policies, transportation policies, and general economic policies.

5.2 Working Teams

To carry out the above tasks UTRC will establish 5 working teams.

1. **Definition and calibration team**. This team will be responsible for defining key variables and parameters such the geographical boundaries of the region, modes of travel, time horizon, accessibility, employment and economic development. As data becomes available and models begin to be calibrated this team will need to continuously determine at what level the analysis will be carried out (e.g., SIC levels, or location sites).

2. **Data team**. This team will be in charge of all data collection activities including a survey of sources of data, data recording and storing and present and planned

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[1] For such analysis see Banister D., and Berechman J., *Transport Investment and Economic Development*, University College London Press, (forthcoming)

infrastructure transportation projects. This team will also be in charge of trend analysis and projection.

3. **Transportation analysis team**. This team will be in charge of developing the set of transportation models to be used, their adoption, calibration and use for prediction analysis.

4. **Land use modeling team**. This team will be in charge of determining which land use model will be adopted, its calibration and use.

5. **Economic development analysis team**. The responsibility of this team is to put together the analysis carried out by the other teams to determine the relationships between transportation infrastructure investment projects and economic development. This team will also be in charge of preparing the final report of this study.

6. **Information dissemination team**. This team will focus on producing reports, working papers and conducting seminars on the methods, data and findings of this study, to all parties involved.

Figure 1:   **General Framework for the Study of the Relationships between Transport Investment and Economic Development**

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                    ┌──────────────────────────────┐
                    │  Transportation Investment    │
                    │  Projects by Mode, Size and   │
                    │          Location             │
                    └──────────────────────────────┘
                         │                    │
                         ▼                    ▼
              ┌────────────────┐    ┌──────────────────┐
              │  Accessibility │    │ Non-Transportation│
              │    Impacts     │    │     Impacts       │
              └────────────────┘    └──────────────────┘
  ┌───────────┐        │                      │
  │ Transport │───────▶│                      │
  │ Policies  │   ┌────────────────┐          │        ┌──────────────────┐
  └───────────┘   │ Travel Behavior│◀─┐       │        │  Economic and    │
                  │ and Conditions │  │   ┌───────┐◀────│ Related Policies │
  ┌───────────┐   └────────────────┘  │   │ Land  │     └──────────────────┘
  │ Land Use  │────────▶│             │   │ Value │
  │ Policies  │         ▼             │   └───────┘
  └───────────┘  ┌────────────────┐   │        │
                 │ Land Use Changes│───┘    ┌──────────────────────┐
                 └────────────────┘  ─────▶ │ Economic Decisions by│
                         │                  │ Households and Firms  │
                         ▼                  └──────────────────────┘
                   ┌────────────────────────────┐    │
                   │  Economic Development by    │◀───┘
                   │     Type and Location       │
                   └────────────────────────────┘
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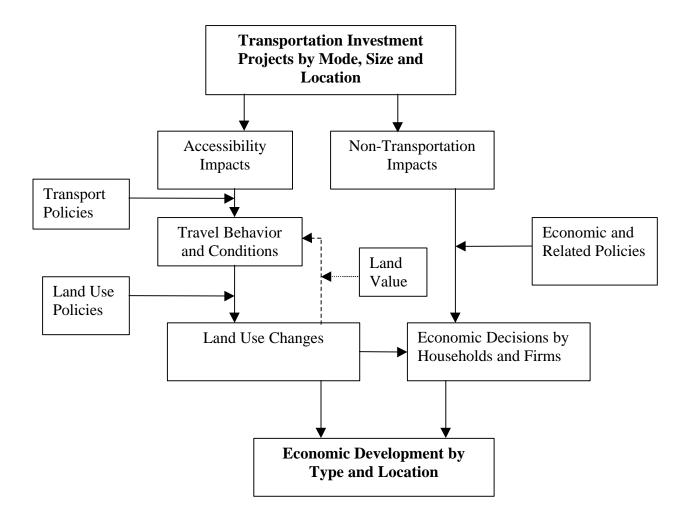
Figure 2: Aspects of Study

I. Data Availability and Sources
- Transportation: Travel and Projects
- Population
- Employment
- Land Use by location

II. Trend Analysis
- Population and Employment
- Travel Patterns: Passengers and freight
- Location: residential, commercial, industrial

III. Accessibility Analysis
- Accessibility modeling by mode
- Empirical analysis of projects

IV. Land Use Analysis
- Modeling: data needs and calibration
- Empirical analysis of accessibility and land use

V. Economic Development Analysis
- Modeling economic development
- Empirical analysis

VI. Policy Analysis
- Strategic Policy Evaluation