

Analysis of Rail Transit Project Selection Bias with an Incentive Approach

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ABSTRACT

Rail transit investments have been widely supported by the local planning agencies and government financing resources for their perceived environmental and social benefits, as well as the compact development patterns rail corridors support. Despite the widespread expectations, the sustainability of rail transit projects is often found questionable, so are the actual benefits rail investments can bring about in practice. One of the causes behind rail investments' less-than-expected performance have been identified as a prevailing bias of local officials toward high-capital rail transit investments that is underwritten by the transit financing mechanism (Pickrell, 1992; Kain, 1990; Johnston, 1988; Richmond, 1999; and Flyvbjerg et al, 2003, 2004 and 2005). This paper examines the funding mechanism problem underlying the rail transit project selection bias and hypothesizes this problem to be a principal-agent problem. Incentive theory is introduced as an analytical tool to model the problem, to better understand the nature and causes of the problem, and to suggest solutions to it. By applying incentive theory to analyze the project development process of the US New Starts program, it is suggested that the funding mechanism problem associated with the bias toward capital-intensive rail investments can be viewed as a principal-agent problem between the Federal Transit Administration (FTA) (the principal) and local project sponsors (the agent). The incentive approach proposed in this paper provides insights for analyzing the relation between central government and local agencies in the planning and decision making process of rail transit investment, and for addressing political problems, primarily rent-seeking behaviors, associated with central government earmark funding.

Key words:

Incentive theory, Principle-agent problem, Light rail transit, and Project selection bias

I. INTRODUCTION

Through recent developments in planning theories, normative rationality has been the one theme that runs through all planning discussions and debates (Friedmann, 1987 and 1997; Lapintie, 2002). Contemporary communicative planning theories, based on the Habermasian concept of communicative rationality, though depict an ideal planning goal – “free from domination, more democratic, a strong civil society and etc.”, has failed to capture what happens in the real world and stayed weak in guiding effective action and change toward the ideal (Flyvbjerg and Richardson, 2002). An alternative approach of planning, introduced by Flyvbjerg (1998) based on the power analysis of Foucault, proposes to integrate the analysis of power into planning theory. This approach, so-called “realrationalitat, or “real-life” rationality (Flyvbjerg, 1996), engages with the “dark side of planning theory” - policy made with power struggles between different interests, where the rationality of planning is exposed as a focus of conflict (Flyvbjerg and Richardson, 2002). The conflicts between interests of different power are in play over the planning processes of rail transit investments, with the outcomes of such conflicts being the distortion of communications, and biased investment choices justified under the name of planning practices. In the spirit of the realrationalitat planning, this paper integrates the analysis of self-interest and conflicts into the understanding of rail transit planning practices. It describes how the practices of rail investments have deviated from the rationale of planning them and explores the analysis tool to understand the conflict of power and interests that penetrated in the planning process. By exploring this dark side of planning, the hope is to bring rail transit planning practices closer to a planning paradigm that is “practical, committed and ready for conflicts” and reality (Flyvbjerg, 1996), and makes possible effective actions.

Over recent decades, the costs of urban sprawl and the infrastructure savings of compact land use have encouraged the regional planning organizations of many US metropolitan areas to pin their hopes for improving future regional growth patterns on transit-focused development – a multi-modal approach that enhances public transportation services and promotes supportive land use development to create multiple transportation options (Porter, 1998, and FHWA, 2006). This planning approach has been supported by the federal governments as an answer to traffic congestion, air quality problems, and the equal mobility needs by both auto and carless travelers. Through Federal Transit Administration (FTA), billions of dollars of financial resources have been provided to support locally-planned, implemented, and operated transit “guideway” capital investments, making possible hundreds of new or extended rail transit systems in the nation (FTA, 2006).

It is in the context of the renewed interests in planning transit-related development in growing cities and suburbs, rail transit projects have been gaining increasing popularity with waves of rail transit construction across North America in the past few decades. Despite widespread expectations for the development and other benefits of rail transit systems, not only such development in practice remains problematic (Porter, 1998), the sustainability of the built rail systems is often found questionable. Accompany the waves of rail transit construction, a large and growing body of research and planning professionals has recognized and cautioned that rail transit investments can and do fall short of their objectives (Deakin, et al., 2002; and Flyvbjerg, et al., 2003). Tracing causes behinds rail investments’ less-than-expected performance, Pickrell (1992), Kain (1990), Johnston (1988) and Richmond (1999) have identified a prevailing bias of local officials toward high-capital rail transit investments that is underwritten by the federal and local transit financing mechanism in the US; while Flyvbjerg et

al (2002, 2003, and 2004) demonstrated the global nature of this phenomenon based on a cost escalation study covering 258 transport projects in 20 nations, where massive evidences were identified showing that initial budgets for transport infrastructure projects are characterized by pronounced optimism bias.

While optimism bias of rail transit investments happens for analytical, political, psychological, financial, and many other reasons, the public funding mechanism is what eventually endorse the problematic project selections and is hence identified as one of the most critical issues that influence the level of optimism bias (Pickrell, 1990; Flyvbjerg et al, 2004). In particular, the funding mechanism for rail projects, which normally involves large contributions from the national governments, tends to stimulate much stronger interests for delivering a project than the intentions to avoid the optimistic cost estimates or ridership forecast. Hence, the justifications of such projects are often found to be highly and systematically misleading (Flyvbjerg et al, 2002). Transport planners are often blamed for producing biased forecast and cost estimates (Wachs, 1989; and Flyvbjerg, Holm et al., 2003). However, if the current public funding mechanism is not rational, planners, working within the existing mechanism, could make rational planning decisions only to find that the system ends up producing irrational results (Edwards and Mackett, 1996).

This paper focuses on the funding mechanism problem underlying the investment choice bias and hypothesizes the problem to be a principal-agent problem. A principal-agent problem occurs when a principal (the national agencies) assigns a task (to realize a well functioning transport system) to the agent (the local agency), who has different objectives than the principal, and are able to pursue its private interests (to obtain national funding and deliver the project) at the expense of the principal's interests (the viability of a project). The principal-agent problem is

systematically modeled and addressed under the incentive theory. Hence, this paper introduces the incentive theory as an analytical tool to model the relation between the national agencies and the local actors in the planning and decision making processes of rail transit projects, and to analyze the funding mechanism problems underlying the optimism bias. The paper aims to gain a better understanding of the nature and causes of the optimism bias, and to suggest potential solutions to the problem.

Specifically, the problem under examination and the objectives of this paper are defined and outlined in section II, which is followed by a review of the incentive theory framework in section III. Section IV applies incentive theory to the New Starts project development process in the US to illustrate and analyze the problem underlying the project selection bias. This theoretical approach to the problem of transit investment decision-making practices has its limitations, which are discussed in section V. The paper concludes that in order to improve rail transit planning process and produce rational investment decisions, the potential principal-agent problem with the public funding mechanism should be visited before any planning, technical or analytical efforts to correct the optimism bias itself. This is because if the underlying funding mechanism is not rational, planner's efforts to make rational decisions could still lead to biased results. While the tool of incentive theory alone is not sufficient for leading to a conclusion to the debates over rail investments, it conveys fundamental insights into the properties, causes and solutions of the optimism bias issue. Hence, a major task of this paper is to introduce incentive theory as an instructive tool for planners, policy makers, national and local authorities and officials to think about the rail transit funding issues, especially to bring into recognition the role of private incentives in motivating public choice behaviors.

II. PROBLEM STATEMENT AND OBJECTIVES

Public investment in rail transit has long been controversial. A concern widely held among the planning and academic community is that to varying degrees, rail transit projects are often the result of a biased decision-making process that favors capital-intensive investment over alternative options for inadequate justifications. Along this line, research has been conducted to explore three dimensions of this issue: the existence, consequences and causes of the problem.

The attempts of planners to ensure the choice of capital intensive rail transit investment has been revealed since the 1970s, mostly through research examining the project development process of rail transit systems (Hamer, 1976; Altshuler, 1979; Johnston et. al, 1988; Wachs, 1989; Kain, 1990). Systematic investigations of this issue have been conducted more recently.

Looking into the forecasts of ridership, capital and operating costs for ten US rail transit systems opened during 1976-1987, Pickrell (1990, 1992) identified errors of the forecasting models that consistently steer the planning process toward the most costly rail transit option under consideration. Similar findings were reached from a 1999 study by Richmond who evaluated all new US light rail projects in operation as of April 1997 and revealed an obsession with high cost technology despite “low-cost approaches to improving transit services that are more effective than either rail or capital-based projects.” The bias in favor of the rail transit investment is not a phenomenon peculiar to the US (Flyvbjerg et al, 2002, 2003, 2004, and 2005; Edwards and Mackett, 1996). Flyvbjerg, Holm et al (2003) studied the cost performance of 258 transport infrastructure projects in 20 nations, and demonstrated that the large financial risks of such projects were “typically ignored or under played in decision making, to the detriment of social and economic welfare”.

Bias toward capital-intensive rail investments are often found to be associated with the following three problems: (1) failures of rail projects to materialize the targeted performance in terms of ridership, speed, operating costs, and development benefits, on which grounds they had been justified (Pickrell, 1990, 1992; Rubin et al., 1999; Gomez-Ibanez, 1985; Dunphy, 1995; Walmsley and Perrett, 1992; Mackett and Edwards, 1997; Flyvbjerg et al, 2002, 2003, 2004, and 2005), (2) anticipated project objectives are moderately met but at very high costs (Gomez-Ibanez, 1985; Fielding, 1992), and (3) under-investment on low-cost and more cost-effective transit alternatives, such as the conventional bus or Bus Rapid Transit (BRT), because resources are often allocated to light rail investments (Gomez-Ibanez, 1985; Kain, 1988; Wachs, 1993; Richmond, 1999; and GAO 2003).

Probing the causes behind the prevailing bias toward high-capital intensive projects, previous research has provided explanations from analytical, political, psychological, and financial perspectives. In particular, the analytical methods used in the decision-making process introduce error, and leave room for those who conduct the analysis to manipulate the analysis and influence the conclusion, because the results of the analyses are very sensitive to the assumptions made (Mackett and Edwards, 1997; Johnston et al., 1988; Kain, 1990; and Pickrell, 1992). From a political perspective, local political leaders tend to place themselves in support of rail projects, which are viewed as positive along most dimensions by diverse constituencies: business and environmental interests, transit-dependent travelers, and general civic pride of residents (Johnston et al, 1988, and Flyvbjerg, 2004). Richmond (1996) explored the psychological factors driving the obsessed popularity of rail projects. In particular, the study examined the psychological mechanisms by which decision-makers inform themselves to make decisions. The study argues that the idea of light rail generates a symbolic promise of community

renewal and produces a series of images, symbols, and metaphors that compose the myths of rail with little emphasis on the benefits rail might actually bring. Local officials' enthusiasm for costly rail transit investment of questionable merit has also been explained from a financial perspective. As concluded by Pickrell (1990, 1992), funding mechanisms seem to cause the problem of biased selection because the central government funding was a function of the total predicted outlays, meaning that high ridership forecasts justify an expensive system which would then bring in more federal funding (Pickrell, 1990, 1992; Mackett and Edwards, 1997). As illustrated in Table 1, although the forecasted capital costs vary greatly by project types (ranging from \$36 million for exclusive busway to \$532 million for heavy rail), the local funding burdens remain at similar level at \$35 to \$75 million, indicating that expensive systems receive more allocation of federal subsidies without significantly increasing local financial burden.

While, to various extents, different factors all contribute to the biased investment choice, the public funding mechanisms, as emphasized by Pickrell (1990), are what eventually underwrite the irresponsible project selections. Thus, Pickrell suggested reforming the problematic federal and local funding mechanisms as an effective way to create incentives for reliable decision-making. However, what remains untouched from Pickrell's work is the underlying ground, on which the funding mechanisms work to embrace prejudiced investment choice, or how incentives could be determined to motivate responsible project selection.

An appropriate model for analyzing the funding mechanisms underlying the project selection bias is provided within the realm of incentive theory, which addresses the so-called principal agent problem. This paper hypothesizes that the funding mechanism problem associated with the bias toward capital-intensive rail investments is fundamentally a principal-agent problem, the nature, causes, and solutions of which could be probed within the framework

of the incentive theory. Hence, the objectives of this paper are to (1) test the hypothesis through the application of the incentive theory to rail project development process, (2) achieve a better understanding about the nature and theoretical foundation of the funding mechanism problem, and (3) with the tool of incentive theory, probe policy directions for devising proper incentives to reduce the project selection bias.

III. THE INCENTIVE THEORETICAL FRAMEWORK

Incentive theory provides a solution to the so-called principal-agent problems (Fabbri, 1996).

The principal-agent problems occur when a principal assigns a task to an agent who has different objectives than the principal; while in the meantime, the agent has private information that is unknown to the principal (Laffont and Martimort, 2002). This incomplete and asymmetric information has fundamental effects because an informational advantage can be exploited strategically; and strategic behavior, exploited improperly, often leads to social costs (Naslund, 1996). Therefore, the principal-agent problem needs to be addressed in order to improve social efficiency. Incentive theory considers when the private information of agents is a problem for the principal, and what is the optimal way for the principal to cope with it.

The Principal-Agent Model

The starting point of the principal-agent model is the situation where the principal assigns a task to a single agent with private information. The principal-agent problem forms because of two basic properties of this situation: the conflicting objectives and informational asymmetry between the principal and the agent.

Conflicting objectives: conflicting objectives are the basic assumption of the incentive theory. In a delegation or assignment situation, the *theory of teams* recognizes the decentralized nature of information, but postulated identical objectives among members of firms or agencies,

and considered the members as a “team” (Laffont and Martimort, 2002). Accordingly, this research focuses on how to coordinate actions among the members of a team by proper management of information (Marschak and Radner, 1972). However, the assignment or delegation becomes more problematic when acknowledging individual motivations and the fact that members of a team may have different objectives (Marschak, 1955; Arrow, 1963).

Economic agents pursue, at least to some extent, their private interests. What is proposed by incentive theory is that this major assumption be maintained in the analysis of any kind of collective decision-making (Laffont and Martimort, 2002).

Informational Asymmetry: informational asymmetry occurs in many contexts. “A bank that lends money to a customer usually knows less than the borrower about his future income. An insurance company often has less knowledge than the policy holder when determining whether damage is due to a lack of proper care for insured property or whether it is caused by an external event” (Näslund, 1996). In a situation of delegation, information is unevenly distributed among decision-makers. Because of the decentralized nature of information, the principal’s information is incomplete, while individual agents have private information (Marschak and Radner, 1972).

The effects of informational asymmetry under a delegation situation are two fold: from the positive side, agents’ private information contributes to their expertise, based on which, the principal’s task can be fulfilled more efficiently. However, asymmetric information also creates negative effects because it determines the distribution of informational rents – the uncompensated profits or values an entity is able to extract from others by manipulating the information under its control, which themselves create the stakes of strategic behavior. It is

through informational rent, agents with private interests are able to strategically pursue their own objectives and thus pose problems to principal and possibly to the society.

There are two types of private information by the agents: hidden information, which leads to the so-called adverse selection, and hidden action that leads to moral hazard. *Hidden information*, or adverse selection, refers to the fact that agents have some private knowledge about his cost or valuation that is unknown by the principal (Laffont and Martimort, 2002). It is an information state that normally takes place before the delegation contract is completed. Hidden information can lead to precontractual opportunism, and results in adverse selection (Folta and Janney, 2002). Examples of it include the case of a bank loan or insurance covering pregnancy and delivery.

Hidden action, or moral hazard, refers to the fact that agents can take an action unobserved by the principal. This is an information state during the contract execution phase. It can cause “postcontractual opportunism”, which often happens in two-party relations that involve an outcome that is observable to both parties, while the outcome depends on one party’s (the agent’s) actions, which cannot or are costly to be observed by the other party (the principal). An example is that general insurance coverage can exaggerate risktaking and affect the way individuals care for themselves and their property (Mirrlees, 1996).

The Impacts of the Principal-Agent Problem

Principal-agent problem often leads to social inefficiency in light of the limited resource for allocation. This impact can be viewed from three perspectives: (1) there are social opportunity costs associated with a particular delegation or assignment contract under incomplete information. In general, informational problems prevent society from achieving the first-best allocation of resources that could be possible in a world where all information would be common

knowledge (Laffont, 2000); (2) additional costs will be incurred because that the strategic behavior of privately informed agents can be viewed as one category of the transaction costs as emphasized by Williamson (1975); and (3) moral hazard in contract implementation, because the agents' actions are hard or costly to observe or monitor by the principal.

Example of the Principal-Agent Problem

An example to illustrate the principal-agent problem is the case of medical insurance, when an insurance company can be viewed as principal and policyholders as agents. They have different objectives since they behave according to their self-interest. There is informational asymmetry since policy holders know better about their health conditions than the insurance company.

The principal and agents' decision-making process can be illustrated in the following example. To the policyholders, if the benefits of taking a medical treatment are \$40, and policyholders' out-of-pocket costs are \$10, then the policyholder will choose to take medical care. However, to the insurance company, total costs of providing the medical treatment can actually be \$100, and it's costly for the insurer to fully monitor a policyholder's eligibility of receiving one hundred dollars worth of treatment. As a consequence, policyholders would exaggerate the use of medical insurance, leading to rises in insurance rate, which create "negative externalities" to those who truly need medical treatment.

Essentially, the problem is that the agents will use the principal's \$100 to achieve their own interest of \$40, as long as agents' out-of-pocket cost is less than \$40. Similar situations can be found in the case of rail transit project selection process, where some cities might achieve funding support for rail systems that are more than they really need.

The Solutions to the Principal-Agent Problem

To solve the principal-agent problem, the essential question to ask is how to provide good incentives for economic agents to reach one or both of the two objectives: firstly, align the objectives between the principal and the agents, such that the agents have the private interests to act in accordance to the principal's preferences; and secondly, induce truthful private information revelation of the agents to overcome the principal's information constraints, such that the agents have private interests to reveal their true willingness to pay in light of the total social costs, and at the same time, "the price paid reflects the social opportunity cost, which contributes to social efficiency (Näslund, 1996)".

IV. APPLICATION OF INCENTIVE THEORY

This paper hypothesizes that the funding mechanism problem associated with the bias toward capital-intensive rail investments is fundamentally a principal-agent problem, the nature, causes, and solutions of which could be probed within the framework of incentive theory.

This study applies the principal-agent model to the federal funding mechanism for rail transit projects in the US. The application serves multiple purposes in this paper: to utilize the tool of principal-agent model to explore analytically and better understand this problem; through the mechanism of incentive theory, to explore principles for addressing the problem; and to test the hypothesis that the funding mechanism problem underlying the project selection bias is a principal-agent problem.

In this study, the hypothesis is tested through applying the principal-agent model to the rail transit funding mechanism. It is assumed that the hypothesis is justified to the extent that all the elements of the model, namely conflicting objectives and informational asymmetry, are applicable to the rail transit decision-making process. Additionally, due to the involvement of

non-quantitative social, economic, political, and psychological factors in the decision making process, a desirable data collection method would be survey or interview, which is outside the scope of this paper. Hence, this paper relies on the previous empirical studies and theoretical literature as the major source of information for the analysis.

The New Starts Planning and Project Development Process

The New Starts program, a Federal Transit Administration's (FTA) discretionary program, is the US Federal government's primary financial resource for supporting locally-planned, implemented, and operated transit "guideway" capital investments (FTA, 2006). This paper focuses on the New Starts Program to exam the funding mechanism problem underlying the bias toward capital-intensive rail projects. This is because the New Starts program is the primary federal program that supports the construction of new fixed-guideway transit systems, and its grants have generally been used to fund rail projects (GAO, 03-729).

FTA funds New Starts projects through full funding grant agreement (FFGA), which is a multiyear contractual agreement between FTA and project sponsors for a specified amount funding, and establishes the terms and conditions for federal participation. By statute, the federal funding share of a New Starts project can amount up to 80 percent of its net cost (see Table 2). State or local sources provide the remaining funding (GAO, 03-1040, 03-729, 03-701).

As illustrated in Figure 1, the overall New Starts planning and project development process comprises multiple phases. To obtain funds, a project must progress through a local or regional review of alternatives, develop preliminary engineering plans, meet a number of federal requirements, including providing data for the New Starts evaluation and ratings process, and receive FTA's approval of the final design (GAO, 03-104, 03-701).

Local transit agencies apply and compete for project funds based on a variety of financial and project justification criteria. Based on the information submitted by project sponsors, FTA annually reviews the grant applications, evaluates projects' technical merits and the stability of the locality's financial commitment and then notifies the congress that it intends to commit New Starts funding to certain projects through full funding grant agreements (GAO, 03-1040, 03-729, 03-701). Figure 2 and 3 illustrate the FTA New Starts evaluation and rating process (GAO, 99-113, pp. 7) and the specific evaluation criteria and performance measures (GAO, 99-113, pp. 16).

Echoing the investment decision-making problems identified in the works of Pickrell (1990, 1992), Kain (1988 and 1990), and Richmond (1996), the federal oversight of the New Starts projects evaluation and implementation has been found an area of concern, because major transit projects continuously experienced cost, schedule, and performance problems, neither could the project evaluation process promote reliable costs estimates (GAO, 03-1040). As shown in Table 3, a GAO August 1999 report on the 14 ongoing projects identified a number of instances in which projects had exceeded their initial cost estimates or had delayed their target opening dates (GAO, 99-240). The problem culminated in the 1990s, when the New Starts program was placed on GAO's high-risk list because it was considered "vulnerable to fraud, waste abuse, and mismanagement" (GAO, 00-104).

To better understand and to suggest possible solutions to the problem, this paper applies the principal-agent model to the New Start project development process. In particular, the project development process is identified as a collective decision-making process between the Federal Transit Administration (FTA) and local project transit agents. Their relationship is defined under the contract of full funding grant agreement (FFGA), where the local transit agents

are delegated the tasks of project development, while FTA is the principal with the twin responsibilities of evaluating and recommending projects, and overseeing their implementation.

Application of the Theory

Through the development of Full Funding Grant Agreement (FFGA), a delegation relationship is set up between the FTA and the local transit agent, with the FTA assigning the project development actions to the local project sponsor. The principal-agent model can be applied to this delegation situation. If the properties of conflicting objectives and informational asymmetry are satisfied in this delegation situation, then the funding problem associated with project selection bias can be viewed as a type of principal-agent problem, hence, the solutions to this problem can be explored within the framework of incentive theory.

Conflicting objectives

Conflicting objectives between federal and local transit agent have been demonstrated in many empirical and theoretical researches.

From the principal's side, FTA's purpose for funding New Starts projects is, in a normative sense, to reach certain social welfare objectives through subsidizing local rail transit investments. However, in the New Starts project development process, FTA's goal is to ensure that federal funds be used to the most suitable projects so that social welfare objectives would be pursued in a prudent and effective manner. To reach this end, project evaluation criteria have been established since the 1970s, and have changed over the years to reflect shifting congressional concerns and interests as well as new knowledge from research and new ideas from professional practice (Deakin, et al., 2002). Today, as can be seen from Figures 2 and 3, New Starts criteria reflect a broad evaluation of transit investment, taking into consideration cost-effectiveness, mobility benefits, economic development impacts, and effects on urban form

and the environment (Deakin, et al., 2002). In brief, FTA's objective in the project selection process is to identify and fund the worthy projects based on the current project selection criteria, which reflect federal decision makers' views about the best-qualified grant proposals.

For the local transit agents, their objectives for applying for a New Starts project emerge from far broader social, economic, and political concerns regarding their specific localities.

Along this line, research has been focused on structured surveys, and case studies to capture the factors that motivate local investment decision-making (Deakin, et al., 2002; Johnston et al., 1988; Mackett and Edwards, 1997; Richmond, 1996; Hamer, 1976).

For example, Deakin, et al. (2002) conducted a structured survey of transit agency staff and a series of interviews with agency executives and other local leaders in areas that have undertaken a major transit investment project over the period from 1998 to 2002. The study covered 41 projects and 23 regions in the US and found that most agencies use the New Starts evaluation criteria as a starting point, but give at least equal weight in project design and selection to state and local policy objectives such as social equity, economic development, and "fair share" distribution of projects among local communities. "Increasingly, priorities are given to projects that are..... proposed to meet the locality's transit needs and related development objectives..... moreover, the availability of federal capital assistance has certainly been a factor in transit agents' investment choices (Deakin et al., 2002)".

Similar findings are indicated in the work by Johnston et al. (1988), who conducted a case study of the Light Rail Transit (LRT) development process in Sacramento, California. The case study shows that local decision makers have broader economic and social concerns that are beyond the grasp of standard evaluation criteria, and local politicians weighted local values and strategic funding factors more heavily in their decision (Johnston et al., 1988).

Additionally, a GAO 2003 report, based on interviews with the federal officials, industry experts and local transit agents in Dallas, Denver, Los Angeles, Pittsburgh, San Diego, and San Jose, reveals that, when selecting a mass transit system, communities consider other advantages and disadvantages, besides its capital and operating costs, and performance. For example, the public may view bus as less likely than light rail to improve a community's image and spur economic development (GAO, 03-729).

Given the fact that the New Starts project development process is a collective decision making process between federal and local transit agents, theoretical foundation for the discrepancy in objectives in project selection could be found in the theory of collective choice, which consider the individual participants in collective choice as the decision-making units, or "the only real decision-maker", and, as a result, the characteristics and rationality of decision making behaviors are based on individual's own expected goal (Buchanan and Tullock, 1962).

In planning and policy making practices, rare attentions have been given to the private objectives of the local agents in the New Start program. This is because it is believed by many that, under the current New Starts project development mechanism, local agents would be willing (or are supposed) to share the federal agency's objectives, but fail to do so because of a lack of good guidance on the federal objectives. Based on this belief, the major efforts have been devoted to improving the evaluation criteria as guidance for the local transit agents to follow, while the objectives and rationales of the individual local agents could easily be ignored by the federal principal when designing capital grant contract.

In brief, it is reasonable to expect local agents' unwillingness to follow the project evaluation criteria of the federal principal. With the assumption of conflicting objectives held, the remaining question is how the agents are able to pursue their own interests, even at the

expense of principal's interest. The answer provided by incentive theory is that there is informational asymmetry in favor of the agent, and the agent will strategically exploit the informational advantages to reach its own objectives.

Hidden Information (Adverse Selection)

Local transit agents have private information that is unknown to the federal principal (FTA). Particularly, they are better informed than the principal about technology and local demand conditions. This is plausible because there will always be some local specific features affecting technology and demand that can not be properly detected by the national authority (Fabbri, 1996).

Another type of informational asymmetry lies in the difference in the degree of awareness about the reliability of project evaluation outcomes. As can be seen from Figure 1, New Starts project development begins with the local system planning and analysis of alternatives, the outcome of which is the information FTA relies upon to evaluate the grant proposals and make project selection decisions. However, this information is found to be of questionable reliability by Pickrell (1990), Kain (1990), and Johnston et al. (1988) as put by Pickrell (1990), "the planning process for many of the largest local infrastructure projects this nation has ever seen is systematically unable to produce reliable information upon which to base public investment choice." Apparently, the local transit agents, who produce the analysis outcomes, have better sense than the federal principal regarding the extent to which the information could be relied upon.

The existence of informational asymmetry is also determined by the hierarchical governmental structure, which is remarkably effective in decentralizing the activities of information processing (Rader, 1992, p. 1393; Melberg, 2003). In the public bureaucracy that involves federal and local transit agents, information passes through local transit agencies to

reach the FTA, which can be viewed as the centralized authority. The longer the chain of the relationship between FTA and local transit agencies is, the higher the degree of informational asymmetry between the principal and the agent (Melberg, 2003).

Asymmetry of information between FTA (the principal) and the local transit agents can lead to the problem of adverse selection to the principal (Marrelli and Pignataro, 2001). That is to say, the selected project might be found of worse quality than that chosen under complete information. A consequence of this adverse selection is a social opportunity cost or a negative externality to the transit agents of the “best” qualified projects. It is for this reason that FTA’s objective to ensure that billions of federal dollars be spent efficiently and effectively can be betrayed.

Hidden Action (Moral Hazard)

With private information and interests, the agents can and will strategically explore information advantage to pursue their private objectives and reduce their own costs, even at the expenses of the principal’s interests, without being directly observed by the principal (Fabbri, 1996). This strategic behavior of the agent is called hidden action or moral hazard.

Examples of hidden actions in the project selection process can be found in the works of Pickrell (1990), Kain (1990), Johnston et al. (1988), and others, which document local transit agencies’ manipulation of forecasting models with the attempts to compete for federal financing of projects they have already committed themselves to support (Pickrell, 1990).

Fundamentally, this type of hidden action in the project selection phase can be viewed as a type of rent seeking¹ behavior exerted by the agents with information advantages, or informational rent. Political rent seeking generates the largest benefits with the least effort.

¹ Rent seeking occurs when an entity seeks to extract uncompensated value or benefits from others by manipulating the economic and political environments under the entity’s control – often including regulations and government decisions (Wikipedia, 2006)

Those local transit agents who fail to participate in the competition process will have their wealth drained away with no corresponding return. The fear that others will pursue and obtain federal earmark funding is easily sufficient motivation not to give up rent seeking (Ross, 2003).

In the project implementation phase, two types of hidden actions can be found to create moral hazard: (1) under-exertion of contract execution efforts: that is, given asymmetric information, say about the effort of the agent, there is no way that the agent can credibly commit to the “best” contract (Melberg, 2003), while the costs for monitoring the agents’ efforts are prohibitively high; and (2) exaggerated risktaking: just like generous insurance coverage can exaggerate risktaking and affect the way individuals care for themselves and their property, lump sum federal grants create the incentive for imprudent use of the grants as implied by the widespread costs overrun of New Starts Projects (See Table 4).

Similar to the effect of hidden information, the results of the moral hazard in the political decision-making process is often the distortion of the efficient allocation of limited public resources.

Summary of Findings

By applying incentive theory to the New Starts capital grant program, it is suggested that the funding mechanism problem associated with the bias toward capital-intensive rail investments can be viewed as a principal-agent problem between FTA (the principal) and local project sponsors (the agent). This is because based on the information obtained from the empirical and theoretical literature, the essential conditions of the principal-agent model, namely conflicting objectives and informational asymmetry between the principal and agent, are satisfied in the New Starts projects development process.

Incentive theory casts new insights to the problem of project selection bias. Essentially, the problem emerges from a delegation situation where FTA (the principal) assigns the task of project development to a local transit agency (the agent) through the contract of Full Funding Grant Agreement (FFGA). In such a situation, the observed local project selection bias arises for two reasons: (1) the objectives of local transit agents are different from those of FTA in developing a rail transit project. Thus, in the process of project development, local transit agencies would pursue their private interests, putting the interests of FTA in potential jeopardy; and (2) there is informational asymmetry in favor of the local transit agencies over the principal (FTA). Local transit agencies will behave strategically to take advantages of their private information to pursue their interests and reduce their own costs, say minimizing private efforts exerted. As long as the local agencies possess this informational rent, their strategic rent seeking behaviors are not avoidable under the current political system.

Within the scheme of incentive theory, the problem of local project selection bias could be defined, by nature, as an incentive problem for the principal (FTA). From the principal's perspective, the problem is to provide incentives to align the objectives between the principal and the agent. That is to design an optimal incentive for the agent and induce the latter to make the best decision from the principal's viewpoint (Fabbri, 1996). The instrument for reaching this end is to solve the information asymmetry problem through incentive design that stimulates individual agents' truthful information revelation. While designing a specific incentive contract scheme is beyond the scope of this paper, several principles can be summarized as suggested by incentive theory:

First, the differences in objectives between the principal and the agents should be given sufficient consideration in designing the contract of full funding grant agreement. Otherwise,

efforts to correct the selection problem, which currently focus on improving the federal evaluation criteria, would be fighting the wrong enemy. This explains why the long-existing academic criticisms toward rail projects have not been well addressed by those who make decisions (Richmond, 1996). It is the ignorance of agencies' divergent objectives that leads the wrong questions to be asked regarding the project selection bias.

Second, to address the problem of informational asymmetry, contracts need to be properly defined to induce truthful information revelation from the agent. This is the so-called *revelation principle*, according to which, a particular scheme to induce truthful revelation is to provide, in each contract, a menu of basic grant payments with corresponding reward (or penalty) rate. The reward (penalty) would be determined based on performance. By selecting one payment option, the agent is induced to reveal its performance target based on its private information.

Third, the level of incentives should also be determined with careful consideration. For example, some research proposes limiting federal support for each project, and making local project sponsors responsible for any cost overrun; in this way, local transit agencies are motivated to make more responsible investment decisions (Pickrell, 1992).

Fourth, to determine the proper incentive level, incentive theory suggests two principles: (1) the federal principal needs to provide a minimum level of incentives (or grant payments), so that the agents are willing to participate in the contract game mechanism. The level of the minimum incentive needs to be addressed in association with the individual agents' objective functions; and (2) the level of incentive should be determined in relation to the quality of performance, which is the fundamental concern of transit subsidization. It is difficult to carry out this scheme, because transit performance is highly related to local conditions and is hard to

quantify, the performance quality is difficult to be detected by the federal principal. However, because transit service is a search good, the quality, e.g., frequency, coverage, and trip time, of which could be observed by the users before use (Fabbri 1996), consumption could be a signal of quality. Therefore, transit incentive payments could be made based on sales or ridership.

V. DISCUSSION OF LIMITATIONS

While incentive theory provides a theoretical framework for understanding the foundation of the rail project selection bias, it is far from capturing all the real-world complexity of this issue. The tool of incentive theory alone could not enable people to conclude the debate regarding the validity of a rail solution to various urban problems. Similar to any other theoretical approach to a practical issue, the application of incentive theory involves assumptions and simplifications of the problem, which creates the following limitations:

Simplified Relationship

The analysis is based on a simplification of the relationships among players involved in the project development process. What incentive theory captures is the contractual relationship between FTA (the principal) and one particular New Starts project sponsor (the agent).

Remaining unexamined in this paper are the role of the state (or province) in the decision-making process, the influence of local interest groups on congressional decision making, and the political complexities of interactions and tensions among local, state, and federal decision makers (Laffont, 1999, p665).

Principal's Perspective as A Given

Throughout the analysis in this paper, an implicit assumption has been made to take the principal's perspective as a given. Underlying this is a further assumption on the benevolence of the federal government agency in the process of project development. Following this assumption,

this paper remains silent on the validity of federal objectives in the development of a rail project. However, this assumption deserves deeper examination, as indicated in the work of Shapiro and Willig (1990), governments have private agendas, it is by giving up the myth of the benevolent state that one can hope to develop a meaningful theory of public choice (Laffont, 2002).

Design of Contract vs. Design of Institution

Even if the benevolent objectives of federal agencies can be safely assumed in the New Starts program, a further question can still be raised regarding whether or not federal intervention to local infrastructure planning and investment is the best way to pursue the benevolent objectives, say social welfare maximization. Hence, additional thoughts about the solutions to the project selection bias are related the scope or extent of federal intervention to the local infrastructure planning. Should the solution be improving the design of the federal-agent contract, or should it be a redesign of the federalism institution?

This question leads to another relevant issue: public intervention. Particularly, debates about the scope of public intervention and more generally about the reform of the state, the structure of the state, and of its hierarchy (Laffont, 1999, p. 331). In classical economics, federal capital assistance to local rail transit projects is viewed as subsidy, which could eventually distort economic activities. Thus the causes of the project selection bias might be traced to the very fact of federal intervention. Original insights on this issue were cast in the work of Smith (1776)², who recommended decentralization for the administration of local public goods and public works, and suggested that public works of local nature should be financed by local revenue³. He

² “A great bridge cannot be thrown over a river at a place where nobody passes, or merely to embellish the view from the windows of a neighboring palace: things which sometimes happen, in counties where works of this kind are carried on by any other revenue than that which they themselves are capable of affording.” (Smith, 1776, p.683)

³ “The abuses which sometimes creep into the local and provincial administration of local or provincial revenue, how enormous so ever they may appear, are in reality, however always very trifling, in comparison with those which commonly take place in the administration and expenditure of the revenue of a great empire.” (Smith, 1776, p. 689)

proposed to finance highways, bridges and canals by tolls proportional to the wear and tear. His main argument to this financing method rather than using the general revenue of the society is a concern on the incentives of the administration to make the proper investments (Laffont, 1999).

VI. CONCLUSION

Incentive theory provides a theoretical foundation and analysis framework to examine the funding mechanism problem underlying the project selection bias toward capital-intensive rail investments. Particularly, in the context of incentive theory, this problem could be diagnosed as a principal-agent problem, which is modeled within the principal-agent framework where a principal (FTA) assigns a task to an agent (a local project sponsor) who has different objectives than the principal, while in the meantime, the agent has private information that is unknown to the principal (Laffont and Martimort, 2002). In this paradigm, the problem of local project selection bias occurs for two reasons: (1) a local project sponsor (the agent) has its own objectives favoring an investment choice that deviates from the project selection rationale of FTA (the principal); and (2) the information advantage of the local project sponsor enables it to achieve its private objectives, even at the expenses of the FTA's interest. Solutions to this principal-agent problem are provided by incentive theory, which is the design of a contract between the principal and agent in a way that provides incentives for the agent to act toward the socially desirable objectives from the principal's point of view.

In order to improve rail transit planning process and produce rational investment decisions, the potential principal-agent problem with the public funding mechanism should be visited before any planning, technical or analytical efforts to correct the optimism bias itself. If the underlying funding mechanism is not rational, planner's efforts to make rational decisions could not necessarily avoid biased results. While the tool of incentive theory alone is not

sufficient for leading to a conclusion to the debates over rail investment, it conveys fundamental insights into the properties, causes and solutions of the optimism bias issue. Hence, a major task of this paper is to introduce incentive theory as an alternative way of thinking for planners, policy makers, national and local authorities and officials to deal with the rail optimism bias issue, especially to bring into recognition the role of private incentives in motivating public choice behaviors.

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Table 1: Effect of the US Federal Subsidy Program on Local Choice among Projects

Millions in 1988 dollars

	Transit Improvement Project			
	Exclusive Busway	Light Rail on Street	Light Rail in Tunnel	Heavy Rail in Tunnel
Forecast Capital cost	36	234	478	532
Forecast Annual Operating Expense^a	47	43	38	37
Forecast Annual Total Cost^b	51	67	87	91
Local Burden Under Current Subsidy Programs	40	41	45	46
Local Burdens Under Unified Transit Grant	35	51	71	75

^aSystem-wide total transit operating expenses upon completion of project.^bAnnual equivalent of forecast project capital cost (annualized at 10 percent and applicable lifetimes for structures and vehicles), plus forecast annual operation expense.

Source: Calculated by Pickrell (1992) from Urban Mass Transportation Administration, Buffalo Light Rail Rapid transit Project Draft Environmental Impact Statement, June 1977

Table 2: Summary of the Financing Plans for Six Transit Projects, as of February 2000

Dollars in millions

Funding Source	South Boston Piers Transitway	San Francisco/ BART Airport Extension	San Juan/ Tren Urbano Rapid Rail Line	Salt Lake City/ University Line	Los Angeles/ North Hollywood Extension	St. Louis/ Light Rail Extension- Area College to Air Force Base
Federal						
New Starts	\$331 (55%)	\$750 (51%)	\$307 (19%)	\$85 (80%)	\$681 (51%)	\$60 (78%)
Highway funds			260			
Formula Funds	150		141			
Nonfederal Match						
State	120	152			226	
Local		581	662	21	173	17
Other			300			
Total	\$601	\$1,483	\$1,670	\$105	\$1,334	\$77

Source: GAO, 2000

Table 3: Cost Changes and Opening Dates Projected for 14 New Starts projects with Full Funding Grant Agreements (May 1999)

Table I.1: Summary of New Starts Transit Projects With Full Funding Grant Agreements as of May 1999							
Dollars in millions							
New Starts Project	Date of grant agreement	Baseline cost estimate	Revised grantee cost estimate	Amount of estimated increase	Percent increase	Total amount of grant agreement	Projected opening date
Atlanta/North Line Extension	12/20/94	\$ 381.3	\$407.4	\$26.1	7	\$305.0	12/16/00
Boston/South Boston Piers Transitway	11/5/94	413.4	528.4	115.0	28	330.7	12/31/02
Denver/Southwest Light Rail Extension	5/9/96	176.3				120.0	7/14/00
Houston/Regional Bus Plan	12/30/94	726.6	780.1	53.5	7	500.0	12/31/05
Los Angeles/North Hollywood Extension	6/9/97	1,310.8				681.0	5/31/00
Maryland/MARC Extension to Fredrick	6/19/95	131.6	134.2	2.6	2	105.3	3/31/01
Northern New Jersey/Hudson-Bergen	10/15/96	992.1				604.1	7/31/01
Portland/Westside Light Rail Extension	9/29/92	963.5				630.1	9/12/98
Sacramento/South Corridor Light Rail Line	6/20/97	222.0				111.2	9/30/03
Salt Lake City/South Light Rail Line	8/2/95	312.5				237.4	3/3/00
San Francisco/BART Airport Extension	6/30/97	1,167.0	1,483.2	316.2	27	750.0	6/30/02
San Jose/Tasman Light Rail West Extension	7/2/96	325.0				182.8	12/20/99
San Juan/Tren Urbano Rapid Rail Line	3/13/96	1,250.0	1,676.0	426.0	34	307.4	5/31/02
St. Louis/St. Clair County Light Rail Extension	10/17/96	339.2				243.9	9/30/01
Total		\$8,711.3				\$5,108.9	

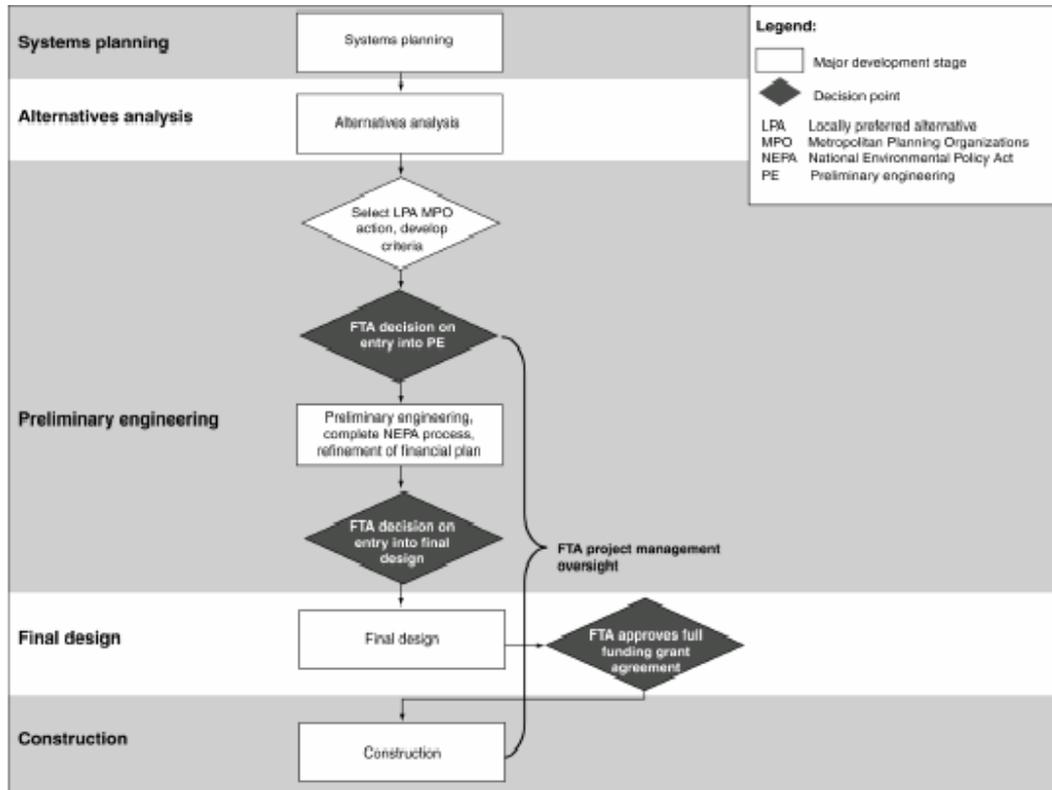
Source: GAO, 1999

Table 4: Cost Overrun of US Light Rail Projects

US Light Rail Costs Rising 20% Annually (2000)					
ESCALATION OF PROJECT COSTS IN THE PLANNING PROCESS					
Line	FTA report date of earlier estimate	Cost per Mile in Millions			Years since earlier estimates
		Earlier Estimates	2000 or 1999 costs per mile	% change	
Dallas-North Central Extension	1997	\$27.77	\$41.38	49.00%	2
San Diego-Mission Valley	1999	\$61.19	\$73.05	19.40%	1
Denver-Southeast	1999	\$30.25	\$46.45	53.50%	1
Kansas City-Southtown	1995	\$32.00	\$44.23	38.20%	4
Minneapolis-Hiawatha	1999	\$32.00	\$47.70	49.10%	1
New Jersey; Bergen Complete	Hudson 1996	\$63.41	\$104.72	65.10%	3
Norfolk	1995	\$7.35	\$28.67	289.90%	4
Orange County	1999	\$68.57	\$75.75	10.50%	1
Orlando	1997	\$35.20	\$41.10	16.80%	2
Phoenix	1999	\$30.00	\$47.78	59.30%	1
Portland-North South	---	\$98.83	\$98.83	0.00%	0
San Diego-Mid Coast	1997	\$22.65	\$30.76	35.80%	3
San Francisco	1999	\$79.59	\$98.83	24.20%	1
Average				54.70%	1.5
Average without Norfolk				32.40%	1.8
Annual Average Increase in Costs				29.60%	
Annual Average Increase in Costs without Norfolk				21.00%	

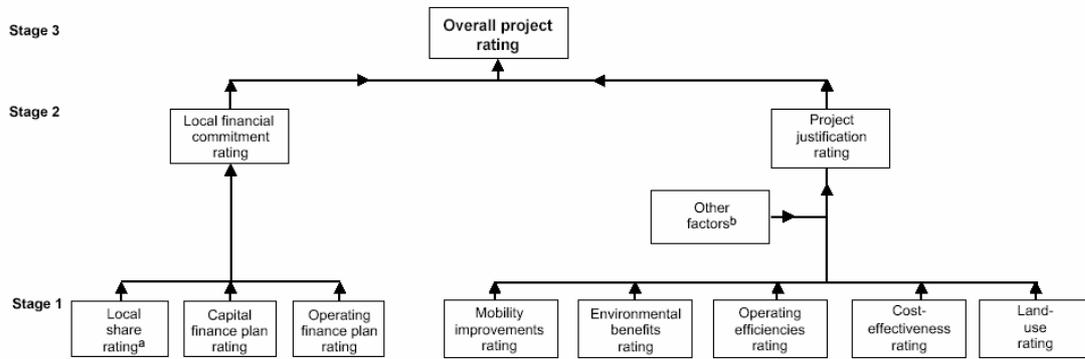
Source: Urban Transport Fact Book, Public Purpose Website: www.publicpurpose.com, April 2003

Figure 1: New Starts Planning and Project Development Process



Source: FTA (2002)

Figure 2: The FTA New Starts Evaluation and Rating Process^{a,b}



^a The local share is the percentage of a project’s capital cost to be funded from sources other than new starts funding.

^b According to FTA, this optional criterion gives grantees the opportunity to provide additional information about a project that many contribute in determining the project’s overall success.

Source: FTA (2002)

Figure 3: Summary of New Starts Evaluation Criteria and Performance Measures

Criterion	Performance measure
Mobility improvements	<ul style="list-style-type: none"> •Change in hours of travel time •Low-income households served by the system, expressed in terms of the number of such households within a half-mile of a project's boarding points
Environmental benefits	<ul style="list-style-type: none"> •Change in pollutant emissions •Change in regional energy consumption, expressed in British thermal units •The Environmental Protection Agency's air quality designation for the region
Operating efficiencies	Operating cost per passenger mile
Cost-effectiveness	Incremental cost per incremental passenger
Transit-supportive land use	<ul style="list-style-type: none"> •Existing land use •Containment of sprawl •Transit-supportive corridor policies •Supportive zoning regulations •Tools to implement land-use policies •Performance of land-use policies •Other land-use factors
Other factors	Local policies, programs, and factors relevant to the success of the project
Local financial commitment	<ul style="list-style-type: none"> •Proposed local share of project costs •Stability and reliability of capital financing •Stability and reliability of operating funds

Source: FTA (2002)