

ABSTRACT

ESSAYS ON OPTIMAL TRANSPORT INFRASTRUCTURE DEVELOPMENT

by

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There is a wide consensus that transport infrastructure development stimulates economic competitiveness and growth. However, such kind of development is long-lasting in nature and requires huge budgetary allocation. Moreover, the contemporaneous public policy has to focus more on other socioeconomic problems such as health care, pension, education, etc. which puts the transport sector under strict financial constraint. The issue of optimal transport infrastructure development therefore, is a major concern among the transportation economists, policymakers, and academics of both the developed and developing countries. In recent years, the world has experienced a rapid growth both in the number and size of cities, and so this issue has become more crucial in urban contexts than before.

Most of the prior literature concerns with the specific type of transport infrastructure development, limited number of travel routes and monocentric city assumptions. There is no extent work on the optimal transport infrastructure in a city model under

“general” settings that can explain any kind of transport structures, any number of modes and routes, and any number of city centers. Literature is also limited on the optimal circumferential highway within a city model and therefore, the influence of a circumferential highway on the city characteristics remains unexplored. One “efficient” way to finance transport infrastructure is to utilize the toll revenue collected from the highway usages. The theory of transportation economics demonstrates that by following a “right” investment policy together with some specific characteristics of highway cost and trip production functions, it is possible to finance the cost of highways from the toll revenue. However, when a highway agency intends to maintain self-financing, while following a “wrong” or in other ward “naive” investment policy which is more likely in the real policymaking, it will result in a substantial amount of welfare loss; and no literature, so far, has seemed to concern with the recovery of such welfare loss.

These gaps in the existing literature clearly indicate that there is a need to address these issues. Thus, in general, the three important issues of transport development deserve careful and in-depth consideration: (a) the optimal urban transport development in a general settings by considering land-use model, (b) the optimal design of a circumferential highway within a city model, and (c) the welfare recovery when the highway investment is made according to "investment cost" policy and not according to "capital cost" policy (naïve policy with short-run marginal cost pricing) with a view to achieve long-run self-financing.

Throughout this dissertation we attempt to establish the optimality conditions of highway investment under “general” settings which can be applied to any kind of transport development, any number of transport route and mode, any number of city center, and any type of city shape. The study then determines the optimal design characteristics of a circumferential highway by using an urban land-use model. The

final focus of the study is on the issue of self-financing of highway investment. We try to develop policy tools that can help restoring the welfare losses resulted from a wrongly conceived investment policy while targeting self-financing.

We applied various model setups to analyze these issues. First, to address the issue of the optimal transport infrastructure from a general perspective, we set up an urban land-use model in which households with identical preferences and endowments maximize their utility by choosing residential location, lot size, and travel mode. The transport system and the city characteristics are exogenous to them. The benevolent transport authority optimizes the uniform level of utility by controlling infrastructure characteristics. Second, to design the optimal circumferential highway, we used the same urban land-use model with three kinds of transport mode options: the city streets, the radial highways, and the circumferential highway. City streets are dense and slow. Radial highways are faster but need access travel. The third mode is the circumferential highway that reduces travel cost by providing quicker access to the radial highways; however, city dwellers have to pay equally for its construction. These three modes offer three different travel routes which divide the city into three market areas. By considering absentee land ownership, we numerically solve for the optimal design of the circumferential highway. Third, we consider a two-stage dynamic game model for addressing the issue of benefit restoration under naïve policy in highway investment. In the first stage, government fixes the toll for highway usages, and in the second stage, the transport authority collects the toll and invests the net of it into capacity expansion for the subsequent period. We consider the net present value of welfare and continuous time in this analysis.

From the analysis of the general optimal transport infrastructure in a closed city with residential land ownership, the key findings are that

- the infrastructure should be developed to an extent at which the marginal cost

of development is equal to the marginal increase in aggregate differential land rent evaluated at the current level of land rent.

The study on optimal design of a circumferential highway in a monocentric city reveals that

- the optimal circumferential highway is partially used,
- the resulting city shape is such that there is a bulge of urbanized area around the circumferential highway,
- the cities with a larger number of radial highways require construction of the circumferential highway further outward from the CBD than the cities with a smaller number of radial highways.

From the analysis of welfare recovery with the second-best dynamic highway pricing under naïve investment policy, the major findings are that

- only when the interest rate is zero, naïve policy under short-run marginal cost pricing does not really cause any harm,
- a vertically disintegrated superior authority can partially recover the welfare loss by taking necessary adjustments in highway pricing,
- interest rate has a great effect on welfare recovery.

The research findings suggest that

- the post-project land price is not essential for determining the optimal level of transport investment,
- the cities of the developed countries need bigger circumferential highways than that of developing countries, and
- the developing countries with higher interest rates are more vulnerable to the welfare consequences resulted from the naïve policy and therefore needs to pay more attention while planning for self-financing in highway sector.