BEHAVIORS OF POLICY ANALYSTS IN PUBLIC INVESTMENT DECISIONS: HOW POLICY ANALYSTS MAKE JUDGMENTS

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Policy analysis emphasizes analytical methods to get better information. Better information, however, plays a limited role in improving the quality of policy making if it is not appropriately interpreted. Analytical information measures the different aspects of a policy problem using different methods: analyses result in information that is created different forms with varying qualities and relative importance. In order to be more appropriate for policy making, analysts have to integrate and to interpret the information using contextual and expert knowledge. However, few studies have paid attention to analysts' judgment behaviors.

This study examined the judgment structures of analysts who perform actual investment analysis. I analyzed why politicians and bureaucrats rely on policy analysis, and how a growing demand for policy analysis leads to an increase in analysts being more actively involved in investment decision process. Especially, I note that it is not realistic or desirable to restrict the role of policy analysts as a technical information provider. As analysts are required to consider multi-dimensional aspects of investment problems, they have to do more integrative analysis with high level of judgment to respond to the needs of their clients.

Analyses of policy analysts' judgments show that policy analysts are not obsessed with economic efficiency when evaluating investment projects. The analysts gave a similar weight to economic efficiency (51%) as they did to policy factors. Also, the large variation of judgments in weighting and scoring that was observed can be explained by several factors: the project fields,

analysts' role in analysis, and their affiliation. Most importantly, we can find strong evidence that analysts' judgments are highly related to their self-interests. I showed that analysts' self-interests are more problematic in the judgments than the cost underestimation. With the judgment analyses, I suggest developing management techniques using the statistical distribution, which allows us to infer the possible range of variation of weighting and scoring.

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PREFACE

To my wife,GeumHwa, and family

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1.0 INTRODUCTION

1.1 BACKGROUND

Policy analysis is not only about increasing the understanding of policy. It is also about improving the quality of policy making (Dror. 1967; Lasswell. 1951; Quade. 1982; Wohlstetter. 1970). Dror argue that "To introduce urgently needed improvements in public decision-making,…, policy analysis ***must*** become an important new professional role in government service" (Dror, 1967:201, emphasis added). However, in supporting the argument for the professional role of policy analysis, policy analysts have struggled with the hostile environment in the classical policy-making process in the United States or other countries, which rely on the complex process of political negotiation and bargaining. The political nature of policy making has depreciated the role of the "new profession"- policy analysts. The role of policy analysts in improving policy making is unduly narrowed into providing the technical information. Despite the increase in the adoption of policy analysis by organizations, academic programs and policy fields, policy analysis does not pay much attention to how to integrate multi-dimensional technical information and how analysts transform it into their own judgments.

Although engineers or economists might be regarded as policy analysts, if they fail to recognize the political aspects and the diversity of public values and the various dimensions of policy issue in decision and implementation, they cannot be policy analysts as the discipline of policy analysis intends to be (Dror 1967).

Also, policy analysts differ from bureaucratic staffs or legislative staffs who work closely in political environment. Bureaucratic or legislative staffs are experts in political negotiation and have a keen sense for anticipating political reaction from voters and for the resulting impact on the landscape of political power. While policy analysts acknowledge the political aspects of policy, they rely more on technical information and are less likely to try to serve the political interests of specific politicians or agencies. In this sense, policy analysts can be regarded as serving a professional role that lies somewhere between the roles of technical and political experts (Ukeles. 1977). In reality, it is not easy to differentiate policy analysts from technicians or government staffs (Meltsner 1976). Nonetheless, the integrative judgment made by balancing technical information and politics is what distinguishes policy analysts from other experts.

The decision model for analysts' judgment is difficult to implement in the policy analysis process. To make judgments, analysts must use information in different forms, measures, and qualities, and then assess the relative importance of information and the alternatives. In addition, their judgments should be accountable and objective. More fundamentally, it is challenging to reflect the differences of decision makers in knowledge, cognitive frames, interests, and ways of reasoning in the decision model. Despite the difficulties, as shown in this dissertation, we can find the promising possibility of the integration of analysts' judgments process in policy analysis.

Public investment is one of the oldest policy fields adopting the systematic economic analysis. After the Federal Navigation Act of 1936 requiring the U.S. Army Corps Engineers to use benefit and cost information for waterway system investment, many advanced methods have been developed to obtain more accurate analytical information. As has been the case in other policy fields, the decision model for analysts' judgments has not been integrated into the analysis process despite the long history of the adoption of economic and policy analysis. Analytical information is provided into a parallel way and analysts' judgments are not explicitly observable (Yoshizumi and Freytag. 1999).

Public investment has a duality. On the one hand, it is an "investment" which can be economically rationalized as the private sector does. On the other hand, it is a "public" activity dealing with conflicting values. Not surprisingly, for public investment decision, we need a large amount of information and an adequate decision process to cover the complex dimension of the problem. This dissertation tries to understand how policy analysts handle the complex aspect of public investment through their judgments.

Public investment is an important activity to governments. Annually, governments spend billions of dollars for public investments. In the U.S., the Transportation Equity Act for the 21st Century (TEA-21) authorized the expenditure of 171 billion dollars on roadways over six years from 1998 to 2003 (U.S. DOT. 1988). In Korea, more than 14% of the general government budgets is allocated for the public investment account each year (Korea BAI. 2004). Aside from the size of the budget, public investments also have considerable impact on the economic and social life of the public. The construction of highway, harbor, and airport systems is a fundamental factor in economic growth and regional development (Turrini. 2004). A region with an underdeveloped infrastructure incurs higher production costs than the region with a well-equipped infrastructure. Countries adopting an unbalanced economic development strategy such as Korea have found that the degree of public investment is a major factor in explaining regional disparities. As a result, local governments compete to draw more resources to their region. Politicians cannot be neutral to regional competition owing to strong political stakes. In addition, the safety, congestion and environmental impacts of public investment have been major concerns.

Public investment undertakes a series of complex processes for its decision. We should not oversimplify public investment as a matter of economic efficiency. Public investment decisions need to be understood in the general context of policy making. Charles Lindblom noted that policy making is serial, that it proceeds through long chains of political and analytical steps, with no sharp beginning or end and no clear-cut boundary (Lindblom. 1968). Unlike the investment decisions of private organizations, a public investment decision is a result of the series of planning, assessment, design and implementation steps involving multiple agencies and governments having different or conflicting interests. Sometimes a policy process is less sequential. The multiple streams theory holds that the problems, policies and politics converge at critical moments and are coupled to open policy windows (Kingdon. 1984; Zahariadis. 2003). The typical highway investment takes around 9 to 19 years from planning by MPO (Metropolitan Planning Organization) or state governments to completion of construction (Siggerud. 2002).

When public issues arrive on a policy agenda, decision-making is surrounded by ambiguous and conflicting sets of problems, policies, and politics (Kingdon. 1984; Stone. 1997). In general, the decision "maker" is not a single calculating decision maker, but is composed of numerous political actors, experts and organizations, with differences in goals and objectives (Rosati. 1981:236-247). In the process of transforming an agenda into a policy, decision makers have to handle problems such as: ambiguity of goals, lack of information, multiple objectives, difficulties of identifying good alternatives and intangible impacts, controlling the uncertainty due to long time horizon and unexpected change of exogenous variables, dealing with conflicting interests and frame of references among decision makers, and considering other interrelated decisions (March. 1988). Even after a decision has been reached, decision makers have to solve unexpected problems during implementation due to a considerable gap that exists between the formulated decision and its implementation(Elmore. 1979; Mazmanian and Sabatier. 1983; Pressman and Wildavsky. 1973). Because of these difficulties of policy decision-making, the dissatisfaction seems to be inevitable.

Public investment is not free from the politics among the conflicting interests groups. In the U.S., criticisms of poor public investment decisions have focused on decisions of the executive and the Congress (Gilmour, et al. 1994). Diana Evans observes that highway decisions in the U.S. are often an outcome of bargaining between the Congress and executive. The congressional representatives want to launch specific programs serving the interests of their districts. When the representatives authorize special projects serving their interests, they frequently insist that their projects (Evans. 1994:46): “demonstrate the benefits of enhancing safety and improve economic vitality of depressed areas”, “relieve congestions and safety”, or “improve economic development and diversification”. The executive often argues that those factors are only nominal and that the real reasons for the legislature’s intervention is to serve the political interests of its members. The Congress, in contrast, criticizes the ambiguity of decision criteria within the executive. The U.S. Senate Committee on Commerce, Science and Transportation expressed its concern that in more than half the cases, Federal Highway Administration uses its discretion to fund lower priority projects (McCain. 1998). For instance, DOT (Department of Transportation) chose only 50% of high priority projects (most promising and promising projects). Its excuse for choosing less preferable projects is usually that: “most of states’ submissions could be considered good projects… It would be unlikely that the office of administrator could select poor projects for funding (although they select less preferable project among submissions)” (U.S. GAO. 1997:11-12). The Congress complains that the performance of infrastructure investment was not clearly measured and bureaucrats neglect to provide enough information for the justification of the expenditure of taxpayers' dollars.

Intensive efforts to rationalize public investment decisions using policy analysis have been tried. In a practical sense, policy analysis is an instrument that assists decision-making or reaching goals. It helps to find causes of problems, to structure problems, to generate information and alternatives, and to provide guidance in making decision (Quade. 1982:4-5; Weimer and Vining. 1999:1). It also plays a political role by framing issues, and providing grounds to support interests of certain groups (Stone 1997: 232-256). Politicians want to use policy analysis to control the discretion of bureaucrats to overcome information asymmetry (Beckman. 1977). The federal government wants to use policy analysis to control and monitor subnational governments. Because of decentralization, the federal government often hands over the authority to allocate investment resources to states and local governments. For instance, ISTEA and TEA-21 of the U.S. government have established a voice for metropolitan areas by delegating greater responsibility for planning and implementation from federal to metropolitan planning organizations (MPOs) (Katz, et al. 2003). To coordinate and control the decentralized planning, the federal government requests more intensive policy analysis for projects soliciting federal funding (ISTEA 1991, TEA-21). The change of public management strategy also allows room for policy analysis. The strong movement of New Public Management focuses on management rather than social values; on efficiency rather than equity; on mid-level managers instead of elites; on organizations rather than process and institutions (Kettl. 2002:93). The plummeted public trust in the government (Gore Jr. 1994), the growth of budget deficit, and the more active role of non-profit and profit organizations in public services (Salamon. 2003) are behind the New Public Management movement. Public expectations of government go beyond financial or legal accountability (Behn. 2001). Such trends frame the value of public policy into efficiency. People want public money spent legally and efficiently. As Paul Light observes, we need to admit that the tides of government reform are not new but have moved back and forth with different ideas such as: scientific management, war on waste, watchful eyes, and liberation management (Light. 1997). Among these different tides, as Light insists, people have had more interest in a "war on waste" and "watchful eyes" during the last decade. For instance, when government cannot show that activities are more efficient than those of private or non-profit organizations, it is often required to share its authority in providing public services with those other sectors. Under those circumstances, government has to provide more evidence than before to justify its public investment spending. Politicians cannot ignore the trend. In Executive Order 12893, the U.S. government clearly states that "Infrastructure investments shall be based on systematic analysis of expected benefits and costs, including both quantitative and qualitative measures" (Executive Order 12893. 1994). Federal spending for infrastructure programs such as direct spending and grants for transportation, water resources, energy, and environmental protection is required to quantify benefits and costs and monetized to the maximum extent practicable[1]. Korea, the UK, and Japan governments also clearly state that investment decisions should be made based on systematic analysis and clear evidence (Advisory Committee for Public Management of Road Administration. 2003; HM Treasury. 1997; Kim, et al. 2000).

Policy analysts are asked to analyze multiple factors related to investment problems. They are asked to search possible alternatives, to find effective physical design and construction methods, and to analyze economic efficiency, environmental impact, regional development,

[1] Under the Executive Order 12893, each agency should use economic analysis to justify major infrastructure investment and grant programs and OMB Circular No. A-102 in 1997 also requests that State and local governments should be consistent with the Executive Order 12893.

possible residents' complaints, relevancy to other plans and laws, and regional equity. It is extremely difficult for a single analyst to perform policy analysis covering such factors. Analysts have to use different expertise. Information for each factor has a different form and is interpreted in various ways. More importantly, analysts have to assess the relative importance among factors and to provide their integrative interpretation of their analysis results.

The above discussions suggest that public investment is a complex decision problem and analysts cannot meet the growing demand for elaborated policy analysis with a monolithic approach. Policy analysts must produce information on multiple factors, integrate that and then provide an adequate judgment that their clients can use. However, literature and practices have traditionally focused primarily on information production while overlooking the integration of information and judgment.

1.2 SIGNIFICANCE OF RESEARCH

Studies on the policy analysis of public investment have focused on: *how to do* policy analysis to get accurate technical information such as discount rates, consumer surplus, shadow pricing or risk analysis (Arrow and Lind. 1970; Marglin. 1963; Mishan. 1982). The theoretical debates over the appropriateness of cost benefit analysis (Campen. 1986; Richardson. 2000) are also related to how to do policy analysis. Surprisingly, however, little attention has been paid to: how policy analysts interpret and make judgment with analysis results. Welfare economics provides that we have to choose a project maximizing net benefit (Gramlich. 1990). This principle is theoretically appropriate. However, if the size of net benefit is highly correlated to the size of project or if there is a significant difference in the size of net benefit across project fields, the principle is not acceptable. Therefore, practically speaking, we would only choose large projects or favor certain project fields that would produce a large net benefit. At the same time, the monetized net benefit includes a considerable amount of uncertainty. We cannot assume that the degree of uncertainty is the same across projects. The problem becomes more complex as we consider additional policy factors along with economic efficiency. When facing multi-criteria decision-making, the principle of maximizing net benefit is limited. Welfare economics or policy analysis does not provide sufficient theoretical and empirical studies on how practitioners should handle those problems.

The question might be less important if policy analysis was done with a single analytical method and the result from the method is clearly interpreted by anybody. However, as shown in the above discussions, policy analysts rely on multiple methods, tools and techniques for assessing social, economic, and environmental effects (Forkenbrock, et al. 2001). Analysts are heterogeneous in that they are trained in different disciplines, and have different interests and personal attitudes toward public investment policy. Moreover, they have to consider multiple factors and integrate them into their analysis[2]. Under these circumstances, it is highly unrealistic to assume that analysis will be directly interpreted without variation.

One might argue it might be enough to know analysts' judgments implicitly through their verbal statements as shown in the conclusions of their reports, or policy recommendations. For instance, analysts use statements such as 'desirable', 'good', 'considerable', or 'not bad'. The problem of such verbal statements is ambiguity. From the statements, we cannot infer how a set of information on a set of multiple factors was transformed into the statements. More specifically, we do not know how much weight is given to each factor and how alternatives are chosen and on

[2] For the details of factors policy analysts consider in their investment projects, please refer to appendix 3.

what grounds. No one would say that the accuracy of discount rate is far more important than reducing the ambiguity of judgment.

The emphasis on the ambiguity of a human being's decision is not helpful in understanding an actual analysts' judgment. The well-known decision model so called "garbage can" (Cohen, et al. 1972) or "multiple streams" (Kingdon. 1984; Zahariadis. 2003) emphasizes the preference of decision-makers as problematic, but it is not useful in predicting analysts' judgments. Many policy and investment decisions are made repeatedly and we might expect that analysts' judgments would follow a certain probabilistic distribution that would allow us to find the pattern of their judgments.

In this dissertation, I emphasize the importance of analysts' judgments in public investment analysis. If we acknowledge policy analysis deals with multi-dimensional factors, produces different forms of information, then it is essential to know how analysts make judgments on investment projects under given analytical information conditions. Former research (Dickey. 1975; Forkenbrock, et al. 2001; U.S. GAO. 2004:14) has pointed to the necessity of using multiple methods and factors, but does not give any empirical evidence as to how much of weight is given to each criterion used by policy analysts. Therefore, to analyze analysts' judgments directly, I use actual decision data on 146 major investment decisions made from 2001 to 2004 by the Korean government. To integrate information production and judgment within a policy process, KDI (Korea Development Institute) and I designed the explicit judgment process requiring analysts to make decisions on how to weight specific criteria and to score a project's acceptability. The systematic analysis of the judgment data helps us to answer: how analysts make judgments under different situations.

The knowledge gap on analysts' judgments in public investment study is substantial. We can expect analysts' judgments to differ from one another among criteria and project fields, but we do not know exactly what the variations it will be. Some argue that economic efficiency is most important, while others insist a regional equity should be placed as the top priority. However, we do not know how individual analysts consider the relative importance of factors among multiple criteria. We know the same benefit cost ratio is interpreted differently, but we do not know how large the difference is. Although these are not trivial questions in actual public investment decisions, we have no systematic knowledge about these differences in interpretation. In an attempt to fill the knowledge gap, I perform the analyses on the variation and scoring to fill the knowledge gap by answering questions such as: i) whether analysts have different views about the relative importance of different decision criteria, ii) whether or not the interpretation on given information is significantly large, and iii) how much the degree of variation differs by the project, project field, affiliation of the analyst, role in analysis, and criteria they have to judge.

In public decision, the opportunistic behaviors of analysts replacing social interests with their self-interests can be a serious problem. We may expect that analysts' self-interests affect decisions, but we do not know whether the influence of self-interest is significant enough to explain the variation of judgment among analysts. In this dissertation, I analyze whether systematic intentional bias is observed in an analyst's judgment and test whether self-interest maximizing hypothesis fits to explain the difference of judgments. At the same time, I also test whether the self-interest maximizing behaviors are related to the reliability of analysts' judgments.

Such analyses help not only to uncover the "black box" of analysts' judgments but also contribute to efficient public investment management. From the analyses of judgments, we can obtain explicit information about which factors are more important or how analysts reach their final policy recommendations. Such information can be transformed into a probabilistic distribution of a possible range of judgments. When certain analysts do abnormal weighting or scoring, we can detect such behaviors. We can also find projects whose analysts in complete disagreement. This information can be used in preventing public investment decisions from being made by special interest groups using extremely weak arguments. For instance, let's assume a project with the strongly supported by a group of influential politicians is acceptable only from the perspective of regional equity. It is likely that the politicians will criticize policy analysts' rejection of the project if the importance of regional equity was underestimated in the analysis. In facing the criticism, analysts could provide evidence as to how other analysts have weighed regional equity in the similar projects.

This dissertation is organized as follows. In the literature review, I explain how policy analysis is placed in the public investment process and critically review the traditional "technical information providers". From the review, I describe research questions which are understudied. In the section on data explanation, I discuss the background of data, AHP (analytic hierarchy methods) which is used for deriving analysts' judgments, and other contextual information on the decision process. In the research design section, I delineate the research scopes and set up research hypotheses. In the analysis section, I perform descriptive analyses on the weighting and scoring, and explanatory analysis to test the self-interest hypothesis. The overall structure similarity and dissimilarity of analysts groups are examined through discriminant analysis. Finally, I discuss the theoretical and practical implications of this study.

2.0 LITERATURE REVIEW AND RESEARCH QUESTIONS

The role of policy analysis in public investment decisions has been understood differently according to the way the role of politics has been framed. One view argues that rationality is not possible in the public arena, since reality is too complex and dynamic, or political bargaining is a dominant process (Stone 1997). The proponents of political process of public policy decision-making regard the attempt to rationalize public decision-making with policy analysis as a ritual or symbolic process. The illustration of interest group politics and bargaining in a public policy process (Altshuler and Luberoff. 2003; Kaufman. 1963; Pressman and Wildavsky. 1973) describes how rational information is largely ignored.

The other view is to acknowledge the positive role of policy analysis. Proponents of rational policy decision-making insist that policy analysis is an important source of information used for investment decision. They believe policy analysis raises the level of argument among contending interests. It is rare that a single powerful decision maker or group easily resolves a battle among jurisdictions or interests groups. Each decision maker or group tries to suggest convincing evidence or grounds to frame issues and to claim their own standings. Aaron Wildavsky notes that many policy decisions may lie in political bargaining at the beginning but once interests are organized, people want to undertake policy analysis in order to crystallize their own objectives or merely to compete with the analysis put forth by others (Wildavsky. 1970:462-463). Each group frequently performs adversarial policy analysis to refute other competing groups' arguments (Busenberg. 1999). The view that policy analysts plays a beneficial role leads to the expectation that the increasing reliance on public policy leads to a higher quality debate and perhaps better public choice among alternatives.

We cannot simply make a judgment on the normative superiority of political versus rational decisions. By the definition of "public", public investment decision-making is conducted in a political context and is therefore influenced by politics. However, the argument that public investment is influenced by politics does not mean that the *only* or even the *most important* determinant of investment decision is politics. Social planning (Kahn 1969), welfare economics, policy science (Lasswell. 1951), or policy analysis (Wildavsky. 1964) have undoubtedly been used, and have influenced public investment decisions. Nowadays, few literatures and policy analysts argue that their effort to rationalize a public investment decision is free from politics. In the process of policy analysis or communication with clients, policy analysts try to balance the political and rational aspects of a policy problem. Thus, we can say that the relationship between politics and policy analysis is not mutually exclusive.

Despite policy analysts' efforts, the role of policy analysts in public investment has been portrayed as engineers performing physical design, economists calculating costs and benefits, or other technical information providers. The image of analysts as technicians is partially due to the belief that policy analysis plays a minor role in investment decision compared to politics. Given the belief, it follows that investment judgment is for politicians or bureaucrats and not for policy analysts. In the following sections, I critically review the traditional view toward policy analysis in public investment. At the same time, I provide supportive evidence for more utilization of policy analysis in public investments, and describe how policy analysts become more important, especially in the Korean government.

2.1 POLICY ANALYSIS AND PUBLIC INVESTMENT

Critics of the analycentric approaches argue that information produced by those methods is not only inaccurate but also insufficiently theoretical and practical in problem solving (Lave. 1996:113-115). Because of omission errors, forecasting errors, measurement errors and valuation errors, they argue that the gap between the estimated and actual costs and benefits is significantly large (Boardman, et al. 1994). Boardman et. al perform an *ex ante*, *in medias res*, *ex post* benefit cost analysis on the same project. It turns out that net benefits change to $40.2, -$128.2 and $394.3 million Canadian dollars, which shows significant variations. Other research show a pattern of consistently underestimated cost (Flyvbjerg, et al. 2003). For rail, average cost escalation is 45% and for roads 20% which is global phenomena observed across 20 nations. Because of different standings, i.e. whose benefit or cost should be counted, we get very different analysis results (Trumbull. 1990; Whittington and Duncan MacRae. 1986). Also, non-market values such as environmental benefits and costs are not easily counted. The debates over existence value (Rosenthal and Nelson. 1992) and valuation of life (Miller. 1989; Viscusi. 1993) are frequently on the table. In addition, regional development, managing conflicts among interest groups, and reducing tension among jurisdictions require more information than the quantifiable information produced by the technical assessment. Even if an analysis provided a fairly accurate result, decision makers in government did not utilize the results, at least, not directly (Weiss. 1977). Most of all, the belief that policy problems are too complex to be solved with rational process prevails among political scientists.

The proponents of decision-making based on the 'technical rationality' of applying engineering knowledge in predicting demands, economic analysis of benefit and cost, and environmental impact analysis argue that those analytical methods are not only functional in providing useful information to decision makers but also normatively desirable by replacing a political rent-seeking among interest groups with objective judgments supported with clear criteria to maximize social benefit (Campen. 1986:80-81; Gramlich. 1981:78). They argue that the critics of rational decision-making do not provide practical prescriptions to improve the efficiency and accountability of public decision-making. Also they insist nothing has supplanted policy analysis as an idealized paradigm for guiding policy choice (May. 1989:210). The incompleteness of methodology is a problem for every decision-making process and is not unique to policy analysis oriented decision-making.

However, the accuracy of analytical methods is not a dominant factor in the adoption of policy analysis. In public decision-making, we have to think about the incentive of utilizing policy analysis to politicians and bureaucrats. In addition, if policy analysis is used in the government decisions, we need to understand the context. In the following, I discuss the incentive structure of politicians and bureaucrats on policy analysis and discuss why policy analysis became a critical process in public investment decision in Korea.

2.1.1 Politicians and Policy Analysis

Politicians can decide the amount of money to be used for public investment and enact laws providing formulas to allocate the money as the TEA-21 of the U.S. does[3]. Politicians, however, cannot arbitrarily allocate public money. Public investment decisions have been institutionalized to reduce the discretion of politicians and bureaucrats. Over the last decades, the amount of discretionary funding distributed by the Congress or executive has been stabilized in the U.S.

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[3] The formula used in TEA-21 is provided in Appendix I.

Since 1930, the U.S. Congress has established several discretionary programs, including the Discretionary Bridge, the Interstate Discretionary, the Interstate 4R, and the Ferry Boats and Facilities programs. However, the discretionary programs explain only a small portion of total transportation investment. The size of discretionary funding of FHWA in TEA-21 was only 1.8 billion dollars. Considering that TEA-21 approved 171 billion dollars on highway related programs, the discretionary programs are only about 1% of total funds. Most detailed decisions on project selections are in the hands of the executive and local governments.

Because politicians have limited resources and information to monitor the spending of budgets, the compliance of bureaucrats to the interests of citizens or even to politicians' interests is a key concern in the policy process (McCubbins, et al. 1989). Information is costly and perfect information is unattainable. The second-best solution for politicians could be to manipulate the agencies' interest structure with rewards and penalties. Standard political oversight such as hearings, budget reviews, investigation, and punishments could be used to enforce agency compliance. Unfortunately, such oversight is not useful in public investment decisions. From planning through implementation, public investment involves multiple decision makers over a long period. This blurs the accountability center. In addition, poor performance measurement or post-evaluation reduce the probability of detecting incorrect decisions. At the same time, even when oversight does identify serious errors, costs are often quickly sunk, making it difficult to reverse the decisions.

Politicians are well aware of these problems. In some cases, the legislature tries to increase its information capacity. Common ways to increase its information capacity is to institutionalize policy analysis organization such as CRS, CBO, or GAO within the U.S. Congress. Congressmen also try to rely on their staffs. Paul Sabatier and David Whiteman insist that policy information[4] or technical information flowing into the legislative body is transmitted by the staffs who can interpret analytical information (Sabatier and Whiteman. 1985:413). The demand for policy analysis increases when Congress faces a poor revenue environment, fragmentation of power and subsequent conflict over policy, and negative public opinion about the legislature (Shulock. 1999:239; Willoughby and Finn. 1996:526).

Administrative procedures are another important mechanism for controlling bureaucrats. McCubbins, Noll, and Weingast (1987:243-246) argue that the purpose of administrative law is not fairness but to help politicians control bureaucrats. By requiring policy analysis within administrative process using laws or executive orders, politicians can control the discretion of bureaucrats and try to maintain power over agencies' policymaking which may drift from their intention.

In Korea, we can find many pre-conditions for increasing the adoption of policy analysis in public investment by politicians. Unlike the U.S., the Korean National Assembly did not create internal policy analysis organizations. Until the National Assembly Budget Office (NABO) was established in 2003, the Korean National Assembly suffered from receiving adequate analytical information for reviewing the executive's proposed budget. Assembly members had to rely on information provided by bureaucrats, which was biased toward bureaucrats' interests. So, the National Assembly sought more information from independent policy analysis.

Also, the increase of tension between the executive and the legislature encouraged the National Assembly to require more information from the budget agency. By the 1980s, a

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[4] Policy information includes "information on the actual content of proposed legislative alternatives, magnitude and cause of the problem they are designed to address, and their probable effect on society". In contrast, political information refers to "information about the positions of other political actors on pending legislation and about the likely impact of the legislation on reelection or career prospects" (Sabatier, Whiteman 1985: 397).

majority party had the political power in both the legislature and the executive. Under the strong leadership of the president, the political tension between the legislature and the executive was relatively low and there was a strong coalition between them. However, the situation changed significantly in the 1990s. The opposition party won almost half of the seats in the National Assembly in 1992[5]. In the 1997 election, the opposition party won the presidential election, but lost the National Assembly election. The rapid change of political structure significantly weakened the coalition between the executive and the legislature. The collapse of the coalition led the legislature to rely more on strict administrative control. The legislature requested more evidence from the executive and a clear administrative process in selecting investment projects. For instance, the government investment evaluation guideline issued in 1982 (MEP. 1982) were not revised until 1996 (Oh and Ahn. 1996). Since the mid-1990s, the executive branches have introduced a substantial number of evaluation manuals and procedures to meet the demand of the National Assembly. Also, to get unbiased information, the National Assembly passed a law ensuring the autonomy of government funded research institutes that were under the strong influence of the executive branches in 1999. The National Assembly also created the National Assembly Budget Office to monitor and review the executive's expenditure in 2003.

Along with the above problems, National Assembly members had to seriously consider a budget constraint. Before the Asian Crisis in 1997, the national debt as percentage of GDP was under 10%. However, the ratio continuously increased since 1997 and reached 26% in 2004. Such a huge increase of national debt is mainly due to the expansion of government expenditures rather than to a decrease in revenue. So, for the politicians, policy analysis is an attractive tool for improving the economic efficiency of investment expenditures.

[5] This is a significant change because for almost 30 years, the opposition party could not get political power in either the legislative or the executive because of the military dictatorship.

There is also a disincentive for politicians to use policy analysis because there is no guarantee that policy analysis will always be consistent with their political interests. In such cases, politicians do not want policy analysis results to be publicized and to bargain with the executive by inserting projects of politicians' district in return for approving the executive's budget request. If politicians are able to coordinate conflicting interests through effective political bargaining and there is a dominant political power, they can minimize the disincentive.

The political environment of Korea, however, makes it difficult for politicians to achieve that goal. Because of the strong demand for the transparency of government decision[6], the ability to monopolize information has decreased. In the absence of dominant political power, the legislature also becomes more vulnerable to the oversight from other parties, interest groups, or mass media. Figure 1 describes the proportion of first time elected legislative members from 1948 to 2004. Compared to the U.S., the rate of membership change in the National Assembly of Korea is very high[7]. So, it is difficult to realize the strong leadership that would enable coalitions to form political rent-seeking.

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[6] When the executive performs policy analysis by contracting out the external analysts or institutes, the analysis reports are publicized through the National Assembly Library. The public can access the National Assembly Library with internet.

[7] As there was the first National Assembly election in 1948, the relative frequency is 100%. Also after the military dictator, Junghee Park, was assassinated in 1979, the first national election was held in 1981 which explains the high relative frequency in 1981.

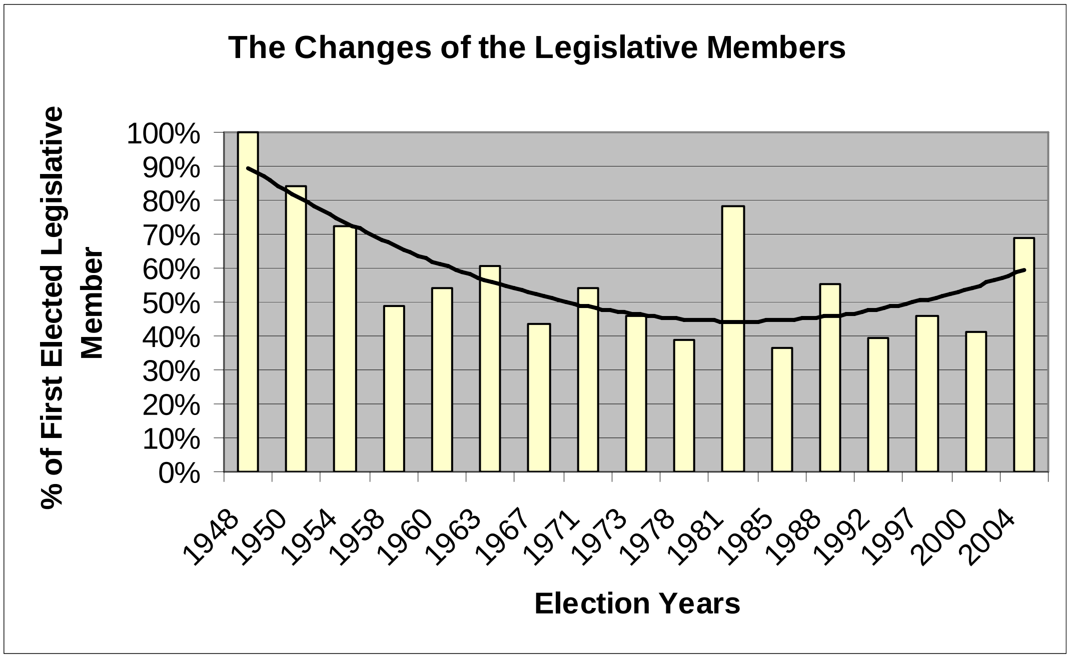

Figure 1 The Proportion of Korean Legislators Who Were Newly Elected

In summary, despite the disincentive in adopting policy analysis, politicians in Korea use policy analysis as a source of information and a tool for controlling bureaucracy.

2.1.2 Bureaucrats and Policy Analysis

We note that politicians have strong political incentives to use policy analysis as a tool for procedural control of bureaucratic discretion. Bureaucrats also have their own incentives and disincentives to use policy analysis in their investment decision process.

One incentive for adopting policy analysis is to be responsive to administrative reform requiring efficient public management. During the 1990s, the trend of New Public Management (Barzelay. 2001; Hood. 1991; Kettl. 2002) instilled the performance oriented public management. The emphasis on performance was not merely political rhetoric. It led to the institutionalization of policy analysis in the practices of government activities. In the U.S., the Intermodal Surface Transportation Efficient Act of 1991 (ISTEA 1991) required a systematic analysis for major public investment projects so called "Major Investment Study" when projects needed federal monies. The Executive Order 12893 of U.S. government states that federal spending for infrastructure programs; "transportation, water resources, energy, and environmental protection", should provide "expected benefits and costs, including both quantitative and qualitative measures". As a result of the Executive Order, the executive branches built up manuals for systematic analysis (FAA. 1999; FHWA. 2004). At the same time, state governments tried to set explicit criteria for project selection (WDOT. 2004).

The emphasis on the efficiency is also found in other countries. The Advisory Committee for Public Management of Road Administration of the Japanese government which institutionalized benefit cost analysis and performance management in public investment process explains the shift to systematic analysis as follows:

There is persistent distrust in the efficiency road administration associated with lack of transparency in the process of choosing projects. Therefore, it is one of the most urgent tasks to dispel the distrust by changing into a highly transparent, effective and efficient administration that meets the needs of the citizens and attaches importance to the outcomes (Advisory Committee for Public Management of Road Administration. 2003:3).

Another incentive is to use policy analysis for controlling internal politics among agencies. Policy decisions can be a result of bargaining games among agencies (Allison. 1971). Unlike rational decision-making, the bureaucratic politics model rejects the assumption of a unitary decision maker, but assumes multiple decision makers with multiple interests. Each agency continually strives to secure its budget and human resources, as well as to protect or extend its operating autonomy and discretion in decision-making. The interactions do not happen randomly but within rules of the game determining who can play, relative advantages, and so on. Not all agencies have enough information to make judgment on investment projects. Some agencies know more about projects than others. For instance, budget agencies which coordinate conflicting interests and have to select among competing programs, do not have enough information on goals, objectives and issues in proposed programs. By letting other agencies reveal implicit information through policy analysis, budget agencies can acquire the information needed to manage the competing interests among agencies.

The third incentive is to reduce political responsibility by using policy analysis for justifying bureaucrats' decisions. The more political attention that is paid to the every phase of government activities, the more frequently bureaucrats are required to hold responsibility to their decisions than before (Behn. 2001). Bureaucrats can share the political responsibility by inviting policy analysts in their decision-making process. They send signals to the public showing that something is being done in an objective way. If a society has strong consciousness such that social scientists are neutral and respectable experts who seek "truth", bureaucrats can legitimatize their decision by including policy analysts in the decision-making process.

There are also disincentives for bureaucrats using policy analysis in their decision process. Primarily, policy analysis does not necessarily accord with bureaucrats' intentions. When policy recommendations of policy analysis are different than those of bureaucrats, bureaucrats cannot ignore them. If they try to ignore policy analysis results, it sometimes brings out criticisms from politicians, interests groups, or mass media concerning the wrong use of bureaucratic discretion. So, bureaucrats have to provide reasonable evidence as to why they would to reject analysis results. Another disincentive is the inadequacy of analysis information. Policy analysis sometimes fails to deliver adequate information needed by bureaucrats. When bureaucrats rely on incomplete information for their decision-making, they take the risk of being proven wrong by other interest groups that organize adversarial policy analysis and suggest contradictory findings. In such a case, policy analysis is not only ineffective in dissolving conflicting arguments but also detrimental to the public trust in bureaucrats' decisions.

In Korea, we can find several factors that led bureaucrats to adopt policy analysis in their decision processes. As a result of the Asian Crisis and the inauguration of the new president Kim, Dae-Jung in 1998, bureaucrats faced strong pressure for government reform. The public sector employment shrank 7% between 1998 and 2001. Government organizations were privatized or merged to reduce inefficiency. The primary response of the bureaucracy was to adopt new processes to reform its management practices. In public investment policy, bureaucrats tried to strictly control project costs by introducing "Total Project Cost Management", and requesting the budget agency to undertake pre-feasibility studies before selecting projects.

With little doubt, new processes required a considerable amount of analytic efforts, which also increased the workload of bureaucrats. In Korea, it is common that one or two deputy directors review tens or hundreds of investment projects[8]. As Korean government agencies lacked internal policy analysis staffs, it was nearly impossible to review all projects with an appropriate level of attention. Thus, the systematic management of public investment projects became impossible without the aid of external policy analysts.

Using external policy analysts was a very attractive alternative because bureaucrats could not only reduce their workload but also show their commitment to efficient public investment

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[8] The personal communication with one deputy director of Ministry of Planning and Budget described the situation as follows: "It is not rare I have to work until mid-night because of heavy workload. While we want to spend more time to review projects requiring budget, it is almost impossible to do. Not is it because of our lack of expertise but because we do not have time and staffs to do".

management. At the same time, as policy analysts in academia and research institutes enjoyed a high level of trust and support from the public, bureaucrats could transfer their political responsibility to analyst groups.

However, bureaucrats realized the disincentives. Unlike the former government reforms, the Kim administration tried to institutionalize analytic processes. Bureaucrats could not use policy analysis in ad hoc manners. Before the institutionalization, there were no explicit criteria when policy analysis should be used for public investment decisions, but the adoption of policy analysis was under the discretion of bureaucrats. The choice of methods and analysts was also decided by the stand of bureaucrats. However, the institutionalization of policy analysis replaced the bureaucrats' discretion to a more transparent and organized process. Bureaucrats can no longer conceal or disregard unfavorable analysis results. Policy analysis results are now public documents that are accessed by the legislature and the public. If the executive agency's decision is not consistent with analysis results, bureaucrats must provide reasonable evidence to the legislature (Korea BAI. 2004).

In summary, bureaucrats have some incentives to use policy analysis within their decision process. They can use policy analysis as a symbol of justifying their responsiveness to demands of politicians or the public. They also benefit from reducing political responsibility by sharing it with policy analysts. At the same time, they can get reference information for managing bureaucratic politics among internal government agencies. However, bureaucrats also have to undertake the cost of sacrificing their discretion. In Korea, despite the disincentive, the strong pressure for government reform and the institutionalization reinforce the role of policy analysis in public investment decisions.

2.1.3 Policy Analysts in Public Investment

Increasing adoption of policy analysis does not mean the increasing role of policy *analysts* in public investment decision. If policy analysts are simply "technical information providers", they will play a minor role in the interpretation of analysis information which directly influences investment decisions.

The image of the technical information provider is problematic. Using this perspective, the utilization of policy analysis is only measured by the direct relationship between technical information and the final policy decision. As Shulock (1999) insists, such a perspective leads to the conclusion that policy analysis is underutilized (Caplan, et al. 1975; Kirp. 1992; Weiss. 1977; Weiss and Bucuvalas. 1980). Although the "enlightenment" role or indirect route of influence is appreciated, the gap between policy analysis and actual decision-making still appears large. David Kirp laments that even if analysts "speak truth to power" (Wildavsky. 1979), little attention is paid to them (Kirp. 1992; Kirp. 2004).

However, when we shift our attention from analysis to analysts, we can capture the dynamic process of public decision-making. First, we need to realize that the politicians, bureaucrats, the public or analysts do not dominate decision-making in government. Each actor in the policy process tries to frame public investment issues differently. Politicians try to frame the public investment from the point of "grand" issue such as regional equity or economic development or they consider the impact of the decision on their reelection. Bureaucrats want to frame public investment within their legal, budget, and political constraint imposed on their decision. Compared to politicians or bureaucrats, policy analysts have to frame the investment problems shaped by political interaction (Stone 1997) as well as their analytical findings and expertise. A noticeable thing is that technical information has to be understood with the process of interactions among politicians, bureaucrats, and policy analysts. Political arguments cannot be purely groundless or absent of analytical information. Politicians and bureaucrats use policy analysis indirectly as a legitimate rationalization or symbol. At the bottom level, information about economic efficiency, engineering knowledge, or social and environmental impact assessment usually becomes a minimum requirement of decision-making. The interactive nature of politicians, bureaucrats, and policy analysts implies that investment decision cannot be solely explained by one player's judgment. When we frame the role of policy analysts as participants of democratic and political decision process, policy analysts can contribute more than a technical information provider.

In actual policy decision-making, we can observe active involvement of policy analysts in the public decision process. The dramatic increase of the number of think tanks of the U.S. from 59 to 306 (Rich. 2004:15) during 1970 to 1996, or the considerable amount of citation of policy analysis results in government documents (Shulock. 1999) illustrate that policy analysts are one of the major actors in the policy process. Formal or informal requirement of policy analysis is not rare in education, regulation, welfare, health, and public investment decision-making. Analysts do research for creating issues and suggest the range of alternatives available to policy makers. They take part in making policy proposals, attend committees, and provide commentary research. They also provide specific estimates of alternatives affecting policy decisions significantly. As politicians do not have time and expertise, they frequently rely on policy analysts.

When we review the lack of human resources within the bureaucracy, we can find more room for analysts' participation in the decision process. According to the U.S. Office of Personnel Management database[9], the DOT employs 57,349. Among them, there are 1484 civil engineers and 111 professional employees are economists. In the case of Federal Highway Administration (FHA), there are only 3 economists. In contrast, 1,484 civil engineers work in the DOT, 75% of them in FHA. Such an unbalanced composition of experts impedes performing systematic economic analysis proposed by the Executive Order 12893. The lack of capacity is not unique to federal government. It is more serious at subnational governments. The study performed by Forkenbrock, Benshoff and Weisbrod shows that 75% of MPOs did not perform traditional benefit-cost analysis more than twice a year (Forkenbrock, et al. 2001:Appendix A-7). Only 13% of state DOTs in the U.S. use a computer economic model for evaluating projects and 41% of MPOs feel that the economic analysis methods carried out by university researchers are too complex (Forkenbrock, et al. 2001:72,79). The U.S. Advisory Commission on Intergovernmental Relations also reported that MPOs, which have to play a key role in planning under ISTEA-91 and TEA-21, suffer a lack of capacity to perform high level analysis (ACIR. 1995). Even if they try to recruit more analysts, the inflexible human resource management of government frustrates the efforts.

Korea is in a similar situation. A budget agency that deals with the public investment budget has only two or three deputy directors handling hundreds of projects. They do not have sufficient knowledge in engineering and have few subordinates to support reviewing project proposals. Also, they have to move other positions because of the circulation system in personnel

[9] http://www.fedscope.opm.gov/cognos/cgi-bin/ppdscgi.exe?DC=Q&E=/FSe%20-%20Status/Employment%20-%20March%202004&LA=en&LO=en-us&BACK=%2Fcognos%2Fcgi-bin%2Fppdscgi.exe%3Ftoc%3D%252FFSe%2520-%2520Status%26LA%3Den%26LO%3Den-us

management. At the same time, many public investments are interconnected with other plans and laws. Analysts have to consider socio-economic conditions, economic factors, environmental factors, and other policy factors. So, in Korea, bureaucrats frequently invite policy analysts to hear their opinions in various committees or seek for their advice in decision-making.

Along with the participatory role of policy analysts in investment decision, the multi-dimensionality of policy problems makes analysts do more active judgments rather than simply provide technical information. In Korea, public investment had been framed as a tool of economic development during the 1970s. Under the unbalanced economic development strategy and authoritarian planning culture, the Korean government concentrated its available capital in equipping and expanding infrastructures such as highways, railroads, harbors, and airports. The priority of investment projects was set according to its contribution to economic development rather than by regional equity or convenience of users. A few authoritative decision makers decided the priority of projects, and the public participation and inclusion of various values were limited. So, policy analysis of each project was mainly for physical design or for minimizing the construction costs. Reflecting the situation, before 1982[10], I cannot find any guidelines for the benefit cost analysis proposed by the Korean government, while I find only 23 academic articles dealing with public investment analysis methods such as benefit cost analysis before 1980s, which explains only 4.7% of total articles from 1967 to 2005 including a benefit cost analysis method[11]. Among those 23 articles, most of them are for general planning, not for the specific

[10] I rely on the National Assembly Library database which covers most published Korean government documents. The database analysis showed that the first document including the keyword "benefit cost analysis" was "Investment Review Manual: Transportation" published by Ministry of Economic Planning.
[11] National Assembly Library Database, http://www.nanet.go.kr, accessed at Dec. 29 2005, Keyword: ALL academic Journals with "benefit cost".

applications. It implies that the demand for policy analysis was very low in the economic development period in Korea.

When the major national level infrastructure projects were completed, however, public investment problems were framed in a more complex way. People paid more attention to various problems such as land use, housing, job creation, and environmental impact. Goals of public investment are more specified and multiple groups set up their own priorities. The weakening of political leadership of the central government brought out conflicts among interest groups. Local governments which were totally under control of the central government tried to make their own regional development plans[12] in the 1990s. Thus, national economic development could no longer be the dominant value for judging public investment.

Several factors reinforced the change in focus from national planning for development to multi-criteria investment review. First, some major projects launched during the early 1990s experienced significant failures. For instance, Kyung-Bu high-speed railroad, Busan 2nd subway line, Yeo-Su airport, and Sae-Man-Geum landfill projects experienced at least two times of a cost increase and three years of project time extension (Korea MOCT. 1999). Those projects were independently implemented as a result of political consideration, not as a part of systematically analyzed higher-level plan.

Second, local governments and line ministries were planning more projects without enough coordination among related organizations. Frequently, local governments' long term plans for public investment conflicted with the central government plan. Local governments tried to launch more projects and emphasized the regional development. In contrast, the central

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[12] For instance, the major research institutes of local governments were launched since the 1990s-Seoul Development Institute (1992), Busan Development Institute (1992), Kyeonggi Development Institute (1994) and Incheon Development Institute (1995).

government had to reallocate budgets according to national agenda rather than region-specific issues. So, it is not easy to coordinate plans of the local and central government.

Third, the frequent change of political leadership also makes it harder to maintain the consistency of plans. The changes make it harder to enforce a single view to guide development. When each project emphasizes different values, the incapacity to form political coalition or to bargain makes it difficult to solve problems with politics. As no politicians or bureaucrats dominate the investment decision, policy analysts' opinions can get more room for influencing the investment decision. Figure 2 describes how policy analysts become important players in the public investment process.

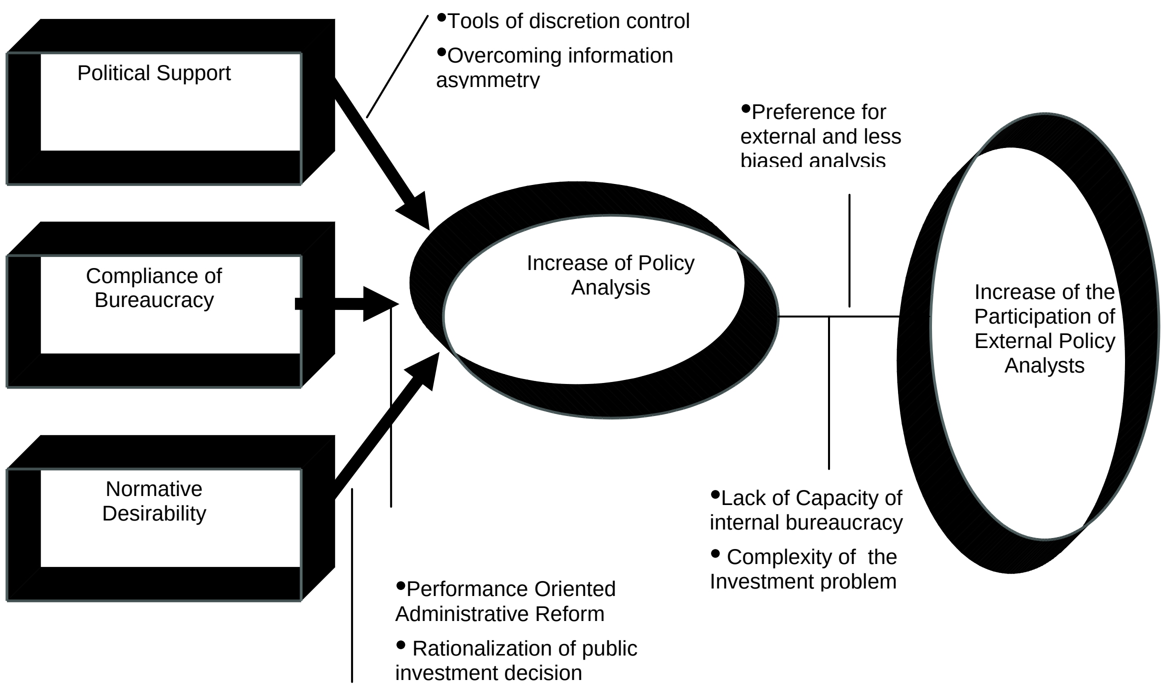

Figure 2 Increasing Roles of Policy Analysts in Public Investment

In sum, the different interests among and between politicians and bureaucrats leave much room for adopting policy analysis in their decision-making. Especially, the political and economic environment makes the Korean government utilize policy analysis more than before. The central government cannot coordinate conflicting interests of local governments and interest groups with a strong authority exercised before the 1990s. The level of information required to the investment decision became more complex and policy analysts are requested to analyze the multi-dimensional feature of public investment. Under this situation, policy analysts can't meet the demand by simply providing technical information.

2.2 POLITICS AND THE IMPACT OF ANALYSTS' JUDGMENTS IN KOREA

The appropriateness of analysts' judgments is highly related to the utilization of it by politicians or bureaucrats. If bureaucrats or politicians regard analyst's judgments as irrelevant to their investment decision, we can conclude analysts' judgments are less useful in improving the quality of public investment decision. The debates over underutilization of policy analysis (Caplan, et al. 1975; Dunn, et al. 1989; Shulock. 1999; Weiss. 1980) heighten concern about the appropriateness of analysts' judgments. It is worthwhile to review whether analysts' judgments are useful and influential in actual public investment decision-making. In the following, I review the influence of analysts' judgments based on the experience of Korea.

It is unlikely that policy analysts totally ignore political aspects of public policy. Students of policy analysis have recognized and emphasized the political aspect of public policy and have tried to include it in their policy analysis (Stone. 1997; Weimer and Vining. 1999). Analysts recognize the importance of various policy factors and also project-specific issues. They try to include many policy factors that are considered importantly by politicians. Moreover, their judgments and behaviors indicate that they do not seek value-neutral policy analysis and do not try to isolate policy analysis from political discourse. So, when policy analysts make overall judgment by integrating the information they have, how do politicians or bureaucrats respond to it?

This section provides an explanation how PFS (pre-feasibility studies) overcomes various challenges from related organizations when they reveal their judgment explicitly. At the same time, I briefly discuss potential risks when the influence of analysts' judgments is too strong.

2.2.1 Accuracy of Analysis

The most distinguishable feature of the PFS is that analysts provide an explicit conclusion. Their judgment is quantified and publicized to others. If projects are rejected, line ministries or local governments would challenge KDI's decision. As KDI is a research institute, it cannot solve conflicting interest with political bargaining. So, we can expect that KDI routinely risks criticism from opponent groups when it explicitly reveals its conclusion.

In addition, bureaucrats and congressmen are not always supportive of KDI. As PFS explicitly reports the degree of project acceptability based on the policy analysis, bureaucrats and politicians have little chance to conceal PFS results when they contradict to their interests. Before PFS, congressmen could negotiate with bureaucrats or put direct or indirect pressure on them to invest more money in their districts. However, when KDI explicitly reports a negative judgment on project feasibility, politicians risk criticism from the public if they are persistent in pushing the project.

One typical way to challenge the PFS is to perform adversarial policy analyses. The contesting groups that fail to get an approval of their projects, mobilize analysts who are favorable to their position. They request adversarial analysts to produce analysis results disputing PFS. In the presence of technical uncertainty and incompleteness of policy analysis, such an adversarial analysis would effectively undermine the validity of PFS. When the adversarial analysis enters into a decision process, the analysis proposed by one group becomes suspect in the eyes of the other group (Busenberg. 1999). In that situation, the expectation that policy analysis may “raise the level of argument among contending interests (Wildavsky 1969:190)” would be unrealistic. The difficulty of reaching consensus causes the stalemate of policy decision and the decision moves into the realm of politics rather than of policy analysis. So, without considerable amount of accuracy that prevents challenges from adversarial groups, PFS is vulnerable to criticisms from related interest groups.

However, KDI reduced the possibility of adversarial analysis effectively through co-opting other analysts groups into their research and PFS. When it built the manuals for PFS, KDI did not solely rely on its internal experts. Despite its strength in economic analysis and high reputation in developing economic policies, KDI lacked expertise in each public investment field. Thus, KDI invited experts from universities, private companies, and other government-funded research institutes in making manuals, and many external analysts reviewed them. Rather than relying on the most advanced methodologies, KDI tried to adopt more reliable and widely accepted methodologies.

KDI also invites external analysts from different organizations for PFS. More than 220 experts[13] from 118 organizations have been involved in pre-feasibility studies since 2000. At the same time, KDI frequently holds research meetings to hear other experts' opinions during its research. Although not all participants' opinions are reflected in its manuals and PFS, KDI includes varying expert knowledge into PFS. So, when contesting groups try to organize analysts to perform adversarial analyses, it is difficult to find analysts who totally disagree with the methods that PFS adopts. At the same time, even if contesting groups may organize adversarial policy analysis, they have to undertake considerable amount of time and resources. As a result, without strong confidence that the PFS contains critical error, local governments and line ministries do not seriously challenge KDI by sponsoring adversarial policy analysis.

The other way to challenge PFS is to argue that important project-specific factors were omitted or mishandled. By emphasizing their project's unique features, contesting groups criticize the incompleteness of PFS. These criticisms are more frequent when contesting groups have no chance to participate in PFS to present their concerns. However, KDI formally and informally requests line ministries and local governments to state clear project goals and problems they want to include in PFS. In some cases, if project initiators request the inclusion of certain groups of analysts, KDI includes them in PFS after discussing with MPB, or invites them to give their views during the PFS process. Although debates over the reliability and validity of KDI's assessment of project specific factors still occur, the preventive inclusion of potentially debatable factors helps to defend against possible criticism. Also, as contesting groups usually bear the burden of proof to show that the project-specific factors they emphasize are critical enough to override KDI judgment, they face an uphill battle.

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[13] I only count experts who participate in AHP. In general, they represent their own organization. The number of analysts participating in pre-feasibility study will be far larger than this number.

As a result, within the public investment analysts' community, KDI's approach is widely accepted. The minutes of the National Assembly committees discussing PFS and the inspection reports prepared by the Board of Audit and Inspection did not include criticism of KDI's methodology. In addition, rather than challenging KDI directly, line ministries and local governments tried to bargain with the budget agency and the National assembly. Thus, despite the potential risk of the challenge to the accuracy of its analysis, KDI successfully reduced it by setting up acceptable analysis manuals, and including many external analysts and project initiators' intentions in its PFS process.

2.2.2 Ministry of Plan and Budgeting and Pre-Feasibility Study

When PFS was launched in 1999, MPB was highly supportive. After the Asian Crisis and political diversification within the National Assembly during the end of the 1990s, MPB had to advocate more strongly for efficient public investment decisions. Under a budget constraint, the competition over limited resources became severe and political criticism over the unclear rule of budget allocation increased. Such criticism of the budget agency was not new. Traditionally, the President and majority party supported the budget agency and it could manage such pressures. However, the instability of politics made it hard to resolve the conflicts of interest with political bargaining between budget agencies and politicians. The milieu of the situation is well described by an official who worked in the MPB at that time. He states:

"The end of the 1990s was a turning point for many public officials. We lost trust from the public because of the huge policy failure in the Asian Crisis. Many competent officials left our organization. The strong pressures of government reform from the new President and opposition parties increased our workload. We could not assume that the majority party would protect us. Under the pressure and changes, many people avoided decisions which may bring out the problem of political responsibility.[14] ”

PFS was a useful tool for MPB in that: symbolizing its effort for rationalization of public investment decision, and transfer or sharing political responsibility with KDI. Not only could MPB use KDI’s analytical skill but also MPB could reduce their workloads for evaluating investment projects. When MPB introduced PFS, it was appreciated within the Korean government as one of the best reforms. Thus, in the beginning, MPB was highly supportive of PFS.

The allowance of explicit judgments of analysts, however, highlights an unexpected problem for bureaucrats: threatening their discretion. When KDI introduced AHP decision method, MPB supported it because they were able to get the integrative information from analysts. Also, as AHP provided a quantitative judgment, MPB could defend criticism by using AHP results as objective evidence supporting their results. The growing influence of PFS, however, changed the situation.

First, MPB’s decision is monitored by the public more than before as the public attention to PFS has increased dramatically. As shown in the figure below, the number of articles of newspapers citing or mentioning PFS or its results has greatly increased since 1999.

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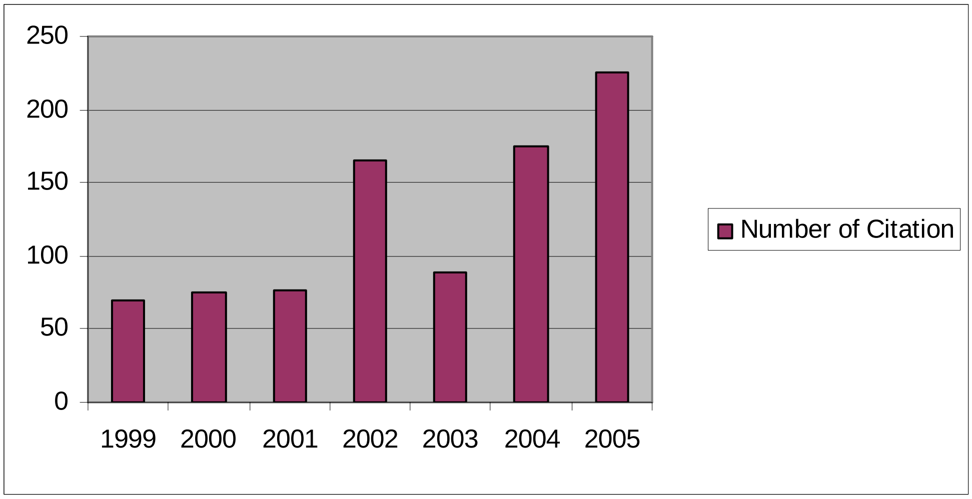
[14] Personnel communication with MPB deputy director.



Note: Korea Press Federation, http://www.kinds.or.kr/ , accessed at Dec. 04, 2005
The number of article in 2005 covers up to Dec. 4th.
The result covers 17 nationwide newspapers.

Figure 3 Numbers of Articles Referring the Pre-feasibility Study (2000-2005)

Second, the National Assembly tries to review and control MPB's decision with PFS. As the Korean National Assembly did not have internal policy analysis organization reviewing investment projects independently until 2003, PFS is used as a primary source of information. So, when MPB makes a different decision compared to PFS, the congressmen request MPB to provide more sound evidence.

Third, within the executive, oversight agencies also use PFS as a primary source of information to monitor the MPB's decision. Compared to policy analysis done by project initiator, KDI's pre-feasibility study has been regarded more reliable and covering intensive economic and policy issues. When oversight agencies find that MPB's decision is not consistent with PFS, they too ask MPB to provide acceptable reasons.

Such a growing influence of the pre-feasibility study can be a potential threat to the discretion of MPB. Although MBP gets benefits from avoiding political responsibility, the loss of decision-making power is also costly. So, MPB tries to find other ways to maintain its discretion in decision-making. It is to use its authority in selecting projects that should undergo a pre-feasibility study. According to the law, projects whose costs are larger than 50 million dollars have to take PFS. However, MPB excluded some projects from PFS without any clear reasons, and allocated budgets to them. By influencing the project selection for PFS, MPB can maintain its influence on the line ministries and local governments. Sometimes, MPB also directly disregarded the conclusion of PFS. From 2000 to 2004, among 78 projects rejected by the pre-feasibility study, the MPB allocated budgets to 13 projects. Also, MPB can influence KDI by commenting its interim and final reports. With such multiple paths, MPB could secure the possibility of exerting their influence in investment decisions.

2.2.3 Responses from the National Assembly and the Oversight Agency

At the beginning of PFS, the Korean National Assembly was also favorable to it. The supportive position of the Korean National Assembly was highly related to the special political situation. In 2000, around 41% of the national assembly seats were filled members serving their first term. The replacement rate increased to 69% in 2004. The large replacement of membership weakened seniority privileges in the national assembly. If we consider the fact that the logrolling is possible when there is mutual trust among members and strong leadership coordinating conflicting interests, then the Korean National Assembly would have difficulty using logrolling or pork barreling in the absence of dominating political power.

A high replacement rate also causes a lack of expertise among assembly members. The worst thing is that the congressmen usually change their Committees. On average, 45.8% of assembly members changed their Committees in 16th National Assembly (2000-2004) (Park.

2004). Also, on average, they maintained their membership to Committees only 6.3 months (Media Daum, Oct. 7th 2004). Such a frequent change of the committee membership causes the lack of expertise in each policy field that the committee deals with. In this sense, PFS is a valuable source that is meeting assembly members' needs for technical information.

However, similar to MPB, the congressmen face the potential threat to their control their discretion of investment decision. When MPB submits budget proposals, the congressmen can bargain with MPB to draw money to their district using their authority over budget approval. When the congressmen in budget-related committees ask for special consideration, MPB has to negotiate with them to pass its budget proposals. However, once analysis results become common knowledge to the public, the congressmen have greater difficulty applying political pressure or making a bargain. The watchful eye of the public and mass media equipped with PFS information make it harder for politicians to do rent-seeking. Also, the one's rent-seeking behavior is criticized by other politicians under the fragmentized political power.

So, the same puzzle arose in the National Assembly, as we saw in the MPB. Despite the benefits from controlling the bureaucrats, the congressmen might sacrifice their influence over investment decisions. From 2000 to 2004, among 78 projects rejected by the pre-feasibility studies, 11 projects were approved during the process of budget review. The congressmen asked the small amount of budgets to keep projects alive in the first year and request more money in the following years. All 11 projects were in the districts of the members of majority party or a member of the Committee of Budget Review and Audit. Other congressmen, especially the members of opposition parties, had little chance to make a change. So, it is natural that political criticism to such behavior arose even within the national assembly. When political tension increased in 2004, leading the impeachment of the President, the congressmen from opposition parties criticized MPB for not following the results of the pre-feasibility studies. Seung Min You, a National Assembly Member of opposition party, states that (ChosunIlbo 10.16.2004):

"The government wastes tax payers' dollars on inefficient projects. Investment analysis should be done by the politically neutral organization and the executive should have to follow its analysis results if there is not any reasonable evidence. "

The review of National Assembly meeting minutes from 2000 to 2004 indicates various criticisms of PFS and its utilization as follows:

i) The arbitrary selection of projects subject to take PFS (National Assembly Construction and Transportation Committee. 2004)

ii) Not to follow the AHP results (National Assembly Administration Committee. 2002; National Assembly Administration Committee. 2003)

iii) Failure to consider the equity of regional development (National Assembly Administration Committee. 2000)

iv) Ambiguity of the legal authority of the pre-feasibility (National Assembly Administration Committee. 2000)

v) Not allocate budget even if the pre-feasibility study accept the project (National Assembly Administration Committee. 2002)

vi) The concentration of the pre-feasibility study to KDI and fail to include other research group's opinion (National Assembly Administration Committee. 2001)

In general, the National Assembly members acknowledge that PFS makes government investment decisions more efficient. They welcome the fact that public investment decision is made by considering both economic and non-economic impacts. Also, they support that the decision should be made under clear rules, and it should be transparently publicized to prevent the involvement of political interests. Of course, there are arguments that PFS didn't reflect their districts' interests but it did not get strong support from other congressmen because of the strong political tension and lack of the leadership within the National Assembly. The typical situation is: once one group tries to influence the result of PFS for their interests, other groups attack it.

Moreover, the public attention to the pre-feasibility study increases as shown in Figure 3, assembly members have to undertake risk of criticisms when they try to disregard the pre-feasibility study without acceptable reasons. As a result, the National Assembly presses MPB for strict application of the pre-feasibility study in investment decisions.

The other reinforcement factor of the utilization of PFS in Korea is the internal oversight by the Korea Board of Audit and Inspection (BAI). BAI is a presidential agency which oversight executive agencies and major policies. As the pre-feasibility study draws much attention from the National Assembly and the public, BAI launched an investigation of the PFS process. The focus was whether PFS was operated in an objective and transparent way. One official who was involved in the inspection of the pre-feasibility study stated that:

"We have a concern that MPB uses the pre-feasibility study as a tool for avoiding their responsibility. Moreover, for the pre-feasibility study is performed by KDI which has a strong relationship with the MPB, we are very suspicious that the pre-feasibility study is highly affected by the influence of the MPB."[15]

Through the in-depth investigation, BAI found that MPB did not have clear rules in project selections. At the same time, the results of PFS is somewhat used in an arbitrary way. Like the National Assembly, BAI criticizes the lack of clear rule when MPB makes different

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[15] Personnel communication with deputy director of BAI.

decisions to PFS. BAI concludes that (Korea BAI. 2004): i) MPB should develop explicit and acceptable criteria in exempting the pre-feasibility study, ii) when MPB has a different position, its decision should be discussed in the committee for the pre-feasibility study which includes members of KDI, line ministries and other experts.

BAI also criticizes the appropriateness of the judgment on policy factors by KDI. It states that unlike the economic efficiency (Korea BAI 2004:3), the judgment on policy factors should have to include members from line ministries and MPB who are able to make a judgment from the point of public values. When the pre-feasibility study only includes analysts, it fails to reflect public values and the priority of government. Despite the criticism, the BAI acknowledges that PFS contributes to preventing budget waste on projects whose efficiency is not clear.

2.2.4 Potential Problems of the Pre-feasibility Study

Ironically, although there are a lot of aspects contradicting to the interests of the MPB and politicians, PFS can survive and becomes more influential in the public investment decision process in Korea. One factor explaining the success of the pre-feasibility study is that KDI successfully portrays PFS as a tool for objective and efficient public investment decisions. Analysis information and judgments are explicitly reported to the public, helping to increase the transparency of the public investment decision process. The high reputation of KDI as an economic research institute and its effort to minimize the political influences by introducing the standardized analysis process also contributes to its success. KDI successfully manages the possible challenges on the accuracy of its analysis by including analysts from different groups.

As a result, neither analyst communities, the National Assembly nor the BAI raised serious questions on the accuracy of methodologies that KDI uses.

However, we can raise some fundamental problems with PFS: i) the analysts' biased judgment, ii) the democratic legitimacy, iii) the public value.

PFS has its intellectual roots in the belief in value-neutral and objective policy analysis. However, as this study shows, policy analysts are not likely to be value-neutral decision makers. Although the National Assembly and the BAI acknowledge that PFS can help decision makers to use more information in decision-making, the interpretation of information is inevitably subjective. Not only the policy factors but also economic efficiency can be interpreted differently according to decision makers. Under this situation, we cannot say the policy analysts' judgment is more objective than that of bureaucrats or politicians.

The pre-feasibility study also violates the fundamental principle of public administration: democratic legitimacy. PFS transfers the considerable amount of authority of public decision-making from the politicians or bureaucrats to policy analysts. Regardless of the objectivity or rightness of the policy analysts' decision, policy analysts have very weak constitutional authority for policy making. Democratic governments govern in the name of the people, and the politicians and bureaucrats share the responsibility to represent the citizens' values and have to serve them. If policy analysts decide the public policy, the democratic legitimacy is replaced by technical legitimacy.

Finally, while KDI relies on analysts' judgment in justifying its selection of evaluation criteria of public investment projects, it fails to get the appropriate input for the value guideline from the National Assembly, local governments, line ministries, or other interest groups. For instance, backwardness of region or environmental impact might not be less important to analysts. However, for the politicians or local governments, such factors would be more important. Also, analysts' judgments focus on their project, they cannot fully consider the national priorities or public values.

2.3 HOW POLICY ANALYSTS MAKE JUDGMENTS?

Although policy analysts have been actively involved in public investment decisions, few studies examined their role. There have been some efforts to infer analysts' preferences indirectly from analysts' alternative choices patterns (McFadden. 1976), from their choice of major decision criteria (Arnold. 1993; Downs. 1992; Ferguson. 2001; Zupan. 1992), or from a limited number of surveys (Dickey. 1975). Those studies infer implicit choice criteria from the consequences or outcomes of the organizational decision. The survey methods were also adopted to examine on which factors decision makers give more emphasis. The indirect revealed preference provided limited information about the preference on the aggregate level criteria rather than about each criterion actually used in their judgment. Some studies (Boardman, et al. 2001; Portney. 1994) report the large variation in valuing the non-market goods according to the way of questioning and the difference of subjective preference. The experimental psychologists (Ritov and Baron. 1992; Samuelson and Zeckhauser. 1988; Tversky and Kahneman. 1991) emphasize the psychological aspect of preference. They refute the expected utility theorists who assume a decision is a function of expected utility. With different experimental settings, they find that the psychological features such as "loss aversion", "omission bias", and "status quo bias" make decision makers deviate from the rational expectation decision. However, few studies use the preference of policy analysts directly revealed in their actual decision-makings.

The lack of empirical studies on how analysts make decisions might be less important if the interpretation of information is not a role of policy analysts but that of decision makers such as politicians or bureaucrats. However, if we acknowledge that information without interpretation and judgment contributes to improving the quality of decisions in very restrictive ways, such a knowledge gap on analysts' judgments is critical in policy analysis theory in several reasons.

First, as we discussed in the previous section, policy analysts are more than technical information providers in the public policy process. Policy analysts perform technical analysis of physical design, economic analysis for benefits and costs, and even do broader levels of social and political analysis. Their major role in the decision process would be to produce more accurate and relevant information and deliver it to their clients. However, policy analysis has other aspects. Dror (1967) emphasizes that the technical aspect of the analysts' role is only a partial one and he insists policy analysts as a new profession should have to place their role in the government, operating within the political and organizational settings. Meltsner (1976) indicates that policy advise of analysts should be more sharply centered on political success and help decision-makers understand the dimensions of a problem and to map actors in a problem situation and its solution. Such an advisory role of policy analysts cannot be achieved solely by delivering technical information. We also have experienced that analysts become more diversified and are organized into political institutions over the last decades. Ideological distribution of research groups range from conservative to liberal and research institutes draw different political and financial support from different political groups. So, policy analysis cannot remain in the realm of technical analysis. (Rich 2004: 230-231). To balance demands on technical information and political interpretation, analysts need to take a judgmental step.

Second, the multidimensionality of policy problems requires policy analysts to integrate information. Public investment is not a unidimensional problem decided by a single number. As shown in Appendix C, policy analysts in public investment have considered many factors supported or required by their clients and other related interest groups. When they deal with such a multi-criteria problem, they might provide information of each dimension in a parallel way without interpretation. This approach, however, has serious defects. Most of all, information users do not know which factor is more important than other factors. Policy analysts could not help to answer the question. The quality of information is also low. When analysts deliver information without interpretation, they will fail to deliver contextual information, their insight and integrative information, which is useful to bureaucrats or politicians.

Third, practically and theoretically, it is highly unrealistic to separate information and interpretation. Analysts' perceptions of public investment affect their choice of methodologies, collecting data, and analysis process. Like other policy problems, public investment problem is not well-defined enough to let analysts find a solution directly without interpretation of the problem. Problem definition cannot be separated from problem solving. So, it is essential to know how analysts frame public investment problems because it affects analysis per se. At the same time, as Habermas insists (Habermas. 1984:10), unlike positivism, the validation of claim is a result of communicative rationality. No information is objective enough to bring out a consensus. So, analysts' judgments are inevitably used when they try to communicate with their clients.

When we acknowledge the importance of analysts' judgments, we can draw a more holistic policy analysis process framework as follow: problem, analysis, and judgment domain.

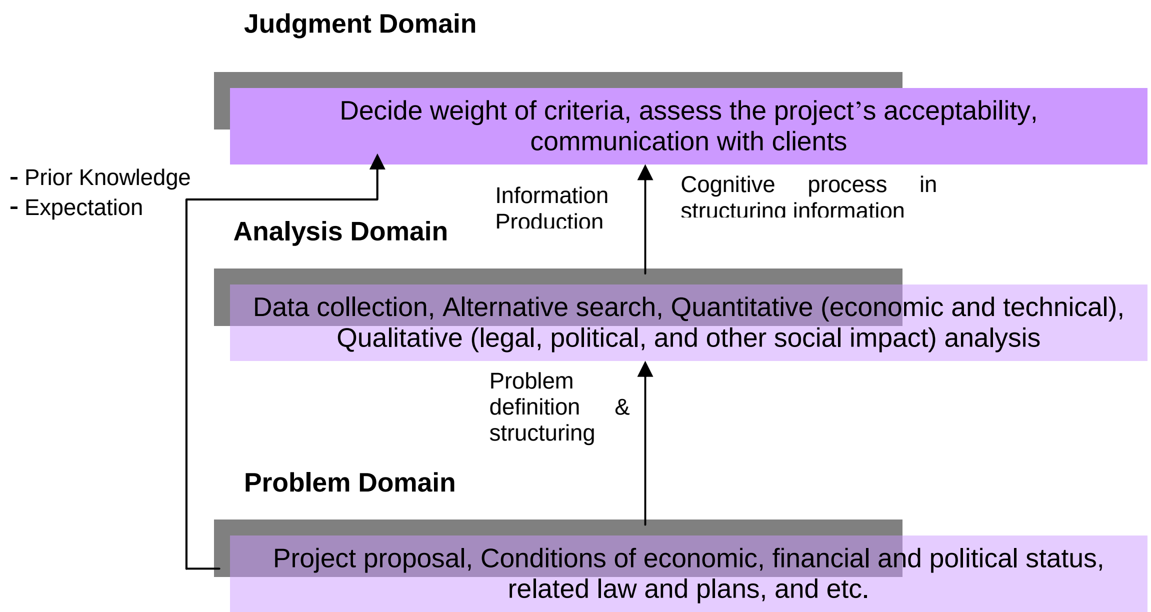

Figure 4 Integrative Policy Analysis Process

Problem domain includes a given investment project, exogenous conditions such as economic and financial status of society, the related laws and plans, and political contexts. As public decisions often have to deal with ill-structured problems, analysts have to take problem definition and structuring steps. Analysts have to decide how to set up the boundary of analysis, and the inclusion and exclusion of related policy issues. In practice, project initiators and decision makers frame each investment project differently according to the way of emphasizing different aspects of projects(Dickey. 1975; Kim, et al. 2000; U.S. GAO. 2004; WDOT. 2004). So, before starting analysis, analysts need to capture the possible problem domains intended by their clients and define the boundary of analysis.

Analysis domain is to collect data, alternative searching, and detail analysis based on available methods. Even if benefit cost analysis, environmental impact analysis, social impact analysis, and other analytical methods have been developed during the last decades, information produced in analysis domain has a large amount of uncertainty and subjectivity.

In the judgment domain, analysts put a weight on criteria, assess project acceptability and communicate their judgment to their clients. As each analyst has his/her own expert field, we can expect their judgment will not be the same. Even after analysts get information through various methods, each analyst does not necessarily interpret it in the same way. Or they may rely more on their intuition than on analytical information. If analysts are active interpreters of policy problems, the heterogeneous interpretation of analysis becomes more important in the investment decision.

Decision-making theories lend insights about how experts make a decision. Mintzberg et al. provided empirical evidence that judgment was frequently used, but bargaining was limited to situations that required the support of powerful stakeholders (Mintzberg, et al. 1976). Also Paul Nutt (Nutt. 1984) with 78 decisions cases reported that most (93%) of decisions applied *judgment*, "applying their intuition to select among courses of action without explaining their reasoning or rationale", while only four percent used bargaining and three percent used the analytical approach in making a decision. Nutt performed another study with 317 strategic decisions and reports that analytical approaches played more of a role (34%) than the former research showed, but still bargaining approach explains fairly few(6%) (Nutt. 1998:1154). The finding implies that the judgment and analytical approaches are not necessarily mutually exclusive. Edward Rhodes (1994) analyzed the U.S. Navy's decisions on budgets, ship construction programs, and annual changes of fleet compositions over 40 years from 1950 to 1990. He concludes that the predictive power of the bureaucratic politics model is limited and that the actual name of the game is not politics (bargaining), but the competition of ideas for intellectual hegemony (Rhodes. 1994:41). The analytic information can be placed at the center of competition of ideas. Although those studies usually focus on the high level decision makers, they agree that individual "judgment" is more influential in decision-making than bargaining. In addition, even if judgment seems to be made with intuition and without explicit explanation, the judgment usually adopts a significant amount of analytical information (Nutt, 1998).

Analysts' judgments have their own unique feature compared with those of politicians and bureaucrats. The intention of policy has to be interpreted by policy analysts because policy is not self-evident and its goal is not always clear. Their interpretations can be biased toward their clients (George. 1980), their discipline (Wildavsky. 1979), or social interests. Some studies raise the possibility of different judgment patterns. For instance, As policy analysis is the result of personal, professional, political, and institutional interests (Meltsner. 1976), we can expect analysts' judgment will not be the same. In addition, analysts have different lenses in interpreting problems according to their expertise. Steven Rhoads, for instance, insists (Rhoads. 1985:815):

"Economists see themselves not as promoting **their** values but representing everyone's values. They seek to allocate scarce resources not according to **their** preference but rather according to individuals' preferences more generally".

Engineers have been depicted as more value neutral and narrow. Although engineers affect rationalizing on the development of public services from water and roadways to other infrastructures, their professional perspective is too narrow to consider the human and social welfare (Schott. 1978:130-131). Engineers are faithful to their organizations and less political than economists (Perrucci and Gerstl. 1969:118-119; Schott. 1978:127). Economists may prefer the low-cost solution but engineers may emphasize the size of effect (Ferguson. 2001:63). In the 1960s and the 1970s, highway engineers were able to plan and construct new highway in relatively "cookie-cutter fashion" confident in a set of technical decision criteria developed by members of their own profession in the U.S. (Altshuler and Luberoff. 2003:221-222). Ever since, they have had to satisfy a myriad of environmental, housing, regional development, historic preservation, and citizen participation while demonstrating that the investment project is politically acceptable by causing less resistance from project opponents. In Korea until the late 1990s, engineers were heavily involved in public investment from planning to implementation. The major role of engineers was to provide technical information about costs and design rather than to redefine goals of projects. However, the growing demands of rigorous economic analysis make economists actively involved in investment analysis. Policy analysts are not all alike entity. Their different professional backgrounds will affect how to frame public investment. Economists may regard public investment as a tool for economic efficiency and engineers may emphasize the physical efficiency. If the difference is significantly large, it will be important to balance the research group after considering professional backgrounds. Also the training of policy analysts has to pay attention to the ways providing more chance to be exposed to other disciplines to increase the mutual understanding.

On the other hand, the difference may not be large because policy analysts have experience working with others having different professional backgrounds. Analysts in public investment interact with bureaucrats, politicians, and other interests group. They are not substantive experts who are interested in increasing and enlarging the scope of knowledge by developing techniques, procedures, and conceptual scheme. They usually aim for the efficient means of obtaining practical results. Their professional background can be blurred through interactions to experts in other disciplines. If this is true, we can find a possibility to build up a general decision model applicable to all public investments, which will help us to make consistent public investment decision-makings.

Project fields also affect the analysts' judgments. The practitioners in public investment often argue that each investment sector such as road, rail, water system, or public buildings have their own unique features. Although many analysts agree that economic efficiency is important regardless of investment sectors, for instance, they may have different preference on the economic efficiency when they make a judgment on their own projects. Because, in many situations, decision makers of the budget agency and the Congress have to choose a limited number of investment projects among different types of projects, it is very useful to know how analysts in each project field interpret the same criteria differently and what kinds of project specific criteria are used in each project field.

The degree of responsibility for decisions can affect analysts' judgments. Analysts cannot be free from the responsibility of their decision. The failure of their decision frequently draws the attention of mass media, the public, and politicians. The more analysts are exposed to high probability of responsibility to their decisions, the more they want to be conservative. Among analysts, some analysts who have to take more responsibility than others will show different behaviors. To avoid legal responsibility, they may want to rely on more objective information rather than subjective information.

We can explicitly observe those three variables-professional background, project fields, and role in analysis- and can examine their influence on analysts' judgment behaviors. However, we also think about other implicit factors affecting to analysts' judgment. We can interpret the judgment of analysts as a result of self-interest. Analysts can make more room for discretion and judge the acceptability of projects to maximize their interests. Sometimes, they may make decisions considering the strategic situation between bureaucrats and themselves. Some studies (Flyvbjerg, et al. 2002; Merrow, et al. 1979; Mott MacDonald. 2002) argue that analysts intentionally underestimate costs to make projects accepted, which is called “optimism bias”. In that case, we may interpret optimism bias is a result of strategic behaviors of analysts to meet their clients’ need. Or other different assumptions on the driving force of decisions such as personal characteristics and psychological reasoning patterns, would lead to different analysts’ judgment.

Although we suppose many possible factors affecting analysts’ behaviors, literatures in public investment have understudied the behaviors of policy analysts. Studies(Dickey. 1975; Forkenbrock, et al. 2001; U.S. GAO. 2004:14) have pointed that multiple methods and factors are used in public investment decisions. However, they did not give any empirical evidence about how much weight is given to each criterion used by policy analysts. They have discussed the information used in decision-making, but did not talk about: what the relative importance between different information is or how analysts interpret it.

To fill the knowledge gap, I try to understand how policy analysts actually make decisions. I mainly focus on two basic judgments: weighting and scoring. Weighting is a judgment about the relative importance among criteria used in decisions. Scoring is a judgment about the project’s desirability by each factor. I assume that problem definition and policy analysis result is shared among analysts within a project. So, this study concentrates on judgment domain of decision-making after controlling for problem definition and analysis. The data explained in the next chapter are collected by actual major public investment projects and contain analysts’ revealed preference on weighting and scoring.

3.0 RESEARCH DESIGNS

3.1 RESEARCH SCOPE

The main goal of this research is to expand our understanding of analysts' judgment. Mainly I focus on public investment decision in this dissertation. "Public investment" is an activity of a public sector increasing and improving the stock of capital employed in the production of the goods and services. In a broader sense, public investment can include a various type of the purchase or construction of capital goods. In national account statistics, investment is defined as expenditures in fixed assets that last for more than one year. The investment account includes not only physical assets but also intangible assets like patents or software[16]. In a narrow sense, public investment usually means the construction of public infrastructure (roads, water systems, bridges, airport railways, etc). Public investment studied in this study is a more narrow sense. This study covers only "major"[17] highway, railway, airport, dam and other construction projects that request the central government's budget in Korea.

Among multiple stages of public investment decision, this study mainly focuses on budgeting rather than the planning stage. Analysis in the budgeting stage is not just a brief overview of proposed proposals in Korea. As explained in Section 2.1 and 2.2, the Korean government requires intensive policy analyses in budgeting stages and MPB (Ministry of Plan

[16] OECD Economic Outlook reports provide Total Gross Fixed Capital Formation tables. It can be used for measuring the change of public investments of each country.

[17] Again, "major" projects used in this research are those requiring more than 50 million dollars.

and Budgeting) launched the pre-feasibility studies (PFS) for reviewing major public investment projects. Because of the importance of analysis at the budgeting stage, MPB (Ministry of Plan and Budgeting) demands not only a benefit cost analysis, but also an analysis of many policy factors such as relevancy to related policy, regional development, environmental impact and etc. So, analysts' judgment deals with more than technical information. So, PFS provides comprehensive and intensive policy analyses for decision-making in budgeting.

The unit of observation is each analyst who took part in PFSs on 148 projects performed by KDI from 2001 to 2004. As shown in Table 9, analysts are classified into four groups according to their affiliation: KDI, university, private company, and government-funded research institute. Analysts or their affiliated organizations have an experience in doing policy analysis for government's public investment at least more than once before they do in pre-feasibility study (PFS). Although it is hard to precisely evaluate the degree of representativeness of sampled analysts to population analysts in Korea, it has been regarded that they represent major analysts who work with the Korean government.

While analysts have to make judgments in every phase of policy analysis, I mainly focus on judgments on deciding relative importance between criteria (weighting) and assessing the project acceptability (scoring), which enable us to understand analysts' perceptions to public investment projects and their interpretation of analytical information for a project choice.

3.2 RESEARCH HYPOTHESES

Because of the lack of studies on analysts' judgments, it is hard to answer the basic questions such as how much weight is given to economic efficiency compared to other policy factors. To fill the knowledge gap, I performed descriptive analyses to get information on the distribution of weighting and scoring, the degree of variations between analysts and project fields, and influence of analysts' roles in analysis and their affiliation on their judgment. In the explanatory analyses, I try to test whether the analysts' judgments are the result of their self-interests, psychological features, or strategic decision. More detail research hypotheses are as follows.

3.2.1 Descriptive Analyses

The main purpose of this research is not to discuss the normative behaviors of policy analysts, i.e. how analysts should make a decision. Instead, I analyze how analysts actually interpret information they have. For this purpose, the basic step for analysis is to figure out the patterns of analysts' judgments. As shown in Chapter 4, the basic decision hierarchy of PFS consists of three levels. In the descriptive analyses, I examine how analysts actually do weighting and scoring on given criteria. I mainly focus on the following problems.

First, I examine whether analysts give more weight to economic efficiency than to other policy factors. The basic decision hierarchy shown in Figure 6 implies that analysts have to consider both economic efficiency and other policy factors in their judgment. Many politicians had argued that public investment decisions failed to consider regional equity or development (National Assembly Administration Committee. 2003; National Assembly Construction and Transportion Committee. 2004). Line ministries or local governments argued that economic efficiency measured by benefit cost analysis frequently fails to capture positive externalities and spill-over effects. Also the public perception of policy analysts is that they prefer quantifiable economic efficiency to qualitative policy factors. Despite these criticisms, line ministries or local governments did not clearly state the weight between economic efficiency and policy factors.

The Korean government manual guiding the transportation investment (Korea MOCT. 2002) suggests assigning a 61% weight on economic efficiency but it gives no rationale. Theoretically, the weighting on economic efficiency and other policy factors is useful in inferring how analysts frame public investment problem. So, we need to examine whether policy analysts give more weight to economic efficiency than to other policy factors, as people seem to think.

Second, I examine the relative importance of basic policy factors compared to project-specific factors. When KDI constructed the decision hierarchy shown in Figure 6, it assumed that six basic policy factors can cover major policy issues in evaluating investment projects. MPB also supported using basic policy factors because it believed that using the same policy factors can prevent the arbitrary inclusion or exclusion of criteria in the decision model. So, in the KDI AHP model, all projects have to include basic policy factors for their decision. However, not a few number of project-specific factors need to be considered in the actual decision. If analysts give minor weight on project-specific factors, we are able to use standardized policy factors for decisions. In contrast, if project-specific factors are more important than basic policy factors, we need to rethink the assumption that basic policy factors cover major policy issues.

Third, the weight distribution among basic policy factors can provide useful information. It enables us to detect extraordinary emphasis on a certain criterion. For the Korean government, the underdevelopment of regions has been an important policy issue. Because the Korean government had adopted an unbalanced economic development plan until the 1980s, some regions suffered from the lack of infrastructure. So, regional equity is frequently cited as an important decision criterion. In other contexts, the importance of related plans or laws is emphasized. Many local governments make their own investment plans which are not consistent with national plans. Even within the executive, when each project is independently planned by different agencies, the risk of duplicated investment increases. So, some people emphasize the relatedness of projects. The weight on basic policy factors will be different according to project fields. In the case of harbor projects, the location of harbor is highly related to geographic factor rather than the backwardness of regions. Or dam projects would emphasize environment impact more than other projects. So, I examine how analysts give weight on each basic policy factor.

Fourth, I examine the variation of weighting among analysts. Policy analysts participating in PFS are experts who have much experience in public investment. We might expect they would be more likely to form a consensus than other non-expert groups would be. However, analysts are not a monolithic entity, but have different expertise, experiences and self-interests, which might lead to large variation in judgments among analysts in weighting criteria. If we can find evidence that the degree of variation is low, we may use the weight as standard value.

Fifth, I test whether the weight according to criteria is affected by project fields, analysts' affiliation, and their role in analysis. One difficulty in public investment decisions is how to consider the difference of project fields. As the competition among project fields to get more budgets is common, a government may want to compare them using the same criteria. For instance, to evaluate the road construction project A and the dam construction project B, we might use the same weight to economic efficiency. However, such an approach would encounter criticisms when there is a significant difference of weight by project fields. The weight on criteria would be affected by analysts' characteristics.

The affiliation of analysts is a useful variable in assessing professional backgrounds and degree of self-interests. Because of multidimensionality of public investment, KDI tries to invite analysts from private companies, universities, or government-funded research institutes. In general, analysts from private companies are engineers. Similar to private analysts, analysts from universities have engineering background and have a specialty in the technical aspect in design, construction and estimation of demand. In contrast, KDI analysts are economists and have specialty in economic analysis. Analysts coming from government-funded research institutes have specialty in each project field but their professional background is more diverse than KDI. They usually understand the policy process within government, but frequently represent the interests of line ministries and project initiators. The difference of professional backgrounds may affect decision makers' judgments significantly. Engineers have difficulty interpreting economic methodologies, while economists usually fail to understand how different traffic modes are interconnected and how they affect the effectiveness of the whole system.

Analysts' roles in analysis may affect their weighting. The principal investigator and the KDI director have more responsibility to MPB and politicians. As PFS is used for the budget allocation of MPB or congressional reviews, analysis results are reviewed by other organizations. It is not rare that principal investigators are called to attend congressional hearing or get investigated by oversight agencies when their projects fail to meet the original expectation. Such pressures encourage principal investigators to make risk-averse decisions. They will be more conservative to the projects which are more likely to be exposed to political responsibility. In that situation, they may put more emphasis on economic efficiency to minimize their responsibility.

We can perform descriptive analyses on scoring behaviors as we do on weighting. In scoring, the variation of scoring within a project is important. Policy analysts in the same project will use the same information to assess the project acceptability. Under the value-neutral and objective interpretation assumption, we may expect to see smaller variation in scoring among analysts. In contrast, the variation will be large when analysts interpret given information subjectively.

3.2.2 Test of Self-Interest Hypothesis

One critical problem in public decision-making is the risk of replacing social interest with the self-interest of decision makers. When social interest is not consistent to the self-interest of decision makers, it is probable that analysts try to maximize one's self-interest. For instance, if one analyst has large returns when a project is accepted, they would overemphasize the desirability of the project than the actual one. Of course, some analysts who highly commit themselves to societal value would not be biased toward their self-interest, but try to make judgment more neutral. As judgment is somewhat subjective, it is important to analyze whether the subjective judgment is a result of decision makers' self-interests. If we find the opportunistic judgment behaviors in which they try to distort their judgment to maximize their self-interest, a question that quickly comes to mind is: how to manage it in the decision process. So, I construct various hypotheses to test whether the self-interest model can explain analysts' judgments, and discuss managerial tools for controlling biased judgments[18].

H1: Analysts have a tendency to underreport the size of costs.

One widely discussed negative effect of self-interested analysts' behavior is "optimism bias" which have been reported by many studies (Flyvbjerg, et al. 2002; Mott MacDonald. 2002; UK HM Treasury. 2003). Studies insist that analysts underreport costs making a project accepted

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[18] The concept of biased judgments is entirely relative and implies no moral disapproval.

because it meets their clients' interests. Such deceptive cost estimation intrinsically assumes that the self-interest of analysts is related to interests of clients who want to have their project accepted. If the cost underestimation is a result of analyst's deceptive behavior, the cost underestimation is more likely to be found in various project fields. Also, if the cost underestimation is the result of analyst's self-interest maximization, analysts will less likely to underestimate the cost when a project has a smaller return. Finally, analysts will have a smaller incentive of doing the deceptive cost estimation if a project is more likely to be accepted. To retest the optimism bias, I analyze: i) whether the systematic cost underestimation is observed in different project fields, ii) whether the degree of cost underestimation is associated with the size of potential return, iii) whether the degree of cost underestimation is related to project acceptability.

H2: The direction of scoring – optimistic or pessimistic scoring – is correlated to analysts' self-interest.

Among analysts, some analysts will be better off when projects are accepted. For instance, analysts from private companies prefer to accept projects because they will have a chance to participate in project implementation. In contrast, analysts from KDI would be reluctant to accept projects because their client, MPB (Ministry of Planning and Budget) is focused on budget expenditure. Scoring of analysts would reflect the difference of self-interests, So, I test whether the scoring direction is clear according to analysts' interests.

H3: The low probability of project acceptance increases the degree of biased scoring.

The strategic behaviors of analysts can be asymmetric depending on the project's acceptability. If a project has a high probability of approval, KDI analysts or private analysts will have little reason to do biased scoring[19]. In contrast, when a project has low probability of being accepted, analysts' incentive to do biased scoring is large. According to the conjecture, I test whether the biased scoring is affected by the probability of project acceptance.

H4: To criteria using quantitative information for their scoring, analysts show weaker intentional bias.

In scoring, pre-feasibility studies produce and use quantitative information for criteria such as economic efficiency, backwardness of the region, and regional economic development. Quantitative information is more easily observed by other consumers of policy analysis than qualitative information. As quantitative information is known to others, analysts would be less likely to do biased scoring.

H5: If analysts show psychological biases such as the status quo bias and loss aversion, then, instead of following the self-interest model, they will have steeper marginal change of score as net cost increase than as net benefit increase.

Although self-interest is a strong driving force of human being's judgment, judgment can be affected by psychological patterns. As discussed in Appendix E, experimental psychology theory suggests that status quo bias and loss aversion behavior are frequently observed in decision-making. If a person's reference point is a project acceptance, he would overweight the status close to his reference point because of status quo bias. Also, for they try to avoid the loss

[19] For private analysts, the acceptance of project is consistent to their interests. For KDI analysts, their goal is to reject projects less desirable rather than to reject highly desirable projects.

from the project reject, they will show asymmetric attitude toward gain (project accept) and loss (project reject). If the theory holds, we will expect that analysts will respond more to changes in perceived costs than to changes in benefits. It will cause the asymmetric and non-linear relationship between scoring and net benefits. So, I test whether this pattern is observed in scoring economic efficiency.

H6: There is a strong association between weighting and scoring.

While the self-interest oriented judgment is more likely to be observed in scoring because it is directly related to project acceptance, weighting can be also influenced by the self-interest. If analysts are highly strategic, intentional bias guided by self-interest can link weighting and scoring. Analysts who prefer to accept a project would be likely to give smaller weight on the negative criteria to project acceptance. Simply speaking, if analysts want to facilitate project acceptance, they will overweight the positive criteria and underweight the negative criteria. So, I test whether analysts strategically associate the weighting and scoring after controlling a project acceptability and project field.

H7: The revealed preference of highly self-interested analysts will have a large inconsistency ratio and low reliability.

When analysts try to manipulate their weighting and scoring to maximize their interests, their judgment would become inconsistent and unreliable. I use CR(inConsistency Ratio) (Saaty. 1980; Saaty. 1994) to assess the consistency of judgment especially in weighting. CR can measure the degree of logical consistency. To measure the reliability of scoring, I included a complementary measure when I designed KDI AHP. The measure asks analysts directly: what is their preference on the project acceptance vs. reject from the point of policy feasibility? For instance, in Table 3 in Chapter 4.0 , decision maker 1 puts a weight on policy feasibility 40% and his revealed preference on the accepting project based on the policy factors is 0.297 shown in the Table 7. So the ratio (Accept/Reject) of policy factors will be (2.88=0.297/0.103). In contrast, if decision maker 1 directly expresses his/her preference on accepting vs. reject project based on the scoring method, he may answer Accept: Reject=65:45 (not shown in the table 2). Then the ratio will be 1.44. By comparing the 2.88 and 1.44 we can measure the "reliability gap" to infer the reliability of responses of the analyst. If the self interest of analysts affects consistency of judgment, the revealed preference of self-interested analysts can be biased. So, based on CR and the reliability of policy feasibility scoring measure, I test whether the self-interest oriented behavior affect the degree of inconsistency and reliability of judgment.

The above hypotheses test tells us about *how much* analysts are different in judgments and whether self-interest is truly a significant explanatory variable in explaining the difference. We may want to know similarity or dissimilarity of judgment by using both analysts' revealed preferences on weighting and scoring in an integrative manner. In this case, the research question will be: if analysts' judgments are different, in which judgments are the similarity or dissimilarity among groups apparent? For instance, the difference among analysts may be clearly shown in the scoring than weighting because of the conflicting self-interests. Or, the difference would be clearly observed in both weighting and scoring on certain criteria. I perform discriminant analysis to answer the questions. Figure 5 illustrate the analytical framework to answer research question described above.

Explanatory Models

•Test of Self-Interest Model

→Systematic cost underestimation bias in proposed projects

→Relationship between positive scoring and reliability of decision

→Relationship between positive scoring and strategic weighting

→Relationship between affiliation and positive Scoring

→Benefit cost ratio and variance of economic efficiency scoring

→Psychological impact: Analyze the asymmetric judgment toward net benefits and costs

→Impact of perfect and imperfect information to scoring pattern

Descriptive Analyses

• Weighting Analyses

→Identify on which decision criteria put more weight.

→Analyze whether there are significant variance of judgment in weighting among analysts

→Analyze whether the variance can be explained by project fields, analysts' role in analysis and affiliation

•Scoring Analyses

→Analyze to which decision criteria analysts show large variation in scoring

→Analyze whether the role in analysis and affiliation explain the variation in scoring

→Analyze the relationship of variation among decision criteria

•Group Similarity and Dissimilarity Determinant Factors

→ Exploring aspects that explain the difference of analyst groups well

Figure 5 Framework of Analysis

4.0 EXPLANATION OF DATA

Although many public investment decisions are made, it is extremely hard to find detailed information about the judgments that lay behind them. In some cases, analysis reports are not open to the public. Even if we can access the reports, they usually list alternatives, fact-findings, benefits, costs, and provide a very brief conclusion without explaining the method of integrating findings. For instance, when analysts find 100 million dollars in net benefits, the necessity to relocate 500 residents, and the risk of endangering 20 wild foxes, they report those facts but usually do not provide information about how to integrate them to reach a final decision, or to assess the degree of acceptability of the project.

To overcome the problem, as a member of Korea development Institute (KDI) which performs policy analysis on public investment projects of Korean government, I introduced Analytic Hierarchy Process (AHP) into the decision-making process. As I will mainly rely on the database in this study, we need to discuss the background and method of the data.

In Korea, since 1999, a policy analysis called pre-feasibility studies (PFS) is required for major public investment projects whose costs exceed 50 million dollars. PFS covers most of major public investments decision in the Korean government and 196 projects have been analyzed by PFS from 1999 to 2004.

Basically, KDI’s AHP consists of weighting and scoring steps. Weighting is to decide relative weight among given decision criteria through pairwise comparison (Saaty 1980). The scoring is to decide relative preference among alternatives of a project. Although AHP can consider multiple alternatives, KDI considers only two alternatives: accept and reject. The scoring is made on each criterion. For instance, a typical question in the scoring step is: with respect to economic efficiency, how much do you prefer accepting project to rejecting project? A detailed explanation of AHP and the decision-making method is provided in the following sections.

4.1 ANALYTIC HIERARCHY PROCESS AND DECISION-MAKING

4.1.1 Background of KDI's AHP model

As we discussed in previous sections and Appendix C, public investment decisions have to consider multiple factors with different types of information and uncertainty. In 1999, KDI performed experimental PFSs on 17 investment projects. KDI found that the studies produced a considerable amount of information such as: benefit cost ratio, engineering assessments on project, economic impact on regions, relevance to related laws and other plans, residents and project initiator's commitment, financial feasibility, backwardness of regions, and environmental impact. However, information was provided in a parallel way not integrated into a final decision. Typically, when a certain project is highly acceptable from the point of backwardness of regions but is less acceptable from the point of economic feasibility, analysts have difficulty providing relevant judgment whether the project should be accepted or rejected. Local governments or agencies challenged KDI's pre-feasibility studies by arguing that factors on which a project scored highly should be given greater weight. Also analysts hesitate to reveal their preferences clearly. They tend to avoid their responsibility by providing different interpretations and ambiguous conclusions.

To overcome the problem, KDI has developed the multi-criteria decision-making model. Four major factors are considered in developing the model (Park and Ko. 2000). First, judgment should be robust to the strategic judgments. For instance, if we use a simple scoring method, a decision maker who wants to accept the projects may try to give a high score strategically to maximize his interest. As AHP separates weighting and scoring steps and adopts pairwise comparison and consistency checking procedure, it was preferred to scoring method. Second, a model has to include basic factors generally considered in public investment decision and to be expandable to include the special factors of each project. It makes decision results comparable to other similar projects while also featuring the case specific situation. Third, weighting and scoring results should be explicitly reported to enhance accountability. For this reason, KDI prefers the quantified judgment rather than verbal judgment (e.g. high, medium, or low). Fourth, the method should be easy to apply and easy to interpret.

KDI reviewed several multiple criteria decision models (Park and Ko. 2000) such as: multi-attribute utility method (Keeney and Raiffa. 1976), Goal Achievement Method (Hill. 1968), Multi-Attribute Utility Theory (Von Neumann and Morgenstern. 1944), outranking method (Roy. 1991). Although those models have their own strengths, KDI (Park and Ko. 2000) chose AHP because it has a strong theoretical foundation, is easy to apply, flexible in including additional factors, and supports group decision-making.

4.1.2 Theoretical Background of AHP

AHP was developed to help people making decision on problems having multiple criteria where both qualitative and quantitative aspects of a decision have to be considered. Thomas Saaty (1980) built up theoretical foundations of AHP and the method has been used from infrastructure investment to business decisions. AHP assumes that we can decompose a problem into a hierarchy of criteria. George A. Miller (Miller. 1967) notes that human being cannot process information simultaneously more than seven plus and minus two. He insists "the span of absolute judgment and the span of immediate memory impose severe limitations on the amount of information that we are able to receive, process, and remember". Saaty insists that decision-making should consider this psychological limitation. Multi-criteria decision problem need to be decomposed into hierarchical structure and analyzed in a systematic way. The decision model also has to respect the psychological limitations of human beings (Saaty. 1980; Simon. 1996). Once we construct the decision hierarchy, a decision is made with following steps: problem identification, constructing decision hierarchy, weighting criteria and scoring alternatives based on the weight.

1. *Problem identification*: This step is to understand the problem at hand, identify the decision makers, specify the objectives and alternatives, and determine which information is directly or indirectly related or associated with the decision.
2. *Construction of decision hierarchy*: In this step, decision makers structure the ultimate goal, define objectives that relate to the goal, determine criteria needed for the assessment of the objective and finally measure the desirability of alternatives by each criterion. The goal is placed at the top level of the hierarchy, and the objectives are placed at Level 1, the criteria at Level 2, sub-criteria measured with specific information at Level 3 and the alternatives are placed at the bottom of the hierarchy (Level 4).

3. *Weighting*: This process is to compare the relative importance of the criteria in a systematic and quantitative manner. Let's assume that there are n criteria, then we represent their n dimensional weight vector as:

$$\mathbf{w} = (w_1,..., w_n) \text{ , where } w_i \text{ is a weight of the criterion } c_i$$

We might directly ask the weight of each criterion c_i. However, such a direct weighting method cannot control the inconsistency or voting manipulation. Instead, AHP adopts a pairwise comparison of the criteria. For instance, a decision maker is asked to compare the relative importance of criterion i as compared to criterion j. The relative importance will be w_i/w_j. From the pairwise comparison, we can get a pairwise comparison matrix A having the form shown below:

$$A = \begin{bmatrix} w_1/w_1 & w_1/w_2 & w_1/w_3 & \dots & w_1/w_n \\ w_2/w_1 & w_2/w_2 & w_2/w_3 & \dots & . \\ w_3/w_1 & . & w_3/w_3 & \dots & . \\ \vdots & . & . & \dots & . \\ w_n/w_1 & . & . & \dots & w_n/w_n \end{bmatrix}$$

Axiom 1 : Reciprocity of relative weight

If a criterion i is preferred to j as much as w_i/w_j, then j is preferred to i as much as w_j/w_i.

According to the Axiom 1, the elements of the matrix A have a special property $a_{ij} = 1/a_{ji}$ for all i and j , from which follows that the diagonal elements are unity and the upper-right and lower-left triangular blocks are reciprocal. Traditional AHP uses 9 point scale to express for the pairwise comparison, which is shown in Table 1. A typical question type, for example, is:

Between economic efficiency and policy factor, which one do you prefer more? If an analyst strongly prefers economic efficiency to policy factor, he will check box 5 as shown below.

Criteria																		Criteria
Economic efficiency	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Policy factor

Table 1 9 Point Scale Used In AHP and Its Semantic Meaning

Value	Preference
1	Equally Preferred
2	Equally to Moderately Preferred
3	Moderately Preferred
4	Moderately to Strongly Preferred
5	Strongly Preferred
6	Strongly to Very Strongly Preferred
7	Very Strongly Preferred
8	Very Strongly to Extremely Preferred
9	Extremely Preferred

4. *Calculation of weight vector*: Based on the pairwise comparison matrix A, calculate the weight vector *w* in the following way.

$Aw=\lambda_{max}w$,

where λ_{max} is the maximum eigenvalue of the matrix. In an algebraic expression,

$$w_i = \frac{\sum_{j=1} a_{ij} w_j}{\lambda_{\max}}$$

In practical terms, the computation of the principal right eigenvector can be accomplished by estimating the limit that follows:

$$w = \lim_{k\to\infty}(\frac{A^k e)}{e^T A^k e)} \text{ where } e=(1,1,\ldots,1)$$

5. *Consistency Test:* Once we get a weight vector *w*, it is necessary to check if the preferences that are contained in the matrices are consistent. For the consistency test, AHP introduces transitivity axiom.

Axiom 2: Transitivity

If a criterion *i* is preferred to *j* by *n* times and a criterion *j* is preferred to k by *m* times, then *i* should be preferred to *k* by *nm* times.

Such a cardinal consistency in the strength of preference measures whether the intensity of preference is expressed consistently to the transitivity axiom. For example, if Criterion *i* is twice as preferable as Criterion *j* and Criterion *j* is three times as preferable as Criterion *k*, then Criterion *i* must be six times as preferable as Criterion *k*.

A measure of consistency proposed in AHP is the Consistency Ratio (CR) that is defined as follows:

$$CR = \frac{CI}{RI}$$

Here, CI stands for Consistency Index measuring the deviation from the perfectly consistent response. It is defined as:

$$CI = \frac{\lambda_{\max} - n}{n - 1}$$

RI stands for Random Index that is the CI of random pairwise comparison matrix. Saaty provides RI table according to different dimension of pairwise matrix. If CR is greater than 0.1, then the pairwise comparisons provided by the expert are not consistent and therefore they should be reconsidered. Theoretically, the 0.1 criteria as an acceptance level of consistency is a little bit problematic (Ko and Lee. 2001). But it is very useful in controlling voting manipulations and increases the consistency of decision.

6. *Scoring and Judgment*: Scoring is to assess a relative preference among alternatives through a pairwise comparison by a given criterion. Synthesis is to decide overall priorities for all the elements of the hierarchy. The synthesis is accomplished by summing priorities under a criterion c times the weight of criterion c. The overall preference of alternative a, w_a, is calculated as:

$w_a = \sum_{c \in C} w^c v_a$, where w^c are overall priorities of criteria c and v_a are the weights that have been calculated for alternative α under criterion c.

There are several ways in integrating individual judgment into group judgments (Park and Ko. 2001; Saaty. 1980; Saaty. 1996) but KDI uses the geometric mean approach, which construct a group pairwise comparison by calculating geometric mean of individual judgments.

4.1.3 Example of AHP Application

The actual example used by KDI will help us understand the application of AHP in PFS. Pre-feasibility studies performed by KDI should include AHP results in their reports. To avoid the arbitrary use of AHP model, KDI developed manuals for AHP (Park and Ko. 2000; Park and Ko. 2001). The AHP application process of KDI is as follows.

1. *Decision Makers and Problem identifications*: To perform more objective studies, KDI recommends including various research groups having different academic disciplines and expertise in PFS. Economists in KDI, engineering companies in private companies, professors at universities, certified accountants, and other government funded research

institutes having expertise in each project take part in PFS. In general, a study is performed by three research groups and each group's principal investigator participate final decisions. Also, the pre-feasibility study director of KDI joins the decision. Thus, at the final decision-making, four experts participate for AHP decision-making process. KDI provides manuals for PFS on several fields: highway, harbour, airport, water systems, and cultural and industry complex investment, and asks each group to follow the guideline. When a group does not want to follow the guidelines, they have to provide acceptable reasons or evidence to KDI. As a result, analysis methods and process are pretty consistent.

2. *Construction of Decision Hierarchy*: the decision support team of KDI provides a basic decision hierarchy, which is shown in the following figure. At the second level, economic efficiency and policy factor are located. The economic efficiency is mainly related to the results of benefit cost analysis. Policy factors consist of two major subcategories-basic policy factors and project-specific factors- which consist of the third level of hierarchy. The basic policy factors consist of six detail policy factors and they are required to be used in all projects. In contrast, project-specific factors are flexibly included reflecting each project's unique situations. Figure 6 shows the decision hierarchy used in pre-feasibility study.

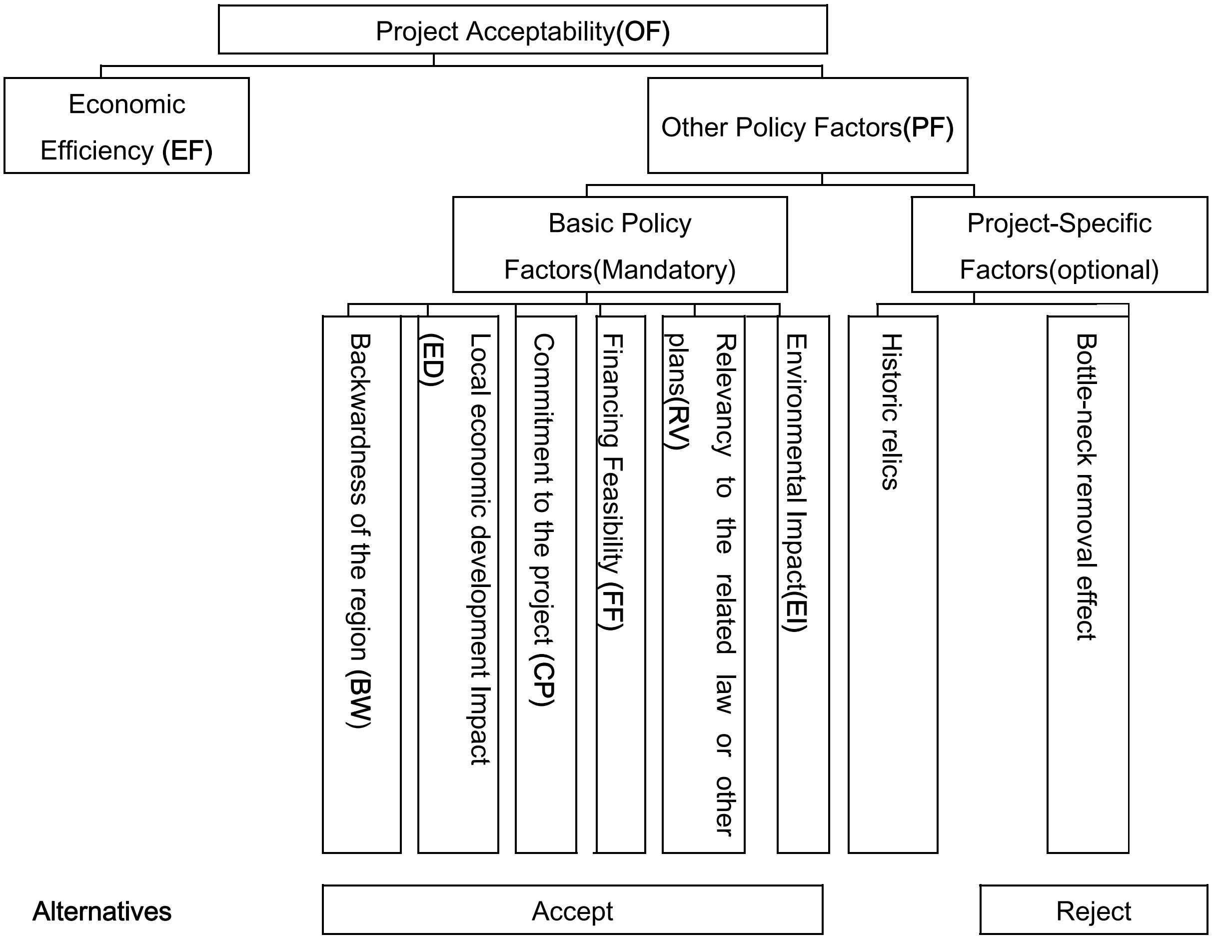

Figure 6 Basic Decision Hierarchy of Pre-Feasibility Study

KDI's criteria used in investment decision-making covers most of the major factors used by other countries. The contents and information used for judgment is shown in the table below.

Table 2 Contents and Information Used in Scoring

Scoring Criteria	Scoring Contents	Information
Economic Efficiency	The project acceptability from the point of economic efficiency	B/C ratio and other information from benefit cost analysis
Basic Policy Factors		
Backwardness (BW)	The project acceptability from the point of equity among regions	Underdevelopment Index

Regional Econ. Impact(ED)	The project acceptability from the point of the size of economic development of project area	$\frac{Size \quad of \quad Value \quad Added}{Gross \quad \mathrm{Re}gional \quad Domestic \quad \mathrm{Pr}oduct}$
Commitment (CP)	The project acceptability from the point of commitment of agencies submitting project proposals and the willingness of residents	Qualitative Information
Financial Feasibility (FF)	The project acceptability from the point of adequacy of government intervention, the priority of spending, and the possibility of funding from others sources	Qualitative Information
Relatedness (RV)	The project acceptability from the point of the relevancy to related laws, plans and policies	Qualitative Information
Environment(EI)	The project acceptability from the point of environmental impact and the possibility of residents' protest	Qualitative Information

Source: Park & Ko (2001).

The DS (decision support) team discusses the appropriateness of the basic decision hierarchy with a principal investigator of each project and asks whether they want to include special factors in it[20]. Once they agree on the decision factors, the DS team asks the principal investigator to clarify the meaning of each decision criterion. Also, the principal investigator has to provide the values of the benefit cost ratio[21], the backwardness of the regions[22], and local economic development impact measure[23] to provide more accurate information to decision

[20] The principal investigator should have to justify when he/she does not include the basic decision factors.
[21] It is not rare that the BC ratio changes as a study goes on because of new findings, assumption change, or unexpected problems. So, principal investigators have to provide final BC ratio they will use for decision.
[22] PIMA develops the index for backwardness of the regions at the county and local government level. KDI recommends using this index for the judgment of the backwardness of region (Park & Ko 2000).
[23] PIMA also develops MRIO (Multi-Regional Input Output) model for assessing regional economic impacts. It recommends to apply the quantitative information for the judgment of regional economic impact.

makers of their projects. After taking these steps, KDI DS team provides questionnaires for AHP and four decision makers of each project submit their questionnaires to the DS team.

3. *Weighting*: each decision maker performs pairwise comparison to decide a relative importance among criteria. As shown in the below table, decision maker 1 weights economic efficiency 60% and policy efficiency 40%. Also decision maker 2 very strongly prefers, i.e. prefers 7 times a criterion BW to CP. The negative integer implies the right side criterion is preferred to left side. For instance, Decision maker 4 prefers ED 3 times to BW.

Table 3 Weighting Results of Four Decision Makers

	DM1	**DM2**	**DM3**	**DM4**	
Level 1					
Economic Efficiency	6:4	4:6	4:6	6.5:3.5	Policy Factor
Level 2					
Backwardness(BW)	3	1	-7	-3	Regional Econ. Impact(ED)
Backwardness(BW)	3	7	1	1	Commitment (CP)
Backwardness(BW)	5	-7	5	-4	Financial Feasibility (FF)
Backwardness(BW)	-3	-7	5	-4	Relatedness (RV)
Backwardness(BW)	3	7	5	-7	Environment(EI)
Regional Econ. Impact(ED)	4	1	5	3	Commitment (CP)
Regional Econ. Impact(ED)	4	-7	5	-2	Financial Feasibility (FF)
Regional Econ. Impact(ED)	-3	-7	5	-2	Relatedness (RV)
Regional Econ. Impact(ED)	3	7	3	-5	Environment(EI)
Commitment (CP)	2	-7	5	-4	Financial Feasibility (FF)
Commitment (CP)	-4	-7	3	-4	Relatedness (RV)
Commitment (CP)	2	2	3	-7	Environment(EI)
Financial Feasibility (FF)	-4	2	1	1	Relatedness (RV)
Financial Feasibility (FF)	-2	7	1	-4	Environment(EI)
Relatedness (RV)	4	7	-3	-4	Environment(EI)

From the above response results, we can get individual's pairwise matrix A of level 2. For instance, the pairwise comparison matrix of Decision Maker 1 will be:

Table 4 Pairwise comparison matrix of decision maker 1

	Backwardness (BW)	Regional Econ. Impact(ED)	Commitment (CP)	Financial Feasibility (FF)	Relatedness (RV)	Environment(EI)
BW	1	3	3	5	0.33	3
ED	0.33	1	4	4	0.33	3
CP	0.33	0.25	1	2	0.25	2
FF	0.2	0.25	0.5	1	0.25	0.5
RV	3	3	4	4	1	4
EI	0.33	0.33	0.5	2	0.25	1

4. *Calculation of weight vector*: we can get eigenvector of maximum eigenvalue by solving a characteristic equations $Aw=\lambda_{max}w$, where λ_{max} is the maximum eigenvalue and w is weight vector. After normalizing the eigenvector with the constraint, $\sum_{i=1}^{n} w_i = 1$, we can get weight vector of criteria. In case of our example decision maker 1 gives weights among criteria as:

Table 5 Weight Vector of Decision Maker 1

Criteria	Weight(w_i)	Overall Weight
Backwardness (BW)	0.25	0.100
Regional Econ. Impact(ED)	0.17	0.068
Commitment (CP)	0.08	0.032
Financial Feasibility (FF)	0.05	0.020
Relatedness (RV)	0.38	0.152
Environment(EI)	0.07	0.028

As the weight vector is for level 2 hierarchy, we can get overall weight of each category by multiplying high level weight to the vector. For instance, decision maker 1 gives a weight on the policy feasibility to 0.4, we could get the overall weight by $0.4*w_i$.

5. *Consistency Test*: The consistency ratio can be calculated easily by using eigenvector. Under the perfect consistency satisfying Axiom 1 and Axiom 2, the maximum eigenvalue of a pairwise comparison matrix will be n. In contrast, the actual decision is deviated from the perfect consistency because of various errors. To measure the deviation, we measure the

difference between the maximum eigenvalue of perfect consistent pairwise matrix and actual pairwise matrix. As a pairwise comparison matrix satisfies $Aw=\lambda_{max}w$, we can get the maximum eigenvalue of actual pairwise matrix with simple liner algebra.

In our example, λ_{max} is 6.44. So consistency index will be: $CI = \frac{\lambda_{max} - n}{n-1} = \frac{6.44-6}{6-1} = 0.088$.

Random Index when n=6 is 1.24. Thus we finally get the consistency ratio,

$$CR = \frac{CI}{RI} = \frac{0.088}{1.24} = 0.07.$$

Although there is a debate about the acceptable level of CR (Ko and Lee. 2001), if CR is less than 0.1 then we can regard the judgment as consistent (Saaty. 1980).

6. *Scoring alternatives and Judgment:* decision makers judge the desirability of alternatives with respective to a given criteria. Although KDI considers multiple alternatives in doing pre-feasibility studies, it recommends considering two alternatives in final AHP decision: Best alternative Vs. Do nothing. So, alternatives in KDI AHP are: accept or reject project.

Table 6 Scoring Example of Four Decision Makers

Accept vs. Reject	**DM1**	**DM2**	**DM3**	**DM4**
Economic feasibility	1/5	1/7	1/2	1/3
Backwardness (BW)	4	5	7	7
Regional Econ. Impact(ED)	4	5	7	5
Commitment (CP)	7	7	7	4
Financial Feasibility (FF)	1/3	7	1/5	1/4
Relatedness (RV)	4	7	5	1/2
Environment(EI)	1/3	7	1/5	1/7

As shown in Table 6, we can find out that decision maker 1 prefers rejecting the project 3 times to accepting it from the point of environment (EI). Also we can observe there is a variation in judging economic feasibility although decision makers use the same benefit cost ratio to their judgment.

We can get final judgment result by integrating weighting result and scoring results. If the weight of given criterion i is w_i and score to an alternative s_i, then the score to accepting the project after considering weight of the criterion i, will be $S_i^A = w_i * s_i/(1+s_i)$:

$$s_i = \frac{S_i^A}{S_i^B}, \text{ and } S_i^A + S_i^B = w_i$$

$$\rightarrow S_i^A + \frac{S_i^A}{s_i} = w_i$$

$$\rightarrow S_i^A = w_i * s_i/(1+s_i)$$

For instance, the weight of BW was 0.1 and decision maker 1 give score 4 to accepting projects. So the evaluation score to accepting project under the given criterion BW is 0.08(=0.1*4/(1+4)). Below table show the final judgment results. If the acceptance score is greater than reject score, we can interpret decision maker decide to accept the project. In our example, a decision maker want to reject (0.578>0.422) the project.

Table 7 Final Judgment Result of Decision Maker 1

Decision Criteria	Judgment on project acceptance
Economic Feasibility	0.124
Policy Feasibility	0.297
Level 2	0.297
Backwardness (BW)	0.080
Regional Econ. Impact(ED)	0.055
Commitment (CP)	0.029
Financial Feasibility (FF)	0.005
Relatedness (RV)	0.121
Environment(EI)	0.007
Accept Project (Total)	0.422
Reject Project	0.578

4.2 CHARACTERISTICS OF ANALYSTS IN KDI AHP DECISION

Public investment analysis requires different expertise. In case of transportation projects, analysts have to assess the traffic flows, physical designs, and the degree of safety level to achieve. The transportation network analysis can provide information about additional traffic demands, the amount of time-savings, the decrease of traffic accident, and etc. At the same time, some analysts have to design the route, choose appropriate construction methods, and assess possible technical problems in construction. Other analysts have to calculate the monetary benefits and costs, which requires the knowledge of welfare economics, especially of benefit-cost analysis. Due to these different level of expertise required, KDI organizes research teams from different organizations.

To each project, in general, KDI invites analysts from four major different organizations: private company, university, government funded research institute, and KDI. Analysts from private companies, in general, perform physical design analysis, transportation network analysis and decide basic construction method and do cost estimations. They usually have engineering backgrounds. As budget agency, MPB, and KDI have limited amount of money available for pre-feasibility study[24], the compensation for the participation of private companies is not so large enough. Instead, private company analysts can enjoy indirect benefits from the participation. One benefit is a future participation in implementation. The participation of PFS can be used to show their experiences in government projects which are counted when they take part in the competition of other government project contracts. In some cases, because they accumulate much information at the planning stages, they are preferred to join in implementation when

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[24] In general, each pre-feasibility study costs $40,000 to $100,000 dollars within 6 month project period.

projects are approved. The other is networking benefit. As PFS deals with major public investment projects, they have more chance to meet high level officials in line ministries, local government, and, sometimes, politicians. Through the interaction with those people, private company analysts can build up personal network. The third benefit is information. Because of interconnectivity of public investment projects, they can access information of other projects or related plans which are being considered.

The other analysts come from universities and government funded research institutes. They perform technical impact analysis such as additional increase of demands, assessing system efficiency, and etc. University analysts have expertise in each project field and are considered pretty value-neutral from the political influence. Unlike analysts of private companies, university analysts have smaller benefits of future participation in implementation. Instead, they enjoy getting information which is useful to their academic research and use PFS to train their graduate students. Also, considering the scarcity of research funds in universities, university analysts have an incentive to join PFS. Analysts from the government funded institutes also have specialty in each project field. As they have more chances to participate in government projects, not only are they technical experts, but also they understand the complexity of policy process and politics. In Korea, government funded research institutes get funds from line ministries which are related to their research fields. For instance, KOTI (Korea Transportation Institute) gets many research projects and funds from Ministry of Construction and Transportation. Although the reliance of financial resource was weakened after government made budget allocation of research fund at the hand of Korea Council of Economic and Social Research Institutes and other Councils in 1999, instead of line ministries, still line ministries are major clients. So, analysts in the institutes have a strong relationship with their supporting line ministries and local governments. They are more sensitive to the interests of their line ministries.

Finally, KDI analysts performed economic analysis. Traditionally, KDI has played a significant role in economic development planning, financial analysis and other economic policies of the Korean government. Most KDI analysts are trained in an economics discipline. KDI is also one of government funded research institute supported by MPB and Ministry of Finance and Economy (MOFE). Compared to other analysts from private companies, universities and government funded research institutes, KDI analysts have less expertise in each project field but they actively involve in transforming analysis results into monetary benefits and costs.

As there is a possibility of favoritism and systematic bias in analysts' selection, how to organize research team is important. The selection of analysts is decided by KDI after discussion with MPB and the project proposing organization. Sometimes, KDI adopts open competitions for outsourcing PFS. When KDI decides a principal investigator of study, the principal investigators can organize other analysts after discussing it with KDI.

For PFS deal with major investment projects, KDI prefers analysts who have experiences in participating governments' investment decision. Not only do they involve PFS, but also they take part in other government committees and frequently advise policy making in the Korean government[25]. Thus, analysts studied in this study represent influential experts group who actively participate the Korean government's public decision.

[25] In Korea, if we consider the relatively small number of experts and closely connected internal experts' network, we expect the strong influence of PFS analysts in other project analysis.

4.3 DATABASE CONSTRUCTION

To build up database of analysts' revealed preference, I rely on two major sources. Primary source is KDI AHP decision data. As explained in above sections, the data include each analyst's weighting and scoring results. The major strengths of the data are: i) they are actual decision-making data, ii) decisions are made with a consistent method and criteria over years, and iii) the revealed preference of analysts is provided with quantified information.

My database covers all major projects considered by the budget agency of Korean government, MPB, to allocate budget from 2001 to 2004. Although pre-feasibility study started in 1999, AHP was adopted since 2000. When KDI first applied AHP in 2000, it did not use consistent decision criteria. Some project included small number of criteria and others included too many. Most serious problem of year 2000 data was that the same criterion was labeled differently across projects. To avoid unnecessary noise, I exclude year 2000 projects. As a result, I can get 148 projects' decision data of which detail frequency distribution of project by year and project field is provided in Table 8. Among the types of project field, "Others" includes industrial park, public buildings, cultural complex, memorial part and etc. In my dataset, there was one airport construction project. I included it to "Others" category, although it is transportation project.

Table 8 Frequency Distribution of Projects by Year and Project Fields

Year	Project Field					Total
	Dam	Harbor	Rail	Road	Others	
2001	0	1	11	20	6	38
2002	4	2	9	9	5	29
2003	5	4	11	19	12	51
2004	2	1	6	15	6	30

Total	11	8	37	63	29	148
%	7.4%	5.4%	25.0%	42.6%	19.6%	100

Also, the frequency distribution of analysts by year, project field, and their affiliations is provided in Table 9. The reason that KDI analysts are involved more than other analysts is AHP allows including a KDI director who take in charge of pre-feasibility program. Not only is the KDI director an important decision maker in pre-feasibility, but also he shares the basic characteristics of other KDI analysts. I classified him as a KDI analyst.

Table 9 The Number of Analysts by Year, Project Fields, and Affiliation.

Year	Project Fields	Gov.	KDI	Prv.	Univ	Total
2001	Rail	2	19	12	9	42
	Road	7	29	24	19	79
	Dam	.	.	.	.	0
	Harbor	1	1	1	.	3
	Others	2	11	7	4	24
2002	Rail	3	15	9	8	35
	Road	3	14	10	9	36
	Dam	.	10	4	4	18
	Harbor	3	3	2	.	8
	Others	.	8	7	5	20
2003	Rail	4	15	12	9	40
	Road	1	28	20	19	68
	Dam	.	7	5	5	17
	Harbor	2	5	7	2	16
	Others	1	24	13	9	47
2004	Rail	.	7	6	6	19
	Road	1	27	15	20	63
	Dam	1	5	2	2	10
	Harbor	.	1	1	2	4
	Others	.	12	5	5	22
Total	All[26]	31	241	162	137	571

[26] Some analysts participated in multiple projects. This data includes 220 different analysts.

One problem of KDI AHP data is the ambiguity of benefits and costs information. When analysts analyze each project, they usually consider multiple alternatives whose benefits and costs are not necessarily the same. Although KDI AHP model required principal investigators to pick up the best alternative and to make decision of acceptance or rejection of the alternative, some projects failed to specify the alternative. To infer which alternative they considered in AHP model, I rely on MPB's news briefing documents of each year. As the documents included information about costs, benefit cost ratio, and AHP score of an actually considered alternative for budget allocation, I can figure out the alternatives used in decision. I compared costs and benefits of AHP data and MPB's news briefing documents, and correct coding errors of AHP data.

5.0 DESCRIPTIVE ANALYSES: VARIATION OF ANALYSTS' JUDGMENT

If we do not restrict the role of analysts to technical information providers, how analysts actively interpret their policy problems and information becomes more important. As information is an essential part of public investment decision-making, there is little doubt, other things equal, that better information about costs, benefits, and social or environmental impacts leads to better decisions. The acknowledgment of the importance of information, however, does not imply the direct utilization of information without interpretation. Because of the unbalanced studies- information without interpretation- and the understudy of analysts' interpretation of information, many people fail to answer simple questions such as: how much weight policy analysts put on the economic benefit-cost analysis? Do analysts within the same project reach a consensus in evaluating the project? It is critical in actual decision-making. For instance, when preliminary pre-feasibility studies were done in 1999, some groups argued that analysts overemphasize economic efficiency. Because there was no judgment data or previous studies how much weight analysts gave on economic efficiency, the criticism could not be tested.

The main purpose of this study is not to discuss the normative analysts' judgment. Instead, I try to provide descriptive evidence on how analysts actually make judgments on weighting and scoring. The variation of analysts' judgment can be analyzed by criteria, different project field, affiliations, their role in analysis, and judgment stage (weighting or scoring). This lets us answer questions such as: how much variation differently do analysts show in weighting different criteria, how differently they score the project acceptability when they are given the same analytical information.

This chapter is organized as follows. The first section provides descriptive analyses of weighting economic efficiency. As shown in the second level of a decision hierarchy in Figure 6, decision makers have to decide the relative weight on economic efficiency versus other policy factors. I analyze how much weight is given on economic efficiency and how analysts weight it differently, depending on the project fields, their role in analysis and affiliation.

In the second section, we provide analyses of weighting on each of the non-efficiency policy factors. As shown in Figure 6, there are 6 basic policy factors (or 6 criteria), which should be included in every project's decision to prevent arbitrary exclusion of important policy factors. If a project considers other than basic policy factors, they are included as project specific factors in the decision model. Weighting between basic policy factors and project specific factors (Level 3 of decision hierarchy in figure 8) and weighting among basic policy factors (Level 4 of decision hierarchy in figure 8) are analyzed. After I perform the descriptive analyses on the variation of scoring, I discuss the implications of the findings at the end of this chapter.

5.1 DESCRIPTIVE ANALYSES OF WEIGHTING ECONOMIC EFFICIENCY

Public investment is a multi-criteria decision problem. As discussed in Appendix C, policy analysts have considered many criteria to assess the desirability of project. Analysts have to decide which criteria should be included in a decision model and how great the relative importance should be. Practically, the multidimensionality is important. The Korean government, as a client of policy analysis, demanded that policy analysts consider not only economic efficiency but also policy criteria such as the commitment on projects, economic development, environmental impact and regional equity. Such a consideration of multiple factors in decision is related to conflicting interests. When the Korea Development Institute (KDI) performed the pilot pre-feasibility studies in 1999, interest groups claimed that KDI gave too little weight to other policy factors compared to economic efficiency. At the same time, they argued that KDI should include more project specific factors, which are usually favorable to them. Although it was not clear whether analysts really did not consider policy factors as interest groups argue, KDI was pressed to defend itself from the criticism of interests groups. Their criticisms tended to make public investment decisions more political. It is not unique to Korea. It has been widely discussed which criteria should be adopted for public investment decision-making (Korea MOCT. 2002; U.S. GAO. 1999; UK HM Treasury. 2003). Unfortunately, however, there were no systematic studies answering the question: how much weight needs to be given to economic efficiency and policy factors in public investment? [27]

The analysis of analysts' actual decision data will help us answer the question indirectly. If we solve similar policy problems repeatedly with similar criteria, and if we know actual revealed preference of decision makers, we can infer the general preference to those criteria. As public investment decisions are annually made and they are relatively well-structured problem, we can estimate the general weighting distribution based on actual decision data. While the following descriptive analyses of weighting are limited to policy analysts' judgments and did not cover other decision makers, it can provide reference information on deciding relative importance among criteria.

[27] This question is somewhat related to normative issue. However, in this dissertation, I simply assume the desirability of weight as the decision minimizing difference. According to the concept, the average decision makers' preference will be more desirable than other extreme decision maker's preference.

5.1.1 Weighting of Economic Efficiency and Level of Specification

When people are asked to reveal their preferences on more abstract problems, their revealed preference varies depending on how the problem is framed. For instance, when we use the contingent valuation method to estimate the non-market goods such as environmental goods or leisure, the way to specify questions significantly affects the valuation (e.g. the value of wild animals Vs. the value of the American bald eagle) (Kahneman and Knetsch. 1992; Pate and Loomis. 1997; Portney. 1994). In public investment, although people emphasize economic efficiency, the degree will not be the same according to the way we specify the investment problem. For instance, some people agree that we should count economic efficiency around 60% in general public investment decision but they change their weight when they actually evaluate a specific investment project (eg. a transit project in downtown Pittsburgh).

To analyze the impact of the level of specification of analysts' revealed preference on economic efficiency, I operationalize the subject of judgment into three levels: general public investment project, project field, and each project. Analysts were asked: how much weight will they give to economic efficiency when they make decision: i) on the general public investment projects, ii) on their project field, and iii) on the project they analyze.

The revealed preferences on weight between economic efficiency and other policy factors are measured by 100% scale. Policy analysts have to weight on economic efficiency vs. policy factors as: x: 100-x, where x is a weight on economic efficiency having values with range from 0 to 100.

As shown in Table 10, analysts give 57.8% on economic efficiency when they make judgments on general public investment projects. In contrast, when they actually make judgment on their own project, the weight changes to 50.94% (N=572). Such a result has several implications.

First, the weight of economic efficiency is relatively lower than the guideline of the Korea Ministry of Construction and Transportation recommending 61%[28] weight on economic efficiency when agencies evaluate road, rail, harbor and airport projects (Korea MOCT. 2002). Unlike the high emphasis on economic efficiency of the MOCT, analysts put a smaller weight on economic efficiency in actual decision-making. Also, while local governments or line ministries frequently emphasized non-economic policy factors and criticized that analysts are biased toward economic efficiency, it turns out that analysts consider other policy factors as of similar importance to economic efficiency. So, it implies that policy analysts do not simply frame the public investment as a problem of economic efficiency but try to balance economic efficiency and other policy factors.

Second, the emphasis on other policy factors increases from general investment problem to specific projects. The weight on economic efficiency decreases from 58% (general investment decision) and 55% (project field) to 51% (their own project). Analysts, in general, agree that economic efficiency is important to general public investment decisions but when they make decisions on their own projects, they consider non-economic factors more seriously. The statistical test for equal population mean[29] shows that the mean difference of weight on

[28] MOCT did not provide any explanation how it got the weight.
[29] As shown in the table, not only do the confidence intervals of mean weight of economic factor not overlap, but also two independent sample mean test conclude the mean differences under significance level of 0.05.

economic efficiency in the general public investment and specific project is statistically significant under a significance level of 0.05.

Table 10 Weight on the Economic Efficiency

Weight on Economic Efficiency	N	Mean (%)	STD	95% Lower CI	95% Upper CI	Range
General Public Investment	571	57.80	8.70	57.08	58.51	50
Project Field	566	54.62	11.77	53.64	55.59	75
Own Project	572	50.94	12.16	49.95	51.94	87

The third interesting aspect of weighting behaviors of analysts is the increase of variation of judgment according to level of specification. We can find the degree of variation measured by standard deviation increases from 8.70 (general public investment), 11.70 (project fields) to 12.16 (specific project)[30]. It implies that analysts reach the high degree of consensus to general issue but the degree of consensus decreases in actual decision-making on their own projects.

Such findings are consistent even after we control for the project field. As shown in Table 11, for instance, analysts in rail construction, on average, think that the weight of economic factor for general public investment decisions should be 59.96% but they just gave 53.57% when they made decisions for their own projects. Also, the variation of judgment of the weight increases from 7.97 to 10.54.

One difficulty of the interpretation of the variation in weighting on economic efficiency is whether the size of variation is large or not. As we do not have any comparable studies on the variation judgments, we cannot say whether analysts show larger variations compared to politicians, bureaucrats or other groups. However, if we apply 2 standard deviation rules[31], we can say the standard deviation 12.16 is significantly large.

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[30] The difference of standard deviation is statistically significant under significance level of 0.05 ($F=0.51$, p-value<0.01).

[31] Under normal distribution assumption, the 2 standard rule suggests 95% of responses will be within (mean±2STD). If the assumption is not held, at least 75% of response will fall into the range (mean±2STD).

Table 11 Weight of Economic Factor on Different Levels of Projects by Project Field

Project field	Subject to Weight	N	Mean (%)	STD	95% lower CL	95% upper Cl	Range
RAIL	General Public Investment	40	59.96	7.97	58.48	61.44	40
	Project Field	50	55.79	9.73	53.98	57.61	50
	Specific Project	40	53.57	10.54	51.61	55.52	40
ROAD	General Public Investment	45	58.65	8.20	57.26	60.04	45
	Project Field	55	59.24	9.63	57.61	60.88	55
	Specific Project	55	54.61	10.59	52.82	56.41	55
DAM	General Public Investment	20	52.67	7.66	51.70	53.63	20
	Project Field	40	43.22	8.40	42.16	44.28	40
	Specific Project	50	41.78	9.18	40.62	42.93	50
HARBOR	General Public Investment	40	58.00	9.26	55.22	60.78	40
	Project Field	45	57.04	12.03	53.42	60.65	45
	Specific Project	55	55.39	14.12	51.15	59.63	55
OTHERS	General Public Investment	50	55.35	9.56	51.84	58.86	50
	Project Field	65	47.12	12.76	42.08	52.17	65
	Specific Project	67	42.31	11.58	38.06	46.55	67

The weight on economic efficiency differs by project fields. For instance, analysts in rail projects give more weight to economic efficiency than do those in dam projects. As such differences may be because of random error, we need to test whether such differences of weight are statistically significant. I performed MANOVA[32] (Multiple Analysis of Variance) with project field as a factor and weights on economic factor of three different levels as response variables.

The mean model for MANOVA can be stated:

$\boldsymbol{y}_{ij}=\boldsymbol{\mu}_i+\boldsymbol{\varepsilon}_{ij}$, (i =1,2, ..5, j=1,2,3)

where, i is factor level and j is response level, and $\boldsymbol{\mu}_i$ is i^{th} factor level's mean response vector, and $\boldsymbol{\varepsilon}_{ij}$ are error vectors which are independent of each other and the homogeneous variance and covariance matrix.

The MANOVA test whether the each project field's mean response vector is the same or not.

H_0 : $\boldsymbol{\mu}_1=\boldsymbol{\mu}_2=\boldsymbol{\mu}_3=\boldsymbol{\mu}_4=\boldsymbol{\mu}_5$

We can decompose the variation of dependent variable vector into the between sum of squares and crossproducts matrix ($SSCP_{between}$), and the within sum of squares and crossproducts matrix ($SSCP_{within}$):

$SSCP_{total} = SSCP_{between} + SSCP_{within}$

To test the null hypothesis, we can use the test statistic, Wilks' Lambda which is defined:

$$\Lambda = \frac{Det(SSCP_{within})}{Det(SSCP_{Total})}$$

[32] We may consider using separate one-way ANOVA (Analysis of Variance) on each level of project but it will raise the probability of a Type I error too high and fail to control the correlation among different level of projects. In this case, the statistical significance of independent variable i.e. project fields will be overestimated. So I performed MANOVA instead of doing ANOVA separately.

If there are no project field effects on the economic feasibility weighting, the Λ will equal one, indicating no differences between groups on the linear combination of dependent variables. As shown in the below table, the Wilks's Lambda is 0.712 and its p-value is smaller than 0.001. So we reject the null hypothesis and can conclude project fields affect analysts' decisions on the weight on economic feasibility. The MANOVA test implies that analysts in different project fields have difference preferences for economic and policy factors.

Table 12 Result of MANOVA Test

Statistic	Value	F Value	DF	Den DF	Pr > F
Wilks' Lambda	0.71223796	16.87	12	1479.3	<.0001
Pillai's Trace	0.29900627	15.53	12	1683	<.0001
Hotelling-Lawley Trace	0.38836283	18.06	12	973.95	<.0001
Roy's Greatest Root	0.34428714	48.29	4	561	<.0001

Based on the Bonferroni *t* tests of difference between means, we can find that analysts in transportation projects (road, harbor and rail) put a higher weight on economic efficiency than analysts in dam and "Others" projects. For instance, analysts in road projects gave economic factors a weight of 12.77% greater than analysts in dam projects. Considering the fact that dam construction usually has to consider environmental impacts and relationship to residents, the result seems reasonable. Also, as "Others" project fields includes cultural centers, industrial park, and government owned public buildings, policy factors can be more important than for other transportation projects. Thus, we can conclude that the weight of economic efficiency is different by project field, and analysts give the largest weight to economic efficiency for transportation projects.

5.1.2 Weighting of Economic Efficiency and Analysts' Role in Analysis

Among analysts, the principal investigator of each project and the KDI director of the public investment management center have more responsibility for their analysis results than other analysts. The KDI director attends each project's meeting for interim and final reports before sending them to MPB. Principal investigators and the KDI director attend the 'pre-feasibility study committee' organized by MPB in which members approve or reject a project. Also, the National Assembly asks them to attend its committees to give their opinions. The oversight agency calls the principal investigator and KDI director when analysis results turn out having serious problems. Because of such responsibility and political influence, I categorize them as a manager group and set up Hypothesis 6-affiliation of policy analysts affects their weighting. Such a role in analysis can be a meaningful explanatory variable for analysts' weighting on economic efficiency.

In weighting between economic efficiency and other policy factors, the manager group may want to rely on more objective information to defend its decision and to minimize responsibility. As economic efficiency is quantified into BC ratio, we can expect that they put more weight on economic efficiency than other analysts. I categorize analysts into two groups: principal investigator and KDI director as manager group (PI="Y"), and other analysts as non-manager group (PI="N"). The following table show how two groups gave different weight on economic efficiency. As shown in the analysis results, analysts in the manger group who bear greater responsibility for their analysis results put more weight on economic factor than other analysts.

Table 13 Weight on Economic Factor by Project Field and Role in Analysis (Specific Project)

Project Field	PI	N[33]	Mean (%)	STD	Min	Max	95% lower CI	95% Upper CI
Rail	N	62	51.85	11.02	30	70	49.06	54.65
	Y	74	55.00	9.97	30	70	52.69	57.31
Road**	N	121	52.23	11.44	30	80	50.17	54.29
	Y	125	56.92	9.16	30	85	55.30	58.54
Dam	N	23	38.70	9.80	20	70	34.46	42.93
	Y	22	45.00	7.40	30	60	41.72	48.28
Harbor	N	15	51.80	12.62	40	80	44.81	58.79
	Y	16	58.75	15.00	40	95	50.76	66.74
Others	N	56	41.04	11.61	8	75	37.93	44.14
	Y	58	43.53	11.51	25	70	40.51	46.56

Although the difference of mean between manager group and non-manager group is not statistically significant[34] except for road projects, all five project fields consistently shows that principal investigators and KDI director rely more on economic efficiency than on other policy factors when they make decisions to accept or reject a project[35]. The finding is also true when analysts are asked to weight on general public investment, as shown in Figure 7.

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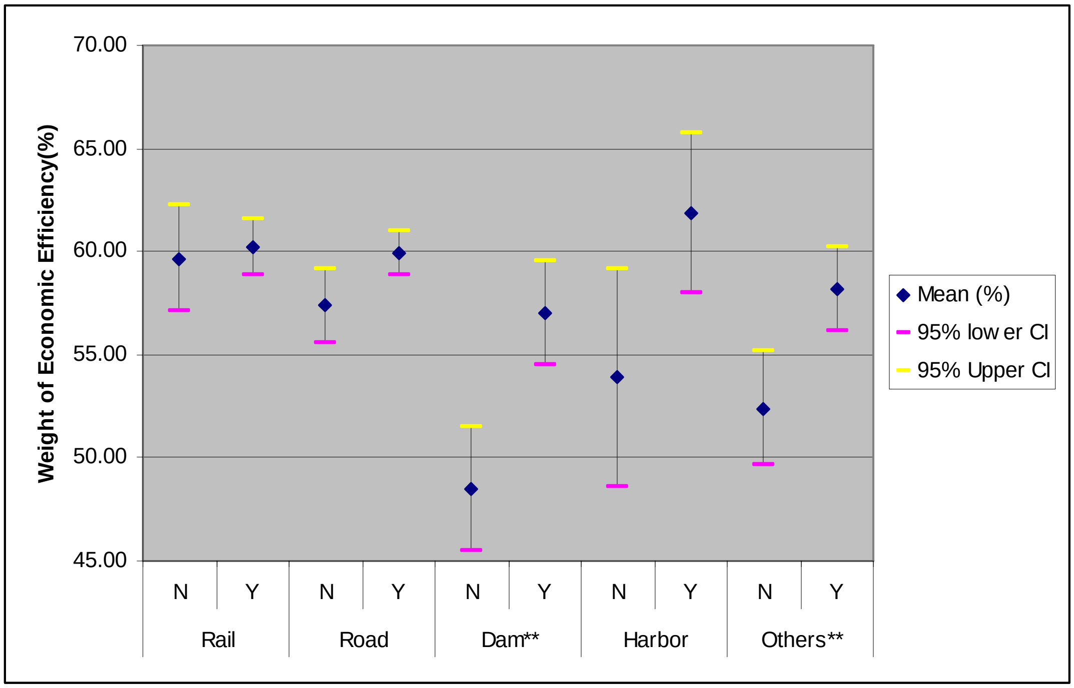
[33] The number of analysts (N) can be different because some projects included more or less than 4 analysts for AHP decision-making.
[34] The 95% lower and upper confidence intervals of two groups are overlapped.
[35] The emphasis on the economic efficiency of manager groups might be because the members of manager group are more likely to be economists (KDI analysts). However, when I performed multiple regression after controlling the interaction effect of analysts' role and their affiliation, manager group still give much weight to economic efficiency.



Note: The number of respondents to each category is the same as in Table 13.
** is statistically significant at 95% significant level

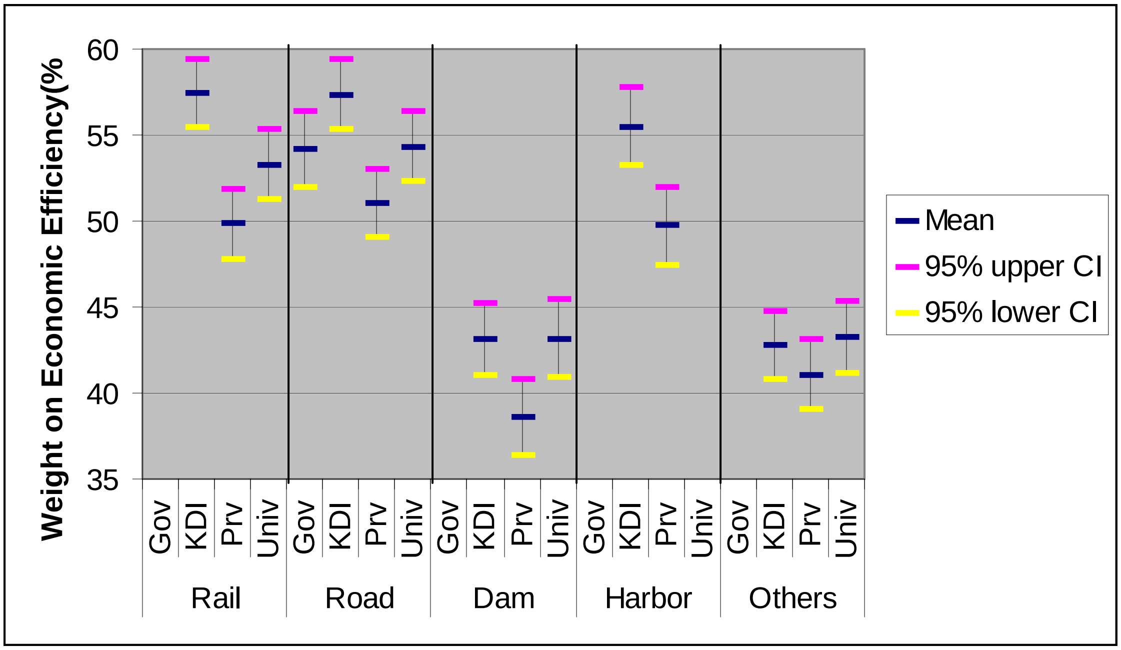
Figure 7 Weight on Economic Factor by Project Field and Role in Analysis (General Public Investment)

In sum, we can find evidence that the role in analysis affects the weighting on economic efficiency. Project manager group gives more weight on economic efficiency than non-manager group, which reflect to their preference for objective criteria for minimizing future responsibility.

5.1.3 Weighting on Economic Efficiency and Affiliation of Analysts

Similar to impact of analysts' role in analysis on the weight of economic efficiency, we can analyze whether analysts' affiliation affects weighting on economic efficiency. Affiliation can be a proxy of the difference of expertise and self-interest. As public investment analysis requires multi-level expertise, pre-feasibility studies include analysts from different organizations: private companies (Prv), government funded research institutes which are specialized to each project field (Gov), university (Univ), and KDI (KDI). Most analysts of private companies are engineers who design transportation network, building structure, and other technical aspects of construction. Analysts in government funded research institutes have a strong relationship with each line ministry which initiates the investment project. Most analysts of KDI are economists and do not have much connection to each line ministry but strong connection to budget agency, MPB. Similar to analysts from private companies, analysts from university have engineering background but they have weaker interests than engineers in private companies when projects are accepted.

The impact of affiliation on the weight of economic efficiency is shown in Figure 8. Analysts from private companies (Prv) put smaller weight on economic factor than KDI and university analysts in the all project fields, although 95% confidence intervals overlapped in some cases. The difference between KDI analysts and private company analysts are statistically significant expect in the “Others” project field. KDI analysts and university analysts gave similar weight on the economic efficiency in road, dam and “Others” projects except rail projects. Thus, we can say analysts of KDI and university put more weight on economic efficiency than private companies.



Note: I did not include some categories if their sample size is less than 10.

Figure 8 Weight on Economic Factor by Project Field and Affiliation of Analysts

In sum, we can find that affiliation of analysts can explain some of the difference in weighting on economic efficiency. The most distinguishable pattern is the difference between KDI and private analyst group. KDI analysts place a larger weight on economic efficiency than private analysts. We can provide two possible explanations on the different weighting behaviors according to analysts' affiliation. First, it may be a result of analysts' different professional backgrounds. KDI analysts are economists and it would be natural for them to emphasize economic efficiency than other analysts. However, it is not clear why private analysts who are most engineers emphasize the policy factors which are not directly related to physical design, construction or other technical issues. In addition, university analysts also have engineering backgrounds but their weighting on economic difference is different to that of private analysts. To measure the pure effect of the professional background, we need to compare the difference of weight between economists and engineers after controlling for affiliation but we are unable to do this because of the limitation of data. For all KDI analysts are economists and most private analysts are engineers, we could not control affiliation to measure the effect of professional background. The other possible explanation is the influence of self-interest. When a project is less economically efficient, private analysts prefer to give more weight on policy factors and try to use more discretion to make project accepted. In contrast, KDI analysts who prefer to conservative expenditure will give more weight on economic efficiency to reject projects with low economic efficiency. Linear regression results[36] support that the difference of weighting between the KDI and private analysts increases when the project has small benefit cost ratio. While further studies should be done to test two different explanations, we can say that affiliation is important to understand the analysts' weighting behaviors.

5.1.4 Linear Model of Economic Efficiency Weighting

The above descriptive analyses suggest that the project field, the analysts' role in analysis and his affiliation all influence the weighting on economic efficiency. To further examine these issues, I performed a multiple regression analysis to observe whether the finding is still significant even after we control for other variables' influence on the weight of economic efficiency. In the multiple regression model, the weight of economic efficiency is used as dependent variable and project field (Ptype), analysts' role in analysis (PI), and affiliation are used as independent variables. The model fit test shows linear model is statistically significant (with F=23.39 and p-value is <0.001). The model explains around 24% of the variation in the dependent variable.

[36] I controlled project fields and included the interaction term of BC ratio and Affiliation in the model.

Table 14 Model Fit of Multiple Regression of the Weight on Economic Factor

Source	DF	Sum of Squares	Mean Squares	F	p-value
Model	8	21068.97	2633.62	23.39	<.0001
Error	562	63286.92	112.61		
Corrected Total	570	84355.89			
Adj-R Square	23.91%				

ANOVA table of multiple regression model shows that affiliation and project fields are statistically significant in explaining the variation of the weight of economic factor under significant level 0.05. PI has a weak effect on dependent variable but statistically significant under significant level 0.1. Based on Mean Square of each variable, we also can find out ptype explains the variation of weighting more than affiliation and PI.

Table 15 ANOVA Table of Multiple Regression of the Weight of Economic Factor

Source	DF	Type III SS[37]	Mean Square	F Value	Pr > F
PI	1	364.19	364.19	3.23	0.0727
Affiliation	3	1120.92	373.64	3.32	0.0197
ptype	4	17665.29	4416.32	39.22	<.0001

Parameter estimate results are shown in the table below. After controlling for PI and Affiliation, analysts in road, rail and harbor[38] projects gave higher weight on economic efficiency than those in dam and "Others" project, which is consistent with our earlier analysis. In the same way, manager groups (KDI director and principal investigator) gave more weight to the economic efficiency. Finally, KDI and university analysts gave higher weight than government and private company analysts. In sum, multiple regression results are consistent with our former findings, even after we control other variables' effect.

[37] The variable PI and Affiliation dummy variable of KDI membership is correlated because KDI director is counted as PI "Y" and having KDI affiliation. In this case, TYPE I SS (Sum of Square) is affected by the order of independent variables. Thus, to control the effect, I use TYPE III SS for ANOVA table.
[38] P-value of regression coefficients of rail and harbor conclude their regression coefficient equal zero. Thus, we can regard the regression coefficient of road, rail and harbor are equal, and larger than dam and "Others" project.

Table 16 Estimated Regression Coefficients

Parameter	Estimate	Standard Error	t Value	Pr > |t|
Intercept	56.8133753	1.40566916	40.42	<.0001
PI “N”	-2.52359911	1.40327806	-1.8	0.0727
PI “Y”	0	.	.	.
Affiliation gov	-4.37822086	2.17999323	-2.01	0.0451
Affiliation KDI	0.26736331	1.45570291	0.18	0.8543
Affiliation prv	-3.07132444	1.28201105	-2.4	0.0169
Affiliation univ	0	.	.	.
Ptype DAM	-13.02840694	1.72677056	-7.54	<.0001
Ptype HARBOR	1.64579397	2.0480191	0.8	0.422
Ptype OTHERS	-12.57877342	1.21178248	-10.38	<.0001
Ptype RAIL	-1.03518167	1.13530728	-0.91	0.3623
Ptype ROAD	0	.	.	.

Descriptive analyses and multiple regression model of weight of economic efficiency provide useful findings and implication. First of all, there is a gap between analysts’ attitude toward general public investment problem and their own project. Although analysts acknowledge the importance of economic factor, they understand the importance of complexity of public investments pretty well. Analysts gave 57.8% of weight on economic factor when they have to make decision on general public investment projects but only gave 50.9% when they actually made decision on their own project. This result can be interpreted in two ways. If we assume analysts are value neutral experts, the more emphasis on policy factors in their actual decision-making implies that analysts try to reflect the complexity of public investment problem in their decision by seriously considering policy factors. In contrast, if we view analysts as self-interested experts, they want to make more discretionary room by giving more weight on abstract criteria. Compared to policy factors, economic efficiency is more objective but harder to manipulate because the quantified information can be reevaluated by other competing interest groups. Although they normatively agree that economic efficiency is important in public investment decision, they may intentionally underestimate its importance because it serves their interests. Such competing interpretation will be analyzed in the next chapter by integrating weighting and scoring results.

Second, I find that analysts in different project fields behave differently in rating the importance of economic efficiency. MANOVA test shows that project field affects analysts' weighting on the economic efficiency over three different levels: general, project field, and their own project. Analysts in transportation projects (road, harbor and rail) put more weight on the economic efficiency than those in dam and "Others" project. The result implies that project field can be an important explanatory factor in explaining analysts' judgments.

Third, the role of analysts in analysis affects their weighting. The manager groups who have more responsibility to their analysis results prefer to put more weight on economic factors than other analysts.

Fourth, the affiliation of analysts affects their weighting on economic factor. KDI and university analysts put more weight on economic efficiency than analysts from private companies and government-funded research institutes. However, we need further studies to determine whether this difference is due to the self-interest maximization strategy of analysts or the result of professional judgments.

5.2 DESCRIPTIVE ANALYSIS OF WEIGHTING ON POLICY FACTORS

The economic analysis transforms various cost and benefit factors into monetized information, and summarizes them into simple numbers such as total cost and benefit, net benefit and benefit cost ratio. In contrast, policy factors consist of multiple sub-criteria which are more qualitative than the economic factor. Normatively we may argue that public investment decision should be responsive to multiple public interests and have to consider as many political, social and other non-economic factors as possible. However, it is very difficult to consider all public interests and criteria in a decision. Inclusion and exclusion of policy criteria for investment decisions is a highly controversial issue in the political arena. For this reason, KDI performed a preliminary study with 17 major public investment projects and tried to identify which non-economic factor should be included in public investment decisions. After reviewing the preliminary study results, KDI published general manuals in which it suggested basic policy factors in 2000 (Kim, et al. 2000). Those factors were modified after reflecting comments of related agencies and experts, and confirmed by Ministry of Plan and Budgeting (MPB) and KDI in 2001. As shown Table 17, six basic policy factors-backwardness of regions, local economic impact, commitment to the project, relevancy to related projects or laws, environmental impact and financial feasibility-were selected. These six policy sub-factors has been used for public investment decision in pre-feasibility studies since 2001.

Among six basic policy factors, two criteria, backwardness of regions (BW) and local economic impact (ED) use quantified information for assessment of project acceptability. In case of backwardness of regions (BW), KDI developed an underdevelopment index (Park and Ko. 2001) using 8 socio-economic indicators: population indicators (population growth rate, aging index), economic indicators (the rate of employees in manufacturing sector, the number of cars per capita, the degree of financial independence) and infrastructure indicators (the miles of paved road per area of region, the number of doctors per capita, and the rate of urbanized land utilization)[39]. The weights of those indicators were decided by 74 policy analysts, economists, engineers and political scientists using analytic hierarchy process (AHP). After the

[39] The three factors, population, economic and infrastructure factors, are derived by variable cluster analysis results rather than by subjective classification.

standardization of each indicator and multiplication of weights, the underdevelopment index is constructed for 170 local counties and cities of Korea. The index is reliable [40] and has been used in many public sector decision-makings.

The other quantitative measure used for scoring on ED is a value added per Gross Regional Domestic Production (GRDP). To assess the regional economic impact, KDI constructed multi-regional input-output (MRIO) model (Kim, et al. 2000). Based on 402 industrial codes of national industrial input-output, KDI reconstructed regional trade flows and simulate the economic impact of each investment project. Based on the MRIO model, KDI calculated the amount of value-added to a region caused by each project and divided it by GRDP to assess the relative impact to regional economic impact.

Table 17 Common Factors Used in Public Investment Decisions in KDI Pre-feasibility Studies

Major Factors	Sub-Factors
Economic Efficiency	Benefit: traveler safety, vehicle operating costs reduction, time savings Cost: construction cost, operation cost
Other Basic Policy Factors	Backwardness of regions (BW) Local economic impact (ED) Commitment of the project (CP) Relatedness to related projects or laws (RV) Environmental impact (EI) Financial Feasibility (FF)

[40] To test the reliability of the underdevelopment index, KDI compared it to other indexes developed by other research and also heard other experts' opinion. It shows KDI underdevelopment index produces pretty consistent classification (Park and Ko 2001).

However, due to the complexity of public investment project, analysts need to consider other project specific factors. Also, some projects have economic factors that are hard to monetize with benefit cost analysis (e.g. the valuation of seasonal variation, spill-over effect of investment). Each project's analysts are allowed to include those project specific factors that are important in decision-making and implementation in their decision hierarchy. Table 18 illustrates project-specific factors considered in pre-feasibility studies.

Table 18 Project-specific Factors Considered in Pre-Feasibility Study

Project Specific Policy Factors	- The possibility of private investment - The impact of seasonal variation of traffic, visits, demand and etc. - Contribution to an unification with North Korea - Preserving national culture and heritage - The balance of operation cost - The impact on military operations - Choice of transportation systems - Possibility of favoritism to certain interest group - Uncertainty in legal process - The urgency of project - The desirability of government intervention - Technical possibility in construction - National agenda - Strategic preparedness of project - Organizational capacity for implementation - Spill-over effects - Impact on public health - Regional connectivity

To avoid arbitrary criteria selection, KDI strongly recommended considering the six basic policy factors in all projects but it also allows including project-specific factors in their analysis. For this reason, the weighting between basic policy factors and project-specific policy factors is one of the important judgment processes in PFS, as shown in decision hierarchy in Figure 6.

The analysis of weight between basic and special policy factors shows the complexity of public investment decision more clearly. Basic policy factors represent the commonly raised policy issues in public investment decision. However, it turns out that analysts think project-specific issues are as important as the 6 basic policy factors. As shown in Table 19, analysts gave slightly more weight to basic policy factors than project-specific factors. In general, analysts gave 53.53% weight to basic policy factors and 46.47% to project-specific policy factors. They think that basic policy factors are not adequate to cover the issues in public investment decision. Moreover, the variation among analysts is large. Compared to the variation in weighting on economic efficiency shown in Table 9, we can observe 2.4 times larger coefficient of variation (0.57) in weighting on basic versus project-specific factors.

Table 19 Weight on Basic Policy Factors Compared to Project-Specific Factors: All Investment Decisions

# of decision maker	Mean (%)	STD	95% lower CI	95% upper CI
572	53.53	30.63	51.01	56.04

For a more detailed understanding of analysts' judgment, I analyzed the difference in weighting by project field, role in analysis and affiliation. There exists difference in the weighting between basic policy factors and project-specific factors by project field. Table 13 shows that Analysts in transportation projects (rail, road and harbor) put weight on basic policy factors 57.3%, 55.94% and 57.54% but analysts in dam and "Others" projects only gave 44.31%

and 46.36%. As dam and "Others" project is less formalized and more complex compared to transportation projects, the emphasis on project-specific factor seems understandable.

Table 20 Weight between Basic Policy Factors and Project-specific Policy Factor by Project Field

Project Field	N	Mean (%)	STD	95% lower CI	95% upper CI
Rail	136	57.30	30.39	52.14	62.45
Road	246	55.94	30.50	52.11	59.77
Dam	45	44.31	30.92	35.02	53.60
Harbor	31	57.54	29.81	46.61	68.48
Others	114	46.37	29.90	40.83	51.92

Unlike its effect on the weighting on economic efficiency, the analysts' role in analysis had little influence on the weighting between basic policy factors and project-specific factors. As shown in Figure 9, the manager group gave higher weights on basic policy factors in rail, road and dam projects but the differences were not statistically significant.

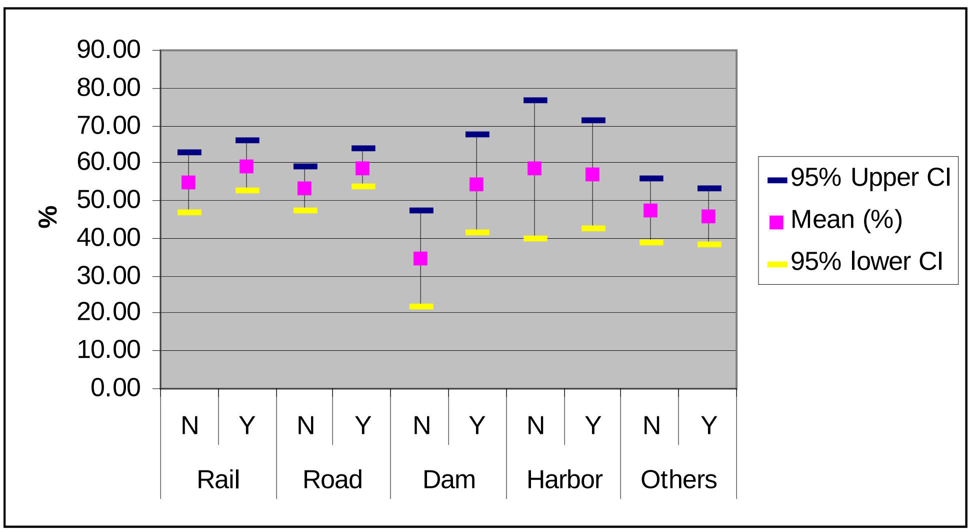


Figure 9 Weight on Basic Policy Factors over Project-specific Factors, by Project Field, by Role of Analysts

Finally, I analyzed how the affiliation of analysts affects their judgment on weighting between basic policy factors and project-specific factors. Unlike the weight on economic efficiency, KDI and private analysts do not show consistently different patterns. I performed the multiple regression analysis of the weight of basic policy factors on project field, analysts' role in analysis and their affiliation. Although the model fit was statistically significant, the adjusted R^2 was only 4.5%. Among independent variables, only project field had a significant effect on the dependent variable. The coefficients of two project fields, dam and "Others", are smaller than other projects, which is consistent with the descriptive analysis.

In sum, analysts do not solely consider basic policy factors in their analysis. They identify project-specific factors and give almost as much weight to them as to the basic policy factors. The variation in weighting is larger than for economic efficiency. This is true even if we control attributes such as project field, the role in analysis and affiliation. In part, the large variation of judgment is because we did not control the special condition of each project. When I included the each project as dummy variables in the model, R^2 increased from 4.5% to 58.8%. It implies that analysts' weight on the basic policy factors can be explained better by considering each project level difference than by project field, analysts' role in analysis and affiliation. This finding suggests that it is not desirable to apply a fixed weight without considering the specifics of each project.

5.3 WEIGHTS AMONG BASIC POLICY FACTORS

We can also analyze the weighting on detailed basic policy factors that are commonly used for all public investment decision-making in PFS shown in Figure 6.

In the below table, we can find that relevancy to related projects or laws (RV) is strongly favored (24.86%) and commitment of the project (CP) and financial feasibility (FF) follow (18.92% and 18.48% each). RV is strongly related to complexity of investment projects. For instance, if road project A is related to an industrial park plan in a neighboring region, analysts have to consider the possibility of implementation, size, and the impact of the industrial park plan. Analysts did not simply consider their own project but tried to consider other related projects. The other noticeable thing is that the variation of weighting on RV is smaller than other basic policy factors. The coefficient of variation of RV is 0.53 which is smaller than that of other factors (0.64~0.94)[41]. It implies that analysts pretty much agree on the importance of RV compared to other criteria.

Table 21 Weights among Basic Policy Sub-factors

Basic Policy Factors	N	Mean (%)	STD	95% lower CI	95% upper CI
Backwardness (BW)	568	12.46	11.70	11.49	13.42
Regional Econ. Impact(ED)	568	15.74	10.82	14.85	16.63
Commitment (CP)	572	18.92	12.11	17.92	19.91
Financial Feasibility (FF)	560	18.48	12.62	17.43	19.53
Relatedness (RV)	564	24.86	13.29	23.76	25.96
Environment(EI)	560	10.73	9.81	9.92	11.54

The low weight to BW gives us an important implication in the context of Korea's public investment. As a result of unbalanced economic development strategy, Korea has suffered a regional inequality between the more developed eastern and the less developed western region. The feud between two has influenced the landscape of political support and presidential elections. Politicians have emphasized the backwardness of regions (BW) as one of primary criteria in public investment. At same time, congressmen, who have to meet their constituents' needs, frequently frame public investment as a tool for regional development. So, they usually argue that local economic impact (ED) should be given high weight, although the project is not economically efficient. Simply speaking, BW and ED are politically important criteria in Korea.

[41] Such a small variation of weighting on RV among analysts is also valid even after we control the project fields. In all project fields, the coefficient of variation of RV is smaller than other policy factors.

Reflecting such a controversial aspect, BW has the highest variation in weighting (coefficient of variation is 0.94). Despite the large variation among analysts, however, analysts put less weight on BW and ED but gave more weight on the RV that is important in project efficiency and implementation.

The weights on each basic policy factor show how analysts perceive differently on the critical policy factors in different project fields. In the dam projects, analysts consider environmental impact (EI) more important than in other project fields. Road projects have high weight in BW and ED compared to other projects. It is consistent with the fact that road construction has been regarded as a pre-condition for regional development in Korea. Also, analysts in “Others” projects gave relatively higher weight on FF. The judgment reflects the fact that many “Others” projects such as cultural complex, industrial park, and other public building projects usually require to share costs with local governments or private sectors. Despite the difference of project fields, RV is considered most important basic policy factors in all fields.

Table 22 Weights among Basic Policy Sub-factors by Project Field

Project Field	Sub-Factors	N	Mean	STD	95% lower CI	95% upper CI
Rail	BW	132	10.01	10.41	8.22	11.81
	ED	132	14.98	11.22	13.05	16.91
	CP	136	19.23	11.25	17.33	21.14
	FF	132	18.83	12.46	16.68	20.97
	RV	136	28.99	15.45	26.37	31.61
	EI	132	9.62	8.94	8.08	11.16
Road	BW	246	16.09	12.88	14.47	17.70
	ED	246	17.84	11.04	16.45	19.23
	CP	246	17.86	10.63	16.52	19.19
	FF	246	16.74	12.19	15.21	18.27
	RV	246	21.28	12.18	19.75	22.81
	EI	246	10.22	9.42	9.03	11.40
Dam	BW	45	10.83	8.50	8.28	13.39
	ED	45	12.16	8.33	9.66	14.66
	CP	45	18.95	10.69	15.74	22.17
	FF	45	13.65	8.01	11.24	16.06
	RV	45	25.73	8.74	23.10	28.36
	EI	45	18.67	12.14	15.02	22.32
Harbor	BW	31	6.23	5.07	4.37	8.09
	ED	31	14.37	8.19	11.36	17.37
	CP	31	20.90	12.16	16.44	25.36
	FF	31	21.39	11.06	17.34	25.45
	RV	31	27.14	11.73	22.84	31.45
	EI	31	9.96	8.09	6.99	12.93
Others	BW	114	9.78	10.60	7.81	11.75
	ED	114	13.88	10.64	11.90	15.85
	CP	114	20.27	15.97	17.31	23.24
	FF	106	23.29	14.22	20.55	26.03
	RV	106	26.83	12.83	24.35	29.30
	EI	106	10.16	9.74	8.29	12.04

There is a very weak distinguishable pattern of the impact of analysts' role in project. Although, manager groups gave smaller weight on BW[42] and ED[43], the difference is not statistically significant. As shown in Table 23, the multiple regression results show that analysts'

[42] 11.75 % vs. 13.21%
[43] 14.05% vs. 17.55%

role in analysis does not affect weighting basic policy factors (p-values are greater than 0.05 and mean square is pretty smaller than for analysts' affiliation and Ptype(project field)). Affiliation significantly affects weighting on basic policy factors except CP. Especially, KDI analysts who are economists gave more weight on FF (22.34%) and RV (28.36%)[44] than other analysts. However, we have to notice that those independent variables only explain 4% to 12% of the variation of basic policy factors. If we include each project's variation in the linear model, basic policy factors can be explained more than 50%. The increase of explanability implies that the variation of weighting on policy factors is explained by project-specific situation rather than the weighting on economic efficiency.

Table 23 Multiple Regression of Basic Policy Factors

Dependent Variable	R square	Independent Variable	DF	TYPE III SS	MS	F-value	p-value
BW	8.7%	PI	1	43.62	43.62	0.34	0.56
		Affiliation	3	303.01	101.00	0.80	0.50
		Ptype**	4	6005.05	1501.26	11.82	<.0001
ED	11.0%	PI	1	51.09	51.09	0.48	0.49
		Affiliation**	3	3382.15	1127.38	10.65	<.0001
		Ptype**	4	1982.39	495.60	4.68	0.00
CP	4.0%	PI	1	111.95	111.95	0.78	0.38
		Affiliation	3	658.58	219.53	1.54	0.20
		Ptype	4	644.22	161.05	1.13	0.34
FF	12.5%	PI	1	7.60	7.60	0.05	0.82
		Affiliation**	3	4170.74	1390.25	9.87	<.0001
		Ptype**	4	4171.58	1042.89	7.40	<.0001
RV	12.0%	PI	1	517.20	517.20	3.28	0.07
		Affiliation**	3	2544.45	848.15	5.37	0.00
		Ptype**	4	5869.36	1467.34	9.30	<.0001
EI	8.4%	PI	1	39.64	39.64	0.44	0.51
		Affiliation**	3	1382.35	460.78	5.15	0.00
		Ptype**	4	3100.19	775.05	8.66	<.0001

[44] Not shown in the table.

In sum, the descriptive analyses of weighting on policy factors give us much insight in understanding policy analysts. Analysts do not rely only on economic efficiency as some people assume. When they analyze their own projects, they weight other policy factors as heavily as they weight economic efficiency. They do not underestimate the importance of project-specific factors in their decisions.

Large variations in weighting are found when analysts weight between basic policy factors and project-specific policy factors (coefficient of variation is 0.57 which is larger than that of economic efficiency vs. policy factor weighting 0.24). Such a variation of weighting can be partially explained by the difference of project fields, but neither analysts' affiliation nor their role in the analysis has a clear effect. Instead, the variation in weighting reflects project-specific situation. R^2 changed from 4.5% to 58.8% after we controlled for each project level variation by including a dummy for each project. As policy factors judgments are highly related to project specific conditions, it is not reasonable to fix weight of each policy factor which is usually preferred by budget agency.

5.4 DESCRIPTIVE ANALYSIS OF SCORING

Weighting is about the relative importance of multiple criteria. Scoring, in contrast, is the analyst's judgment on the project acceptability based on given information. So, scoring is more strongly related to analysts' self-interests than weighting is. The analyses of scoring illustrates why the provision of technical information is only a partial aspect of investment decision. Most of all, it shows that information produced by policy analysis could be interpreted very differently even by the analysts who produce it. The interpretation of BC ratio is a good example. According to welfare economics, projects with greater than BC ratio, 1, are acceptable. We might assume that analysts' role is to provide accurate BC ratio. However, when we have BC ratio 1.1, it is not clear how much supportive evidence it is for a project acceptance. Moreover, if we acknowledge the incompleteness of the methodology and the uncertainty in economic analysis, BC ratio 1 cannot be an absolute basis for project acceptance even if efficiency were the only decision criterion.

In the AHP model used by KDI, for each criterion, analysts have to give a score to two alternatives: accept or reject a project. It the uses 9-point scale in scoring shown in Table 1. For instance, if an analyst gives score 5 regarding economic efficiency, it implies the analyst reveals his preference to the project as accept: reject=5:1 from the point of economic efficiency. In contrast, if he gives score -5, he makes a judgment accept: reject=1:5. To avoid the ambiguity scoring, KDI provides a basic guideline with which analysts have to judge, shown in Table 2.

Unlike weighting, the variation of scoring is highly related to each project's unique characteristics because the project acceptability is different in each project. It implies that we have to control for the between project variation in the analysis. The unit of analysis in the following analysis is a project, although the unit of observation is an analyst. I discuss the degree of variation in scoring among analysts within the same project.

To measure the variation among analysts, we can use standard deviation among analysts within a project. However, when we try to measure the variation of scoring with standard deviation, the sensitivity to outliers becomes an issue. If one analyst in a project, for example, gave extraordinarily high or low scores compared to others, standard deviation will be large even though other analysts gave similar scores. It will cause an overestimation of variation. Because of the reason, we need to use more robust statistics to measure the variation of judgment. Here, I use IQR (Interquartile Range), MAD(Median Absolute Deviation) and range as complementary measures. IQR is defined the difference between 75th value minus 25th value. To a given criterion, MAD is defined as follows (Hampel. 1974:388):

$MAD_i = Med_i(| x_{ij} - Med_i |)$, where *i* is a indicator of project, x_{ij} is score of analysts *j* in project *i*, and Med_i is median score of project *i*.

The relationship between IQR and population standard deviation (σ) can be formalized as follows. If a random variable X follows normal distribution, X~ N(μ, σ^2), the 25th value will $\mu - 0.675\sigma$ and 75th value will be $\mu + 0.675\sigma$. Thus, IQR of normal distribution will be, $IQR = 1.35\sigma$. With this relation, we can infer σ when IQR is known. Also it is known that the relationship between MAD and standard deviation is as: $\sigma = 1.4826 * MAD$. When I applied the relationships, it turns out that sample average standard deviation (s) is smaller than the standard deviation estimated by IQR ($\hat{\sigma}_{IQR}$) and larger than the standard deviation by MAD ($\hat{\sigma}_{MAD}$). Thus, I interpret average standard deviation (s) as a measure of variation of scoring in the following.

The average STD[45] in Table 24 measures the average standard deviation of a project by criteria. Before reading the table, we need to think about meaning of the unit. Although we know the average standard deviation of economic efficiency is 2.47, we have no clear idea whether it is a large variation or not. Chebyshev's rule will enable us to guess *how many observations are within one, two, and three standard deviations from the mean.* Under the normal distribution assumption, within one standard deviation of mean, 68% of observations will be included. When

[45] Average STD=$\frac{s_i}{n}$, where i is an indicator of each project, n is the number of project, and *S* is sample standard deviation.

we can't assume normal distribution, we can guess at least 75% of observations will be within two standard deviations. This explanation, however, is not very useful to get a sense of whether the standard deviation of scoring is large enough to lead to a different decision.

To find a critical standard deviation changing a decision from accept to reject, or reject to accept, we need to consider the weight and score together. Let's assume a project gives weight on BW, w=0.2. Also assume that the project has a mean score (MS) on BW, 1.24 (accept: reject=1.24:1). The final score given to project accept alternative will be w*MS/(1+MS)=0.11 and 0.09 will be given to project reject alternative. However, when certain amount of variation (STD) happens to scoring and it changes MS to MS-STD, the variation changes a decision from project acceptance to project rejects, if

w*(MS-STD)/(MS-STD+1)<1/2*w

→ STD> MS-1.

So, if STD is larger than 0.24, the results between accept and reject project based on BW will be changed. The result suggests that the influence of variation on decision is related to weight and score together. If mean score is large, the larger variance between analysts is tolerable because it does not change the decision between accept or reject. But if a mean score is small, the small variation can change the direction of decision (eg. from accept to reject). With the reasoning process, I assess whether the variation of scoring is significant or not. It turns out that analysts' scoring variation is large enough to change a decision in all criteria except in CP[46]. So, we can conclude that the variation of scoring among analysts is large enough to affect the final decision.

[46] The mean score of each criterion is not shown in the text but average standard deviation is shown in Table 24.

Table 24 Multiple Measures for Variation of Scoring

Criteria	Average STD	Average IQR	Average MAD	Average Range
Economic Efficiency(EF)	2.47	3.59	1.07	5.22
Basic Policy Factors				
Backwardness (BW)	3.28	4.89	1.52	6.90
Regional Econ. Impact(ED)	2.46	3.57	1.11	5.26
Commitment (CP)	2.18	3.23	0.99	4.62
Financial Feasibility (FF)	2.87	4.26	1.34	6.12
Relevancy (RV)	2.76	3.96	1.24	5.95
Environment(EI)	2.61	3.77	1.06	5.55

Table 24 shows the variation of scoring among analysts. It provides several useful findings. First, the large variation in scoring is observed in the judgment on economic efficiency. On average, standard deviation of scoring on economic efficiency is 2.47 (shown in Table 24) and a project showing the largest variation among analysts has a standard deviation, 7.56 (not shown in the table). Such a large variation implies that analysts judge differently to a given economic analysis results. The meaning of BC ratio 1.2, for example, is not the same to analyst A and analyst B.

Second, we find a relatively small contribution of quantitative information in reducing the variation of scoring among analysts. One piece of conventional wisdom is that objective and quantitative information can reduce the possibility of different interpretation. So, the variation of scoring on EF (economic efficiency), BW (backwardness of region) and ED (regional economic impact) which use quantified information would be smaller than that of other criteria which use qualitative information. Unlike the expectation, the average range of BW, the difference of highest scoring analyst and lowest scoring analyst, is around 6.90 and standard deviation is as much large as 3.28. Such a large variation in BW is not because of information deficiency. KDI provided quantified underdevelopment index and recommended analysts to use it in scoring BW.

Despite the quantitative information, analysts still make different judgments. The large variation is also observed in the economic efficiency and regional economic impact. Analysts use quantitative information for scoring economic analysis (benefit cost analysis) and regional economic impact (Multi-Regional Input-Output). Despite the quantitative measure used for scoring, the variation of scoring on EF and ED is not much different than for other criteria relying on qualitative information.

Third, compared to BW, commitment to project (CP) shows the lowest variation in scoring (mean of STD is 2.18 and range is 4.62). In 148 projects, analysts gave an average score of 4.01 on CP. Such a low variation and high score implies that analysts tend to agree about the high importance of this criterion.

Fourth, the degree of variation in scoring is different according to project fields. Figure 10 and Figure 11 show the mean of the standard deviation and the 95% confidence interval by each project field, by criteria. The rail project shows high average standard deviation (3.3) in scoring on FF (Financial Feasibility) compared to other criteria. Such a large variation is related to the size of project and funding source. As shown in Table 25, on average, the construction costs of rail project are around 780 million dollars. Because the Korean government's Transportation Special Fund, which is a major funding source for transportation investment, was mainly spent on roads (61.2%)(Korea MOCT. 2003), analysts for rail and harbor projects are showing their concern about whether funding will be available. In Dam project, the scoring on EF and on environmental impact (EI) shows a large variation. Estimates of benefits are usually more uncertainty for dam projects. In Figure 10, we can observe large variation in EF among analysts in dam projects. Also, dam project has difficulty assessing environmental impact. Such problems are also reflected in scoring the EI.

Fifth, road projects show pretty consistent and small variation in scoring. The average standard deviation of scoring is small for most criteria and its confidence interval is also consistently smaller than for other project fields. The result implies that analysts in road projects interpret analytic information more consistently than other analysts.

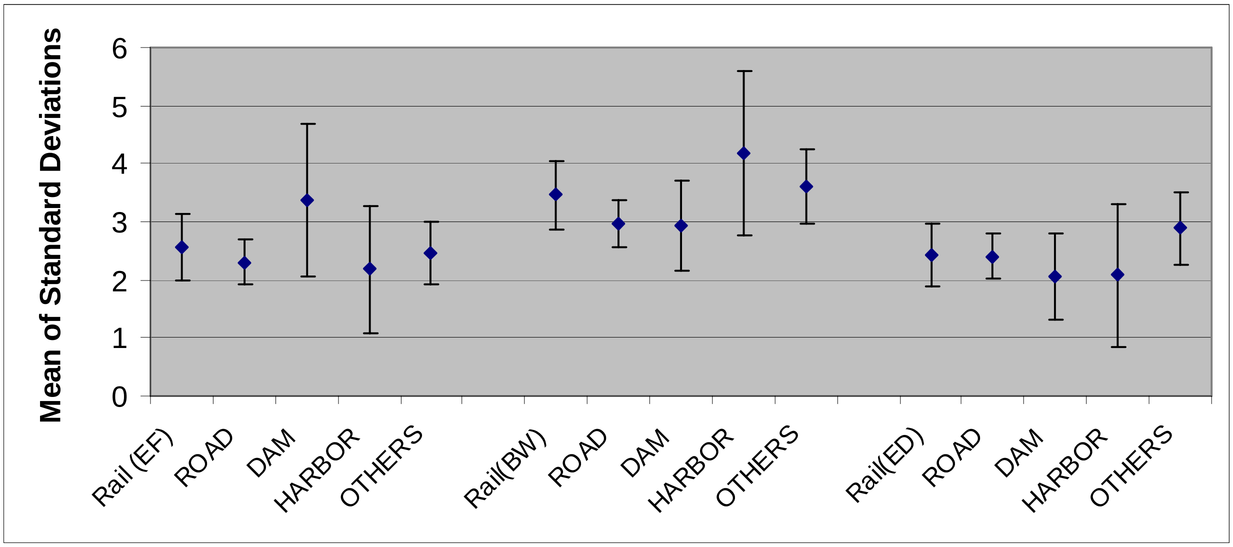


Figure 10 Estimated Average Standard Deviation of Scoring by Project Fields (Criteria Using Quantitative Measures)

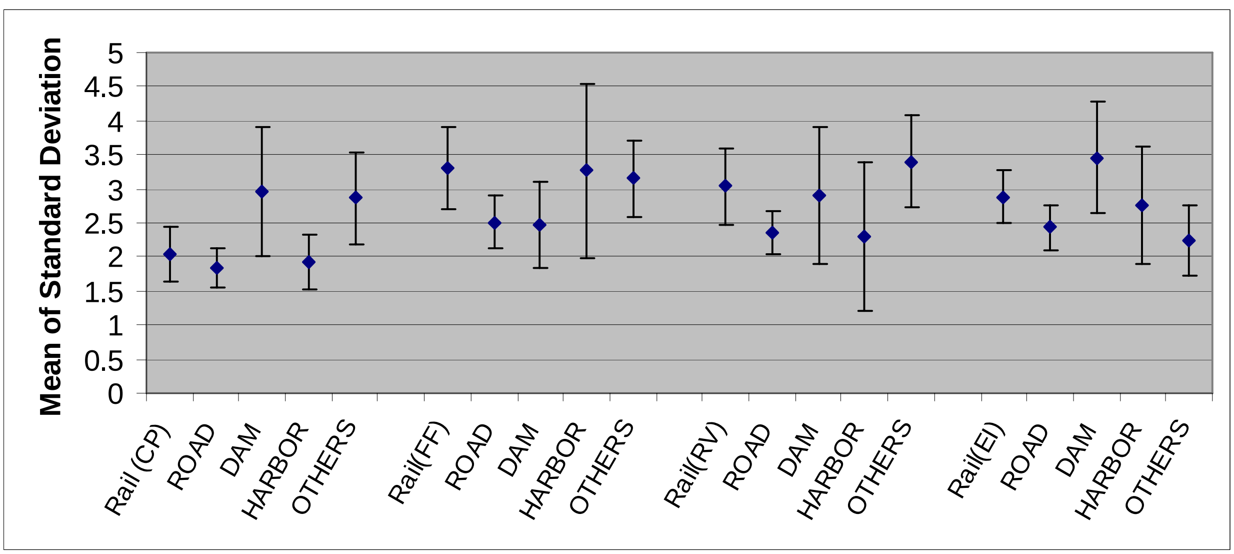


Figure 11 Estimated Average Standard Deviation of Scoring by Project Fields (Criteria Using Qualitative Measures)

Table 25 Average Estimated Project Cost by Project Fields

Project Field	N	Average Estimated Project Costs ($Mil.)	STD	MIN	MAX
RAIL	37	779.84	859.09	26.92	4155.90
ROAD	63	418.94	652.51	19.54	4300.20
DAM	11	336.26	172.65	61.40	634.90
HARBOR	8	752.38	883.08	68.98	2217.40
OTHERS	29	258.36	210.70	49.30	935.50

In sum, we can conclude that the variation in scoring among analysts is large enough to influence the project choice. Note that the scoring is done by experts who have better knowledge about policy problems than most. Despite their superior expertise and information, they were nota able to achieve a consensus. The quantitative information is not so much helpful in reducing the different interpretation of information. While BW, EF and ED use quantitative information, they do not have smaller variation in scoring compared to other criteria using qualitative information.

Instead, the variation of scoring reflects each project field's features. Analysts in rail and harbor projects have difficulty making judgment on FF but those in dam project show large variation in scoring in EI and EF.

We should not interpret the existence of variation as evidence of the uselessness of analysts' judgment. We can show that analysts' judgments greatly reduce the amount of variation in scoring. If we assume that four "straw men" make judgments on weighting or scoring with 9 point scales in a random manner, the probability that average standard deviation is less than 3.28 which is the largest standard deviation (BW) in the actual scoring of analysts in this study, is less than 10%[47]. So, we can conclude that the revealed preference of analysts' scoring reduce the variation significantly.

5.5 SUMMARY OF FINDINGS AND IMPLICATIONS

In this chapter, I performed descriptive analyses of analysts' revealed preference on weighting and scoring especially focusing on basic patterns and the degree of variation. The major findings can be summarized as follows:

Weighting between economic efficiency and policy factor

i) A significant variation in weighting of economic efficiency exists among analysts.

ii) Analysts weight more on policy factors (49%) than other Korean government agencies expect (39%).

iii) Analysts emphasize more on other policy factors when they make decision on their own project than do on general public investment.

iv) The variance of analysts' weight increases when they are asked to judge more specified problem.

v) Findings ii) and iii) are observed in all project fields.

vi) The weight of economic efficiency differs by project fields. Transportation investments (road, rail and harbor) gave higher weight on economic efficiency than dam or "Others" projects.

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[47] I simulated 1,000 projects' decision in which 4 analysts give scores to a criterion.

vii) Analysts' role in analysis affects weighting on economic efficiency. The principal investigators who are highly responsible for their analysis results put more weight on economic efficiency than other analysts.

viii) Affiliation affects weighting on economic efficiency. KDI analysts and university analysts gave more weight on economic efficiency than analysts from government funded research institutes or private companies.

Weighting between basic and project specific factor

ix) When analysts weight basic policy factors and the project-specific factor, they give slightly more weight to basic policy factors (55.34%).

x) The variation is large (standard deviation is 30.63%) in weighting x).

xi) Transportation investments (road, rail and harbor) gave higher weights to basic policy factors but dam or "Others" projects gave more weight to project specific factor.

xii) Although weighting on basic policy factors is not significantly affected by analysts' role in analysis and affiliation, principal investigators and KDI analysts gave larger weight to basic policy factors.

xiii) The weighting between basic and project specific factors is affected more by project specific features rather than general attribute of analysts (e.g. role in analysis or affiliation).

Weighting between six basic policy factors

xiv) In general, analysts emphasize basic policy factors with the order of: relevancy to related project > commitment to project > financial feasibility > regional economic impact > backwardness of region > environmental impact.

xv) If we consider that backwardness of regions and regional economic impacts are highly emphasized by politicians in Korea, the finding in xv) suggests that analysts' judgments will be different to those of politicians.

xvi) Project fields and affiliation of analysts affect the weighting among basic policy factors but analysts' role in analysis does not.

xvii) Project field, analysts' role in analysis and affiliation explained only 4% to 12% of the variation in the weights for basic policy factors, which implies the project specific features are more important explanatory variables. When we control for project level variation, we can explain more than 50% of the variation in weighting.

Scoring analyses

xviii) Even after controlling between project variations, there is significant unexplained variation in scoring among analysts within a project. The degree of variation generally follows an order: backwardness of region> financial feasibility > relevancy to related plans or laws > environmental impact > economic efficiency >regional economic impact> commitment to project.

xix) Rail and harbor projects show a large variation in scoring on financial feasibility due to the large project costs in constructions.

xx) Dam projects show a large variation in scoring on economic efficiency and environmental impact.

xxi) Compared to other projects, analysts in road projects show consistent scores with small variation.

xxii) Perhaps surprisingly, scoring on the criteria using quantitative information (EF, BW, and ED) does not have smaller variation than scoring on the criteria using qualitative information.

Descriptive analyses in weighting and scoring uncovered judgment characteristics of policy analysts. Evidence strongly supports that policy analysts do not all agree on which criteria should be emphasized more. The significant variation in weighting is observed in all project fields and criteria. We can also identify that analysts are not as focused toward economic efficiency as other interest groups argued. When they make judgment on their projects, they give as much weight to other policy factors as they do to economic efficiency. In addition, they do not underestimate the importance of project-specific factors.

The large variation in scoring confirms that analysts interpret information differently. The utilization of quantitative information is insufficient to achieve uniform interpretation. The findings raise an important question: Is the different interpretation is related to self-interest of analysts? If so, we have to figure out the way to manage the self-interest judgment behavior within a decision model.

6.0 SELF-INTERESTS AND ANALYSTS' JUDGMENTS

The descriptive analyses in the last chapter showed that weighting and scoring vary considerably among analysts and project fields. In this chapter, I analyze whether the difference is the result of intentional behaviors of analysts. The problem of the intentional bias is that analysts' decision is strongly influenced by personal preference and interests, which causes a selective and biased interpretation of information. One well-known intentional bias in public investment is "optimism bias" in cost estimation, which describes the behavior of analysts that they underestimate project costs than actual costs making project accepted. The intentional bias will not be only applicable to cost estimation. Analysts' judgment in weighting and scoring will be affected by preoccupied preferences. The assumption of rational decision maker expects the weighting and scoring is independent. The high weight on economic efficiency, for instance, does not necessarily imply a project is acceptable judged by economic efficiency. However, if weighting is affected by analyst's personal preference, analysts who want to make project accepted will give smaller weight on economic efficiency if the project is less desirable from the point of economic efficiency.

To test the self-interest hypothesis, I check whether the intentional bias is found in the cost estimation. For the systematic cost underestimation is evidence that analysts manipulate their analysis intentionally, I also test whether cost underestimation is observed when analysts' stakes are high. Second, I test whether analysts' scoring is systematically different according to their different self-interest. If some analysts gain benefits from the acceptance of projects, their scoring results reflect such interest. Under the strong intentional bias, analysts may manipulate both scoring and weighting toward the direction of maximizing their interests. Third, I test the degree of bias varies according to the size of self-interest. Even if analysts' scoring bias is consistent with the direction of their self-interests, if the bias does not vary according to the degree of self-interest, it undermines the self-interest hypothesis.

6.1 INTENTIONAL BIAS IN COST ESTIMATION

6.1.1 The problem of cost underestimation

In public investment, a cost estimate is key information for government decision. Korea (Kim, et al. 2000), Japan (Advisory Committee for Public Management of Road Administration. 2003), the U.K. (HM Treasury. 1997) and the U.S. (Executive Order 12893. 1994) explicitly require economic cost information for their investment decisions. So, inaccurate cost estimates can be a serious threat to efficient investment decision-making. The inaccuracy of information comes not only from incompleteness of analysis method but also from the biased intention of analysts.

Empirical studies have reported a significant amount of "cost underestimation"- estimated project cost smaller than actual cost- in public investment (Altshuler and Luberoff. 2003; Flyvbjerg, et al. 2002; Merrow. 1988; Ohk. 1995). "Cost underestimation" suggests that an opportunistic behavior of analysts prevails in public investment analysis. Altshuler & Luberoff indicate that the estimated cost for Boston's artery/tunnel project changed from 3.7 billion in constant 2002 dollars in 1983 to 14.6 billions dollars in 2002 (Altshuler and Luberoff. 2003:116) . The costs of Denver International Airport more than doubled and Seattle's planned new light rail lines increased by more than 50% (Altshuler and Luberoff. 2003:245). Edward Merrow concludes, based on 52 major public and private projects completed in the 1960s and 1970s, that, on average, costs increased by 88% (Merrow. 1988). Nijkamp and Ubbels (1998) report the cost underestimation at the stage of project planning. They analyzed eight projects launched in the Netherlands, Denmark and Finland and found that all of them underestimated the cost. Boardman et. al. (1994) tracked the change of costs to the Coquihalla highway project in British Columbia at the stages from ex ante and in medias res to ex post. The total costs changed from \$354.4 to \$767.6 and finally to \$913.5 million in 1984 constant Canadian dollars. Flyvbjerg et.al. (2003) conducted a large sample study covering 258 projects in 20 countries between 1927 and 1998 and conclude that 90% of transportation infrastructure projects underestimated costs. They report that actual costs are, on average, 45% higher in rail projects and 20% higher in road projects than estimated costs. Ohk (1995:26-29) analyzed the Korean government's major construction projects completed or under construction from 1985 to 1994. He found that among 153 projects, 51% projects show more than 20% of cost increase and only 20.6% of projects were completed within the planned year. Also the Ministry of Construction & Transportation (MOCT) of Korean government reported that the actual cost of 8 major public investment projects implemented were more than twice as large as the predicted costs (Korea MOCT. 1999). Those studies provide strong evidence that the underestimation of project costs is large, widespread, and persistent.

The causes of cost underestimation, however, have not been fully studied. The traditional explanation is technical uncertainty. Technical uncertainty is mainly due to "state uncertainty" and "methodological uncertainty". To measure the cost of public investment projects, analysts have to make assumptions about exogenous variables (e.g. gross domestic product growth rate, industrial structure, technology change and political intervention). Changes in exogenous variables increase state uncertainty. Mega projects requiring lengthy periods for construction and maintenance suffer from a high level of state uncertainty. Relatively, the changes in exogenous variables bring out cost increase rather than cost decrease[48]. This "methodological uncertainty" is due to imperfect data used in analysis, imperfect methods for forecasting the flow of costs, incomplete shadow price, lack of expertise, and honest mistakes. From this technical uncertainty perspective, cost underestimation is an unavoidable error made by policy analysts.

The traditional explanation of uncertainty of cost estimation, however, has been challenged by many researchers. One widely supported explanation is that it is an intentional and willful error rather than a technical error. Martin Wachs (1989) strongly supports this position. Based on his interviews and observations, Wachs states:

"Planners, engineers, and economists have told me that they have had to "revise" their forecasts many times because they failed to satisfy their superiors. The forecasts had to be "cooked" in order to produce numbers that were dramatic enough to gain federal support for projects whether or not they could be fully justified on technical grounds" (cited in Altshuler and Luberoff, 2003:246).

Bent Flyvbjerg (Flyvbjerg, et al. 2003; Flyvbjerg, et al. 2002) points out that if errors were due to technical uncertainty, we still could not explain the consistent bias toward underestimation. He also notes that he cannot find any evidence that the development of elaborated analysis techniques has reduced the cost underestimation problem. He insists that cost underestimation has lasted over decades during which analysts have tried to reduce technical uncertainty. Flyvbjerg et al. (2002:290) conclude that:

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[48] For instance, the increase of price, the delay due to political intervention, and new technologies increase cost.

"The use of deception and lying as tactics in power struggles aimed at getting projects started and at making a profit appear to best explain why costs are highly and systematically underestimated in transportation infrastructure projects."

Altshuler and Luberoff (2003:247) also support this view. They acknowledge that the cost escalation of public investment has become more important and argue consistent underestimation is an example of the "tragedy of commons" which only helps advance specific projects, not the public interest. The "intentional bias" perspective reinforces the argument that policy analysts are caught in an over-advocacy trap (George. 1980), in which they serve their client's interests rather than the societal interests. This also weakens the normative usefulness of economic analysis because the reliability of policy analysis is undermined. Researchers (Flyvbjerg, et al. 2002; Wachs. 1989) criticize analysts in public investment because analysts try to meet their clients' interests and fail to serve the public's interests.

Evidence of cost underestimation and interpretation of it as misbehavior of policy analysts, however, has some problems. First of all, cost underestimation can be a result of "selection bias". Studies review only implemented projects and those where estimated and actual costs are available. Quirk and Terasawa (1986) point out that the probability of a project's acceptance by government is negatively correlated to the size of costs, i.e. projects whose costs are overestimated will be highly likely to be rejected. If we include only projects accepted, there is a systematic bias towards cost underestimation because projects overestimating their cost will be less likely to be included in data. They explain that the reason Merrow et al. (1979) could not find cost underestimation in the cost estimates of U.S. Army Corps Engineers in post war period (1954-65) is due to the fact that the political decision in project selection increases the inclusion of projects whose costs are overestimated. Although they acknowledge the limitations of their explanation, if "intentional bias" is true, we would have found cost underestimation bias in rejected projects. No cost underestimation studies included rejected projects.

Second, a cost increase during an implementation stage can be a result of confounding factors both controllable and uncontrollable by analysts. For instance, project delay due to political reason or the influence of other related projects or law can affect cost increases. In this case, the cost increase is not because of a problem of analysis but the problem of uncertainty of projects.

Finally, project initiators such as local governments or line ministries can have conflicting attitudes toward cost estimation. As a gate keeper, the budget agency usually wants to contain project costs. Project initiators know the situation well and try to ask for more budget than they actually need if they have confidence that the project will be accepted by Congress. In contrast, when project initiators are not sure about the acceptability of projects, they will try to underestimate cost, making project more attractive. If analysts manipulate their cost estimation to meet their clients' interests, we should find asymmetric cost variation according to acceptability of projects. Former studies have not controlled for such asymmetric attitudes.

In this section, I try to test whether the cost underestimation is intentional. Unlike other studies, which examined cost changes between the congressional approval and the implementation stage, I focus on the change in the cost estimate between the planning and budgeting stages. In general, we can have many different cost estimates at the planning stage. At the very early stage of planning, project initiators usually estimate costs very roughly, just including major cost factors. Such an initial cost estimate is successively revised over the process of investment decision-making. In contrast, cost information used in investment decision-making is the estimated costs submitted to the budget agency and Congress for approval. In Korea, a budget agency, MPB, performs economic analysis independently to check whether the submitted cost estimates are reliable through pre-feasibility study. The cost is used at budgeting stage. If we compare the estimated cost at the planning and budgeting stages, we can control "selection bias" because it includes both potentially acceptable and rejectable projects. At the same time, compared to cost variation during the implementation stage, the cost change between planning and budgeting stages is less affected by factors that analysts cannot control such as economic growth, changes of related law or plans or political influence. Thus, the behaviors of cost manipulation can be more clearly observed.

6.1.2 Research Hypotheses

Most cost underestimation studies focus on cost variation in implementation: between the estimated cost at the point of government approval and the actual cost after completion. Pressman and Wildavsky and other implementation theorists (Elmore. 1979; Mazmanian and Sabatier. 1989; Pressman and Wildavsky. 1973) have agreed that the gap between plan and implementation is common in public policy because of multiple goals and participants. The gap will widen when the implementation process is lengthy. In the U.S., the typical highway investment takes around 9-19 years from planning by MPO (Metropolitan Planning Organization) or state governments to completion of construction (Siggerud. 2002). In Korea, at least 4 to 5 years are required for the completion of major highway construction. Such a lengthy implementation process can cause a large cost variation regardless of analysts' intentional cost underestimation. Because construction costs are positively correlated with time, we can't exclude the possibility that the cost variation in implementation stage is a result of long implementation time. In that case, it is not appropriate to use the cost variation to test cost underestimation hypothesis.

Instead, we can rely on cost variation between planning and budgeting. Because of uncertainty and competing interests, cost variation is larger from planning to budgeting (Mott MacDonald. 2002) than cost variation between congressional approval and implementation after controlling for exogenous variables. The clients of analysts at the planning level are, in general, local governments or line ministries. Those organizations prefer to report underestimated costs, making their projects more attractive. In contrast, in budgeting, analysts' clients will be budget agency. They want relatively more precise analysis of cost because they have to allocate limited budgets among competing projects. After receiving an approval to launch a project, analysts and clients would have little incentive to report the underestimated cost. So, if cost underestimation is a result of analyst's misbehavior to meet interest of their clients who want to launch the projects, we have to focus more on behaviors of analysts in the stage between planning and budgeting, which has been understudied in the former literatures.

To test the "intentional bias" in cost estimation, I suggest four hypotheses shown below.

First, we have to find evidence of cost underestimation. So,

H1-1: There are significant cost underestimations between estimated costs in the planning and budgeting stages.

If cost underestimation is due to the misuse of discretion of analyst's expertise, controlling the discretion by requiring compliance with detailed procedures will reduce cost underestimation behaviors. Based on the assumption, the costs estimated with more discretion will be lower than the costs estimated with strict manuals and guidelines. So,

H1-2: The costs estimated with more discretion are lower than the costs estimated with strict manuals and guidelines.

The size of projects also affects the degree of cost underestimation. Compared to small projects, large projects bring more stakes to politicians, local governments and line ministries. If the size of projects is correlated with the degree of interests, we can expect that cost underestimation will be positively correlated to the size of projects. So,

H1-3: The cost underestimation is positively correlated to the size of projects.

Finally, analysts will show asymmetric behaviors according to the possibility of projects being accepted. As Flyvbjerg et al. (2002) argue, a major purpose of a "lie" is to get projects approved. When projects appear to and have considerable net benefits, cost underestimation is not necessary. Analysts may want to ask for a greater budget if they are convinced of the possibility of acceptance. In contrast, when a project's desirability is low, analysts may provide deceptively low cost estimates, making projects attractive. To test this hypothesis, we use benefit cost ratio as a proxy of actual desirability in this study. So,

H1-4: The smaller the benefit cost ratio, the larger cost underestimation that will be found.

6.1.3 Analyses and Results

To measure the degree of cost underestimation between planning and budgeting stage, I collected estimated costs at each stage. The project costs at the planning stage were estimated by local governments or line ministries. When they estimate costs, they rely on external policy analysts with whom they have a close relationship from government funded research institutes, private engineering companies and universities. After finishing reviewing project at the line ministries or local governments, they submit a final proposal to the Ministry of Plan and Budgeting (MPB) to request a budget. I used the costs in the final proposal as planned cost.

Budget cost is also not unique. The estimated costs by a budget agency are not necessarily the same as costs approved by Congress. In Korea, the MPB submits budget proposals to the National Assembly based on the pre-feasibility studies of KDI. Although there is a slight difference in project costs between the MPB and the National Assembly, I used the cost estimated by KDI pre-feasibility study as a cost estimate at the budgeting stage[49].

The discretion of analysts in cost estimation is different in planning and budgeting stages. At the planning stage, precise manuals do not guide the costs estimations. Because of the lack of capacity, local governments do not prepare detailed manuals for cost estimation and have to rely on analysts' expertise. To prevent inconsistent cost estimation and to get comparable cost estimates, KDI developed general guidelines and analysis manuals, under the approval of the MPB, for each project field such as road, rail, water, airport, and science and cultural complex projects. Analysts of each project have to follow guidelines when they perform economic and

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[49] In other countries, the cost estimate proposed by the budget agency and final costs approved by congress will not be the same. However, in Korea, the National Assembly can't increase proposed budgets by budget agency without approval of the executive. Thus, using KDI estimates will not affect our results.

other policy analysis, unless they can provide sufficient reason to override guidelines. Thus, the cost estimate at the budgeting level is more objective and consistent than at the planning level.

The cost underestimation is measured by a percent change between costs at the planning and budgeting stages: UR=$\frac{CB-CP}{CP}$, where UR is cost underestimation rate, CB is estimated cost at the budgeting stage, and CP is estimated cost at the planning stage. In general, the time gap between CB and CP is not large because it takes around 6 or 12 months for KDI to evaluate submitted proposals and get CB. Thus, the impact of project environmental changes on cost estimation is not large.

Finally, I measure the probability of project acceptance with the benefit cost ratio, which is used for testing H1-4. The cost estimate is used for deciding the project acceptance from the point of economic efficiency. Because of high correlation between BC ratio and project acceptability, we can use BC ratio as a proxy of project acceptability[50]. The deceptive cost underestimation assumes that analysts in planning stage know the "true" BC ratio but underestimate the cost to make project being accepted. However, it is not easy to know "true" BC ratio that the analysts have in mind. At the planning stage, line ministries or other project initiators report cost estimation but do not usually report the benefit-cost ratio. Even if they report the benefit-cost ratio, the inclusion rule of benefit factors is too subjective. However, as BC ratio estimated by pre-feasibility studies is less biased and estimated with manuals, we can use the BC ratio of budgeting stage as a proxy of true BC ratio. Thus, I use the benefit cost ratio acquired from pre-feasibility study to test H10-4.

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[50] Of course, project acceptability is not solely defined by economic efficiency. However, as cost underestimation is the effort to increase the attractiveness of project by overestimating economic efficiency, analysts' deceptive behaviors would be more likely to be observed when the true size of economic efficiency is low.

If Hypothesis 1-1 is true, we can expect to find a significantly positive cost underestimation rate (UR). The UR of 144 projects was estimated having a sample mean 12.4% with confidence interval [4.5%, 20.69%] under significant level 0.05. It implies that, on average, the cost estimated by the budgeting agency was 12.4% higher than the cost estimated at the planning stage. Such a cost underestimation is statistically significant and seems to support the pervious literatures' findings, while other aspects discussed below weaken it. Rather than having monotonic patterns, cost underestimation fluctuates over time. When we observe the cost underestimation rate (UR) by year, cost underestimation is observed in year 2002(28.7%) and 2003 (21.8%)[51] but not in year 2001 (0.4%) and 2004 (-6.7%) as shown in the figure below.

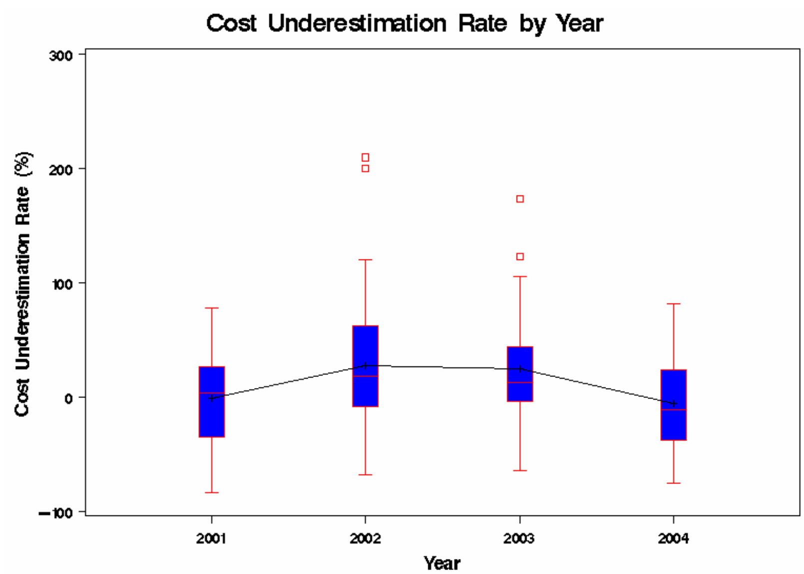

Figure 12 Cost Underestimation Rate by Year (2001 to 2004)

UR is also different according to project field. As shown in Table 26, harbor and dam projects show higher cost underestimations, 66.5% and 51.9%. Such a large UR is statistically significant, and we can reject the null hypothesis, "UR=0". In contrast, rail, road, and "Other"

[51] While cost underestimation is observed in 2003 and 2003, it is not statistically significant.

projects have low UR (10.0%, 3.0% and 10.4%)[52] whose 95% confidence limits include 0, which implies that we cannot reject the hypothesis UR=0. If we integrate all samples and perform confidence intervals of UR, we can observe slight cost underestimation, i.e. UR=12.4% with confidence limits [4.10%, 20.69%].

Table 26 Descriptive Statistics and 95% Confidence Limits of Cost Underestimate Rate

	N	Mean	STD	Lower 95% CL	Upper 95% CL
Dam	9	51.91%	62.30%	11.21%	92.61%
Harbor	7	66.49%	37.20%	38.93%	94.04%
Rail	37	10.01%	47.98%	-5.45%	25.47%
Road	63	3.04%	51.94%	-9.79%	15.86%
Others	28	10.39%	36.80%	-3.24%	24.01%
All	144	12.40%	50.62%	4.10%	20.69%

From the results, we can observe the cost underestimation (12.4%) but this is mainly because of certain project fields such as dam and harbor. Most projects (128 among 144 projects) in rail, road and "Others" type of projects show little cost underestimation. The discretion of analysts does not seem to significantly affect cost underestimation. Costs estimated by KDI are calculated with proposed manuals that analysts must follow. In contrast, local governments and line ministries usually do not provide explicit guidelines to analysts in cost estimations and analysts therefore have more technical discretion. Under Hypothesis 1-2, the more discretion in planning stage should have to lead the larger cost underestimation because analysts in the stage enjoy more discretion. However, the size of cost underestimation is small in rail, road and "Other projects".

I also analyzed the correlation between the size of projects (measured by original costs) and UR. If we assume the clients of analysts have more stakes in large project, we would find

[52] Compared to the study of Flyvbjerg et. al. (2003) which suggests 45% and 20% of cost underestimation in rail and road projects, UR is so small.

positive correlation between size of project and cost underestimation. As shown in Table 27, however, for three of 5 project fields, the correlation negative and statistically insignificant. Also, other two project fields show positive correlation and statistically insignficiant.

Table 27 Correlation between the Size of Project and Cost Underestimation

	Dam	Harbor	Rail	Road	Others	All
correlation coefficient	-0.330	0.408	-0.020	0.070	-0.170	0.013
# of project	9	7	37	63	28	144
p-value	0.379	0.363	0.897	0.073	0.386	0.88

Finally, I test hypothesis 1-4: whether the cost underestimation is greater when the BC ratio of the project is lower. Before we construct a linear model to test this hypothesis, we need to consider the random effect of the project field factor. We can differentiate the level of observation by project fields and each individual project. Each project (level 1) will be included in a project field (Level 2). In Table 26, we observed that the variation of cost estimation is different among project fields. It implies that the variations within a project field will not be the same as the variations within the other projects in different project fields. This causes a violation of the homogeneous variation assumption in general linear model. At the same time, if observations within a project field are more homogenous than observations randomly sampled from whole projects, we cannot assume the independence of observations, which is a fundamental assumption of most of linear model.

Sullivan et.al. provide a simulation result between a model that controls the level effects and a model that does not control level effects (Sullivan, et al. 1999). It concludes that ordinary regression techniques produce estimates of standard errors which are too small resulting in inflated type I error and misleadingly tight confidence interval[53].

For that reason, rather than consider a project field as a fixed effect variable, we consider it as a variable having a random effect. Such an assumption leads us to use a multi-level linear modeling (Singer. 1998) or Hierarchical Linear Model (HLM) (Bryk and Raudenbush. 1992) approach.

Model specification of HLM model for hypothesis 4 will be as follows:

Level 1 Model:

$Y_{ij} = \beta_{0j} + \beta_{1j} BCratio + \beta_{2j} OriginalCost + r_{ij}$, where Y_{ij} is a UR of i^{th} project in a project field j, $r_{ij} \sim N(0, \sigma^2)$

Level 2 Model:

$\beta_{0j} = \gamma_{00} + u_{0j}$,where $u_{0j} \sim N(0, \tau_{00})$, γ_{00} the average project field mean UR.

Combined Model:

$\rightarrow Y_{ij} = \underline{\gamma_{00} + \beta_{1j} BCratio + \beta_{2j} OriginalCost} + u_{0j} + r_{ij}$,where Y_{ij} is a UR of i^{th} project in a project field j, $r_{ij} \sim N(0, \sigma^2)$, $u_{0j} \sim N(0, \tau_{00})$

In the model, we may concern the multicollinearity between the variable *BCratio* and *OriginalCost*. However, when we check the correlation between *BCratio* and *OriginalCost*, the correlation coefficient is very small (0.016 with p-value=0.85)[54].

[53] Similar findings based on empirical data were provided by Osborne(2000).

[54] The heteroscedacity problems was not found, when I test it using White Test in the multiple regression of UR on benefit cost ratio and original cost.

In a combined model, the underlined part is fixed effect term and the other parts are random effect terms[55].

First, I test the chi-square test to determine whether it is necessary to model the covariance structure of the data at all. As shown below in "Null Model Likelihood Ratio Test" table[56], the null model likelihood ratio test indicates a significant improvement over the null model consisting of no random effects and a homogeneous residual error.

Table 28 Model Fit of Hierarchical Linear Model

Null Model Likelihood Ratio Test

DF	Chi-Square	Pr > ChiSq
1	5.19	0.0228

Second, the estimated project level variance (σ^2) and project field level variance (τ) are shown in the table. Those estimates can be used to measure the intraclass correlation, which represents the proportion of variance that occurs between project fields. As the interclass correlation is defined as $\hat{\rho} = \dfrac{\hat{\tau}}{\hat{\tau} + \hat{\sigma}^2}$, the estimated intraclass correlation is 19%, indicating that about 18.96% of the variance in UR is between project fields.

Table 29 Estimation of Random Components

Covariance Parameter Estimates

Cov Parm	Subject	Estimate
UN(1,1)	τ	0.05515
Residual	σ^2	0.2384

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[55] To estimate parameters, I use SAS PROC MIXED procedures.
[56] The "Chi-Square" value is -2 times the log likelihood from the null model minus -2 times the log likelihood from the fitted model, where the null model is the one with only the fixed effects.

Finally, I estimate other fixed effects coefficients. γ_{00} is estimated as 0.2254, and the other two regression coefficients are provided in the tables below. The results show that after controlling for project fields and the size of project, the benefit cost ratio is not statistically significant in explaining the variation of UR (p-value is 0.9018). Thus, we can conclude that a less preferable project (low benefit cost ratio) does not show stronger cost underestimation pattern.

Table 30 Coefficient Estimates of Hierarchical Linear Model on Cost Underestimation

Solution for Fixed Effects

Effect	Estimate	Standard Error	DF	t Value	Pr > |t|
Intercept	0.2254	0.1413	4	1.60	0.1859
Original_cost	2.15E-6	8.016E-6	137	0.27	0.7889
Bcratio	0.008260	0.06685	137	0.12	0.9018

Type 3 Tests of Fixed Effects

Effect	Num DF	Den DF	Chi-Square	F Value	Pr > ChiSq	Pr > F
Original_cost	1	137	0.07	0.07	0.7885	0.7889
Bcratio	1	137	0.02	0.02	0.9017	0.9018

Solution for Random Effects

Effect	ptype	Estimate	Std Err Pred	DF	t Value	Pr > |t|
Intercept	DAM	0.1911	0.1567	137	1.22	0.2247
Intercept	HARBOR	0.2572	0.1641	137	1.57	0.1193
Intercept	OTHERS	-0.1162	0.1341	137	-0.87	0.3878
Intercept	RAIL	-0.1343	0.1317	137	-1.02	0.3095
Intercept	ROAD	-0.1978	0.1252	137	-1.58	0.1164

In sum, if "intentional bias" of cost estimation hypothesis is true, we would find evidence supporting the four hypotheses. However, I find only weak support for cost underestimation from the analysis of 144 projects. Analytical discretion does not seem to affect cost estimation. Even for the large projects in which analysts' clients have high stakes, analysts do not underestimate project cost. Moreover, analysts do not underestimate costs for less acceptable projects. Even in harbor and dam projects, which show fairly strong cost underestimation patterns, the cost underestimation pattern is likely related to complexity of projects rather than analysts' intentional cost underestimation,. In case of dam projects, the compensation costs for real estate and relocation of residents increase once project plans are announced. At the same time, it is hard to predict the possibility of floods or ecological impacts that affect the size of projects. Harbor projects also have high technical uncertainty. Not only is it difficult to estimate the future logistic flow, but it also requires consideration of related land transportation and infrastructure. In that case, the project cost will be changed largely to reflect uncertainty. In conclusion, we can see that cost underestimation is in some projects as former studies suggested. However, there is no strong evidence that cost underestimation is an intentional bias.

One possible criticism of these results will be the tendency of the budget agency to be a "gate keeper". In general, the budget agency wants to limit proposed budgets. So it may put pressure on KDI to report low costs, which may make UR smaller than actual cost underestimation rate. As the cost estimations of pre-feasibility studies follow the general manual, however, the budget agency's preference of a low budget is not likely to affect cost estimation. Also, even if the budget agency limits budgets size inadequately, as project cost will increase during implementation, budget agency will not have strong incentive to unduly manipulate the cost.

A more appropriate explanation of my findings is related to the institutional setting of public investment in Korea. In Korea, cost variation is intensively monitored by the budget agency even after a project's approval by the National Assembly. The budget agency (Korea MPB. 2003) applies very strict rules in reviewing additional spendings requests. If there were large cost increases at the initial stage of project implementation, the MPB would perform other independent feasibility studies to determine if cost increases were acceptable. Also when cost increases are significant in the middle of implementation or even after its completion, budget agencies and other oversight agencies investigate the source of cost variations (Korea BAI. 2004). Under this institutional setting, accountability pressures can minimize intentional cost underestimation. When analysts in the planning stage realize that their estimated costs are reviewed by other independent analysts, they are unlikely to provide irrelevant cost estimates. At a minimum, my findings suggest that cost underestimation is not a necessarily inevitable behavior but can be restricted through an efficient investment decision-making process. Despite only the weak evidence of cost underestimation, however, we should not confirm the image of value-neutral policy analysts. Analysts may try to maximize their self-interest by manipulating benefit sizes. Also, analysts make room for their self-interest maximization during their judgment process, which I will discuss in more detail below.

6.2 Intentional Scoring

The weak evidence of the intentional cost underestimation found in Section 6.1 does not exclude the possibility of self-interest guided judgment. Judgment is far more subjective than cost estimation. There is no strict rule to decide whether one's judgment is right or wrong. For that reason, we can expect there is much more room for self-interest to enter at this point than in cost estimation. Because of the difficulty of getting explicit judgment information, however, the intentional bias in judgments has not been studied so much.

Analysts in the pre-feasibility studies have different self-interests. Analysts from private companies have a strong incentive to promote project acceptance. They have a chance to participate in implementation when projects are accepted. They are also able to maintain friendly relationships with the line ministries or local governments who are some of their largest clients. Similar to analysts from private companies, analysts from government funded research institutes have an interest in high scores because their research funds depend on line ministries and local governments. Thus, under the self-interest hypothesis, we expect that analysts from private companies and government funded research institutes would guide their decision toward high scoring. In contrast, analysts from KDI have a close relationship with the budget agency, Ministry of Plan and Budgeting (MPB). Under the pressure for economizing budget expenditures, MPB prefers more conservative decisions. Such client preferences may affect KDI analysts. Also, as KDI is an economic research institute, most of its research is related to the MPB or the MOFE (Ministry of Finance and Economy) but less related to line ministries or local governments which initiate and implement public investment projects. So, we expect that the self-interest of KDI analysts make them do more low scoring.

Unlike those analysts, analysts from universities have a more complex interest structure. They have weak economic incentives for compliance to the interest of line ministries or local government. They usually care about reputations from other colleagues in academia and want to be more neutral from conflicting interests. Under this conjecture, we may expect their scores to be intermediate between KDI and private analysts.

For testing the influence of analysts' different interests on scoring pattern, I analyze whether a high or low scoring is systematically observed corresponding to the direction of self-interests. Then I try to examine under what conditions the systematic scoring bias is stronger. Based on the assumptions of analysts' attitudes toward scorings, I perform hypothesis tests suggested in the section 3.2.2 to test whether the systematic bias is related to intentionality of maximizing their self-interests.

6.2.1 Optimistic or Pessimistic Scoring

In the section 5.4, we showed that there was significant variation in scoring among analysts. The existence of variation in scoring per se might not a problem in decision-making because analysts having different experiences, professional backgrounds, personality and interests can assess project acceptability in different ways. However, if scoring has systematic patterns such as optimistic or pessimistic regardless of projects or criteria, the differences in scoring would be the result of more than personal differences. If we recall PFS was to get more objective information and judgment, such an intentional bias would weaken its normative desirability.

In order to measure the systematic optimistic or pessimistic scoring, I control analysts' scoring by project fields, affiliations and criteria. This is necessary because scoring is significantly affected the unique feature of each project. So, rather than using absolute sizes of score, I operationalize them using the deviation of scoring from each project's average score to control the difference between projects. Deviation of scoring (S) of analysts *i* in project *j* to criterion *k* is measured:

$Deviation_{iik} = (S_{ijk} - S_{.jk})$, where $S_{.jk}$ is project *j*'s mean score of criterion k

If the deviation is greater than 0, we can assume it is high scoring; otherwise low scoring. Tables below provide average deviation scores by project fields and affiliation.

Table 31-1 Deviation of Scoring by Project Field, by Affiliation (Economic Efficiency)

	Affiliation											
	KDI			Prv			Gov			Univ		
	EFS Deviation			EFS Deviation			EFS Deviation			EFS Deviation		
	N	Mean	StdErr	N	Mean	StdErr	N	Mean	StdErr	N	Mean	StdErr
Project field Rail	56	-1.37	0.27	39	0.94	0.40	9	1.41	0.43	32	0.86	0.50
Road	95	-0.98	0.18	68	1.32	0.32	12	0.82	0.92	66	-0.10	0.25
Dam	22	-1.96	0.45	11	0.93	0.84	1	-1.40	.	11	3.11	0.98
Harbor	10	-1.62	0.53	11	1.55	0.63	6	-0.28	0.79	4	0.19	0.31
Others	55	-0.32	0.27	32	0.56	0.51	3	2.92	2.29	23	-0.32	0.54
All	238	-1.04	0.13	161	1.07	0.21	31	0.91	0.47	136	0.35	0.

Table 31-2 Deviation of Scoring by Project Field and Affiliation (Backwardness of Region)

	Affiliation											
	KDI			Prv			Gov			Univ		
	BWS Deviation			BWS Deviation			BWS Deviation			BWS Deviation		
	N	Mean	StdErr	N	Mean	StdErr	N	Mean	StdErr	N	Mean	StdErr
Project field Rail	54	-2.55	0.39	38	1.86	0.37	9	1.50	0.98	31	1.72	0.37
Road	96	-1.48	0.30	68	1.05	0.31	12	1.01	0.67	66	0.90	0.25
Dam	22	-1.31	0.48	11	2.35	0.89	1	-3.00	.	11	0.54	0.80
Harbor	10	-3.99	0.89	11	1.85	0.92	6	2.14	1.16	4	1.69	0.82
Others	55	-1.30	0.43	32	1.31	0.58	3	1.58	2.81	23	1.10	0.69
All	237	-1.77	0.19	160	1.44	0.21	31	1.30	0.51	135	1.12	0.20

Table 31-3 Deviation of Scoring by Project Field and Affiliation (Local Economic Impact)

	Affiliation											
	KDI			Prv			Gov			Univ		
	EDS Deviation			EDS Deviation			EDS Deviation			EDS Deviation		
	N	Mean	StdErr	N	Mean	StdErr	N	Mean	StdErr	N	Mean	StdErr
Project field Rail	54	-1.24	0.35	38	1.42	0.32	9	1.02	0.52	31	0.12	0.34
Road	96	-0.54	0.28	68	0.50	0.24	12	0.89	0.43	66	0.11	0.30
Dam	22	0.13	0.46	11	0.97	0.49	1	-3.00	.	11	-0.94	0.69
Harbor	10	-1.88	0.61	11	1.09	0.38	6	0.71	0.68	4	0.63	0.65
Others	55	-0.27	0.37	32	0.45	0.46	3	2.33	2.21	23	-0.43	0.68
All	237	-0.63	0.17	160	0.78	0.16	31	0.91	0.34	135	-0.05	0.21

Table 31-4 Deviation of Scoring by Project Field and Affiliation (Commitment to Project)

	Affiliation											
	KDI			Prv			Gov			Univ		
	CPS Deviation			CPS Deviation			CPS Deviation			CPS Deviation		
	N	Mean	StdErr	N	Mean	StdErr	N	Mean	StdErr	N	Mean	StdErr

Project field												
Rail	56	-0.55	0.24	39	0.94	0.23	9	0.41	0.32	32	-0.30	0.45
Road	96	-0.19	0.17	68	-0.17	0.22	12	1.70	0.61	66	0.15	0.24
Dam	22	-1.04	0.49	11	1.64	0.75	1	-1.20	.	11	0.55	0.92
Harbor	10	-1.30	0.36	11	0.55	0.62	6	0.88	0.57	4	0.44	0.28
Others	55	-0.39	0.39	32	0.49	0.40	3	2.33	1.62	23	-0.08	0.79
All	239	-0.45	0.14	161	0.40	0.15	31	1.13	0.33	136	0.05	0.22

Table 31-5 Deviation of Scoring by Project Field and Affiliation (Financial Feasibility)

	Affiliation											
	KDI			Prv			Gov			Univ		
	FFS Deviation			FFS Deviation			FFS Deviation			FFS Deviation		
	N	Mean	StdErr	N	Mean	StdErr	N	Mean	StdErr	N	Mean	StdErr
Project field												
Rail	54	-1.96	0.40	38	2.02	0.43	9	1.07	0.79	31	0.62	0.46
Road	96	-0.62	0.27	68	0.52	0.33	12	0.50	0.86	66	0.27	0.23
Dam	22	-0.42	0.45	11	1.45	0.70	1	-3.60	.	11	-0.28	0.56
Harbor	10	-2.83	1.15	11	1.40	0.72	6	1.61	0.32	4	0.81	0.72
Others	51	-0.76	0.41	30	1.36	0.45	2	0.38	1.13	22	0.05	0.70
All	233	-1.04	0.19	158	1.17	0.21	30	0.75	0.45	134	0.29	0.20

Table 31-6 Deviation of Scoring by Project Field and Affiliation (Relevancy)

	Affiliation											
	KDI			Prv			Gov			Univ		
	RVS Deviation			RVS Deviation			RVS Deviation			RVS Deviation		
	N	Mean	StdErr	N	Mean	StdErr	N	Mean	StdErr	N	Mean	StdErr
Project field												
Rail	56	-1.96	0.43	39	1.53	0.30	9	1.15	0.54	32	1.24	0.33
Road	96	-1.23	0.25	68	0.84	0.18	12	1.31	0.54	66	0.69	0.24
Dam	22	-1.02	0.56	11	1.20	0.85	1	-7.00	.	11	1.47	0.66
Harbor	10	-1.61	0.89	11	1.02	0.38	6	1.19	0.84	4	-0.56	0.69
Others	51	-0.86	0.47	30	0.70	0.46	2	0.63	1.63	22	1.02	0.80
All	235	-1.32	0.19	159	1.02	0.15	30	0.92	0.42	135	0.90	0.20

Table 31-7 Deviation of Scoring by Project Field and Affiliation (Environmental Impact)

	Affiliation											
	KDI			Prv			Gov			Univ		
	EIS Deviation			EIS Deviation			EIS Deviation			EIS Deviation		
	N	Mean	StdErr	N	Mean	StdErr	N	Mean	StdErr	N	Mean	StdErr
Project field												
Rail	54	-1.13	0.35	38	1.00	0.41	9	0.28	0.74	31	0.66	0.42
Road	96	-0.40	0.24	68	0.33	0.28	12	0.46	0.67	66	0.16	0.28
Dam	22	-2.44	0.44	11	1.92	0.52	1	-3.60	.	11	3.29	0.63
Harbor	10	-1.49	0.60	11	0.10	0.82	6	1.43	1.31	4	1.31	0.62
Others	51	-0.60	0.31	30	0.33	0.45	2	1.00	0.00	22	0.80	0.43
All	233	-0.85	0.16	158	0.59	0.19	30	0.50	0.45	134	0.67	0.20

As shown in above tables, to all 7 criteria in all project fields, KDI analysts revealed the weakest preference for project acceptability. In contrast, private analysts show the most positive scoring, expect only on the CP criterion in road projects. Analysts from government funded research institute also show high scoring except on economic efficiency in harbor projects[57]. While university analysts show mostly high scoring, it is not as strong as those of analysts from private companies or government institutes.

Among analysts group, the order from low to high scoring is KDI<Univ<Gov<Prv in EF, BW, CP, FF and RV. In case of ED and EI, the order slightly changes into KDI<Univ<Prv<Gov, and KDI<Gov<Prv<Univ. While we might acknowledge analysts' heterogeneous preferences or each project's specific conditions, such a consistent pattern of optimistic and pessimistic scoring by affiliation suggests that an affiliation can be a significant explanatory variable for revealed preference on project acceptability.

The strength of KDI analysts' negative scoring behavior is different according to decision criteria with an order, BW>RV>FF~EF>EI>ED>CP. Also the strength of private analysts' optimistic scoring is different with an order, BW>FF>EF>RV>ED>EI>CP. When we remind of relatively small variation in weight on BW shown in Table 21 (STD of weight on BW was smaller than RV, FF and CP), it seems that small variation in weighting does not mean the large variation in scoring.

Thus, while the strength is different by criterion and by project field, we can conclude that KDI and private analysts show negative and positive scoring behaviors consistently according to their interests.

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[57] I disregarded dam project whose sample size is only one

6.2.2 Degree of bias and Probability of Acceptance

The previous section provides evidence that the direction of bias in scoring is consistent with the way to maximize KDI and private analysts' self-interests. KDI analysts consistently show low scores, while the private analysts give the high scores to most criteria in different project fields. However, under the self-interest maximization assumption, it is not reasonable that analysts score differently when certain projects are highly acceptable. For instance, if a project has a high BC ratio, it will have a high probability of acceptance from the point of economic efficiency and there would be no strong reason for private analysts to exaggerate the project acceptability. In contrast, if a project has a low BC ratio that implies a low possibility of project acceptance, they will show stronger positive scoring bias to increase the chance of project acceptance. Thus, when the analysts' self-interest is influential factor in explaining the variation of scoring among analysts, the degree of negative or positive scoring should be asymmetric according to the probability of project acceptance because the self-interest is related to the probability.

In the following, I analyze the relationship between the degree of bias in scoring and the project acceptability in each criterion.

6.2.2.1 The Degree of Bias in Scoring and Project Acceptability (Economic Efficiency)

The probability of project acceptance is hard to measure directly but we can use the BC ratio as a proxy of project desirability that is also positively related to the probability of project acceptance. When BC ratio is small or large, we can assume the project acceptability on economic efficiency will be low or high. Here, I group projects into three levels: low, medium and high probability of acceptance based on the BC ratio. The threshold of each level is decided by 25% quartile (BC ratio=0.6485) and 75% of quartile (BC ratio=1.2650).

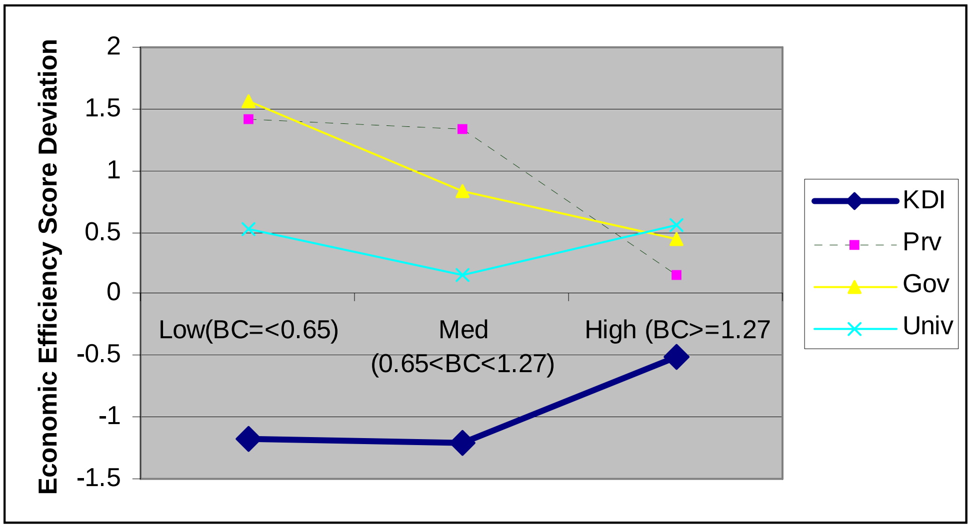

Figure 13 Deviation of Scoring in Three Different Levels of BC ratios

As shown in the above figure, it is pretty clear that analysts of KDI and private companies in lower BC ratio projects show larger negative and positive scoring biases in scoring economic efficiency. The difference between KDI and private analysts, however, decreases as BC ratio increase. This finding is maintained if I control for the project field[58]. The government institute analysts show a larger positive bias when BC ratio is low but the bias decreases when BC ratio is high. Compared to other analyst groups, the scoring of university analysts is less biased.

To show the difference between highly negative and positive scoring by analysts, the following analyses focus only on KDI and private analysts in order to avoid the inclusion of unnecessary variation in the model. For a more detailed analysis, I constructed a multiple regression model of deviation of scoring on the BC ratio, affiliations and their interaction[59].

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[58] Detail tables at the project field level are not provided in here.

[59] As simple regression analysis showed project field has no statistical linear relationship with deviation of scoring, I did not include it in the model.

$$Deviation_{EF} = \beta_0 + \beta_1 BCratio + \beta_2 Affiliation + \beta_3 BCratio * Affiliation + \varepsilon$$

, where affiliation=1 when analysts are from KDI, affiliation=0 when analysts are from the private companies.

Multiple regression results are provided in the following table. As shown in the table, model fit is statistically significant (p-value <0.001). Over 18% of total variation is explained by the regression model.[60] It turned out that BC ratio has negative relationship (coefficient is -0.397) to deviation, i.e. the larger BC ratio, the smaller deviance analysts will show. Also, consistent with our former finding, KDI analysts did pessimistic scoring (coefficient is -2.765). If we disregard the interaction term, on average KDI analysts underscored 1.278(=1.487-2.765) but private analysts overscored 2.765.

Table 32 Impact of BC ratio on Optimistic and Pessimistic Bias

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	449.870636	149.956879	30.04	<.0001
Error	395	1971.778466	4.991844		
Corrected Total	398	2421.649102			

R-Square	Coeff Var	Root MSE	DEVEFS Mean
0.185770	-1189.411	2.234244	-0.187845

Parameter		Estimate	Standard Error	t Value	Pr > |t|
Intercept		1.487173406 B	0.28604076	5.20	<.0001
Bcratio		-0.397274532 B	0.21328078	-1.86	0.0632
Affiliation	KDI	-2.764915450 B	0.37712259	-7.33	<.0001
Affiliation	prv	0.000000000 B	.	.	.
Bcratio*Affiliation	KDI	0.641005763 B	0.29303571	2.19	0.0293
Bcratio*Affiliation	prv	0.000000000 B	.	.	.

[60] Adjusted R-Square is 18%.

Interaction effect shows the role of BC ratio to analysts' scoring more clearly. In case of KDI analysts, they rapidly weakened their pessimistic scoring as the BC ratio become large, as shown in the response lines in Figure 14.

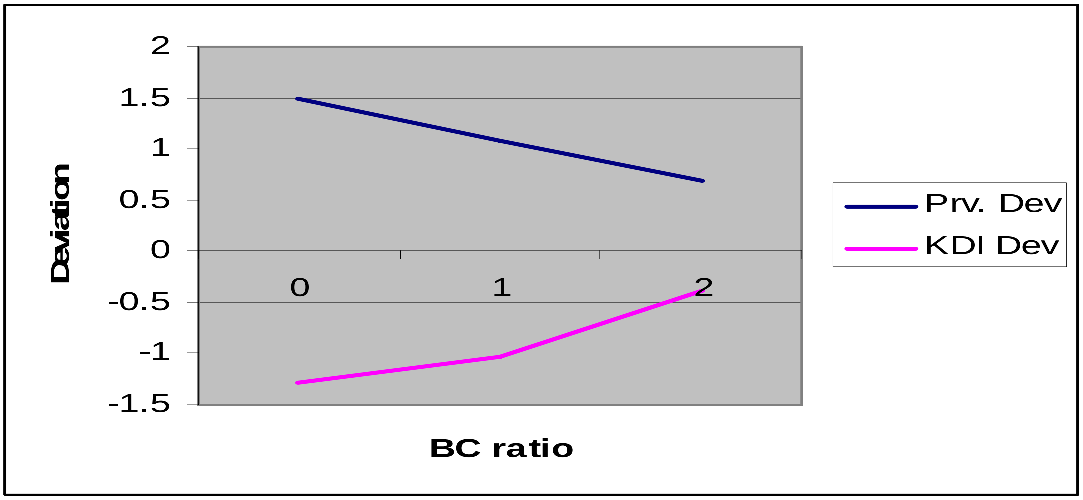


Figure 14 Response Lines of Deviation to BC ratio

Thus, we can conclude that when a project has lower economic feasibility, private analysts show stronger optimistic bias but KDI analysts reveal stronger pessimistic scoring. Such tendency will be weakened when they make decision with projects having higher probability being accepted from the point of economic efficiency.

6.2.2.2 The Degree of Bias in Scoring and Project Acceptability (Other Criteria)

In the former discussion, we find the asymmetric negative or positive bias according to the probability of project acceptance in scoring on economic efficiency. If the bias scoring is the result of self-interest, a similar pattern should observed in scoring on other criteria.

Unlike the scoring on economic efficiency, however, scoring on policy factor usually relies on subjective measures. So it is not easy to assess the probability of project acceptance because of the absence of reference information to judge the project desirability. However, two policy factors, backwardness of regions (BW) and regional economic impact (ED) use the quantitative measures (Underdevelopment Index and Value added per GRDP) for assessing project acceptability.

To analyze the relationship between the deviation of scoring on backwardness of region (BW) and UI (Underdevelopment Index), I used the multiple regression model. In a similar way to the analysis of bias in economic efficiency, the deviation of BW is defined at each project level by subtracting individual analyst's scoring on BW to the project's average mean score. As UI is scaled from 1 to 170 (the greater number implies lesser developed region), a project will have a high probability of acceptance when UI is large. The multiple regression model is constructed as follows:

$Deviation_{BW} = \beta_0 + \beta_1 UI + \beta_2 Affiliation + \beta_3 UI * Affiliation + \varepsilon$, where affiliation=1 when analysts are from KDI, affiliation=0 when analysts are from private companies.

The linear model is statistically significant (p-value of ANOVA table is less than 0.001) in explaining the variation of deviation. The adjusted R^2 was 28%. As we observed the strong positive scoring of private analysts and negative scoring of KDI analysts in Table 31-2, the regression coefficient of affiliation (-4.09) also show the strong pessimistic scoring of KDI analysts. We also find that the negative relationship between UI and deviation of BW scoring (-0.013).

Table 33 Impact of Underdevelopment Index (UI) on Positive and Negative Scoring

ANOVA Table

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	1175.724301	391.908100	51.12	<.0001
Error	390	2989.643183	7.665752		

Corrected Total	393	4165.367484

R-Square	Coeff Var	Root MSE	DEVBWS Mean
0.282262	-589.7665	2.768709	-0.469459

Parameter Estimates

Parameter		Estimate		Standard Error	t Value	Pr > |t|
Intercept		2.246755284	B	0.34575922	6.50	<.0001
UI		-0.013313954	B	0.00427366	-3.12	0.0020
Affiliation	KDI	-4.909157549	B	0.44030238	-11.15	<.0001
Affiliation	prv	0.000000000	B	.	.	.
UI*Affiliation KDI		0.028387625	B	0.00543165	5.23	<.0001
UI*Affiliation prv		0.000000000	B	.	.	.

The interaction between UI and affiliation suggests that the difference between KDI and private analysts will rapidly decrease when their project is in clearly underdeveloped region. As shown in Figure 15, the optimistic or pessimistic scoring is strong when UI is low but it is rapidly weakened as UI grows which means high probability of project acceptance from the point of backwardness of regions.

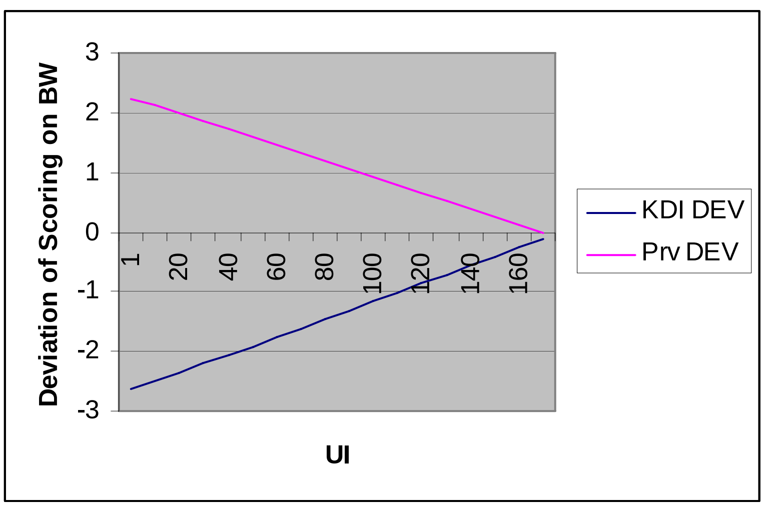


Figure 15 Response Lines of Deviation of Scoring on BW According to UI

Similar analysis can be done on the to the regional economic impact (ED) measured by value added per GRDP(VA_GRDP). The multiple regression model is constructed as follows:

$Deviation_{ED} = \beta_0 + \beta_1 VA\_GRDP + \beta_2 Affiliation + \beta_3 VA\_GRDP * Affiliation + \varepsilon$, where affiliation=1 when analysts are from KDI.

Unlike the scoring on economic efficiency and backwardness of region, only 7.8% of the deviation of scoring on ED is explained by multiple regression model. In addition, while the regression coefficient of VA_GRDP is negative, it is not statistically significant. We also cannot find an interaction effect between VA_GRDP and affiliation. This implies that intentional bias due to self-interest of analysts is weak in scoring on ED.

Table 34 Impact of VA_GRDP to Optimistic and Pessimistic Scoring

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	194.027433	64.675811	10.90	<.0001
Error	384	2278.922870	5.934695		
Corrected Total	387	2472.950304			

R-Square	Coeff Var	Root MSE	DEVEDS Mean
0.078460	-3367.752	2.436123	-0.072337

Parameter		Estimate	Standard Error	t Value	Pr > |t|
Intercept		0.786249484 B	0.19503965	4.03	<.0001
VA_GRDP		-0.067423809 B	0.16147029	-0.42	0.6765
Affiliation	KDI	-1.449012390 B	0.25350561	-5.72	<.0001
Affiliation	prv	0.000000000 B	.	.	.
VA_GRDP*Affiliation	KDI	0.105921553 B	0.19804667	0.53	0.5931
VA_GRDP*Affiliation	prv	0.000000000 B	.	.	.

While we have quantitative measures for EF, BW and ED, other criteria do not have such objective measures to assess the project acceptability. So it is not easy to test whether the project acceptability affects the size of scoring difference. We, however, can indirectly measure the project acceptability to each criterion using $S_{.jk}$ which is a mean score of project *j* to criterion k. For instance, when the mean score to criterion FF in a certain project was 5.5, we may assume that the project is highly desirable from the point of FF.

Using the mean score to each criterion, I assign the probability of project acceptance to low, medium and high with 33% and 66% percentiles of the $S_{.jk}$ in 146 projects as threshold values. The degree of negative and positive scoring is measured as the deviance from mean or median of each project. As shown in Table 35, KDI analysts show the weakest pessimistic scoring in on EF, BW, FF, and RV, when as the project acceptability is high. Similarly, private analysts show the same pattern on EF, BW, ED, FF, and RV. Expect on CP and EI, we can say that negative and positive scoring of KDI and private analysts is weaker when the project's acceptability is high.

Table 35 Deviation of Judgment and Project Acceptability

Criteria	Affiliation		Acceptability		
			Low	Medium	High
EF	kdi	Mean	-0.74789	-1.73556	-0.67829
		Median	-0.75	-1.5	-0.70833
		N	87	75	76
	prv	Mean	1.18679	1.82853	0.24732
		Median	0.66667	1.875	0.36667
		N	53	52	56
BW	kdi	Mean	-1.75517	-2.43969	-1.11194
		Median	-2	-3.25	-0.58333
		N	87	76	74
	prv	Mean	1.83491	1.81481	0.65912
		Median	2	2.26667	0.66667
		N	53	54	53
ED	kdi	Mean	-0.23315	-0.59103	-1.33006
		Median	0.5	-0.5	-1.41667
		N	90	91	56
	prv	Mean	0.91282	0.75254	0.67585
		Median	1.125	0.75	0.66667
		N	52	59	49
CP	kdi	Mean	0.1177	-0.61454	-0.91224
		Median	0.25	-0.75	-1.25
		N	81	94	64
	prv	Mean	0.17179	0.47514	0.55067
		Median	0.125	0.5	0.75
		N	52	59	50
FF	kdi	Mean	-2.2047	-2.05556	-1.959
		Median	-3.2	-0.4	-1.75
		N	156	162	148
	prv	Mean	2.90522	2.02894	2.10432
		Median	3.5	2.5	1.41666
		N	102	106	108
RV	kdi	Mean	-1.53605	-1.06053	-1.33676
		Median	-1.75	-1	-1.5
		N	86	76	73
	prv	Mean	1.19074	1.03367	0.84286
		Median	1.25	1	1
		N	54	49	56
EI	kdi	Mean	-0.34122	-1.18255	-1.20614
		Median	-0.25	-0.5	-1
		N	93	64	76
	prv	Mean	0.00989	0.7961	1.05256
		Median	-0.33333	0.75	1
		N	59	47	52

The findings are not affected by the change of threshold value for classifying high, medium and low project acceptability. The figure, shown in the below, uses 25% and 75% quartiles as threshold values. We can find that analysts show little deviation to highly acceptable projects. Also, in some criteria (EF, BW and RV), the deviation of scoring the medium acceptable project shows higher variation than lower acceptability projects.

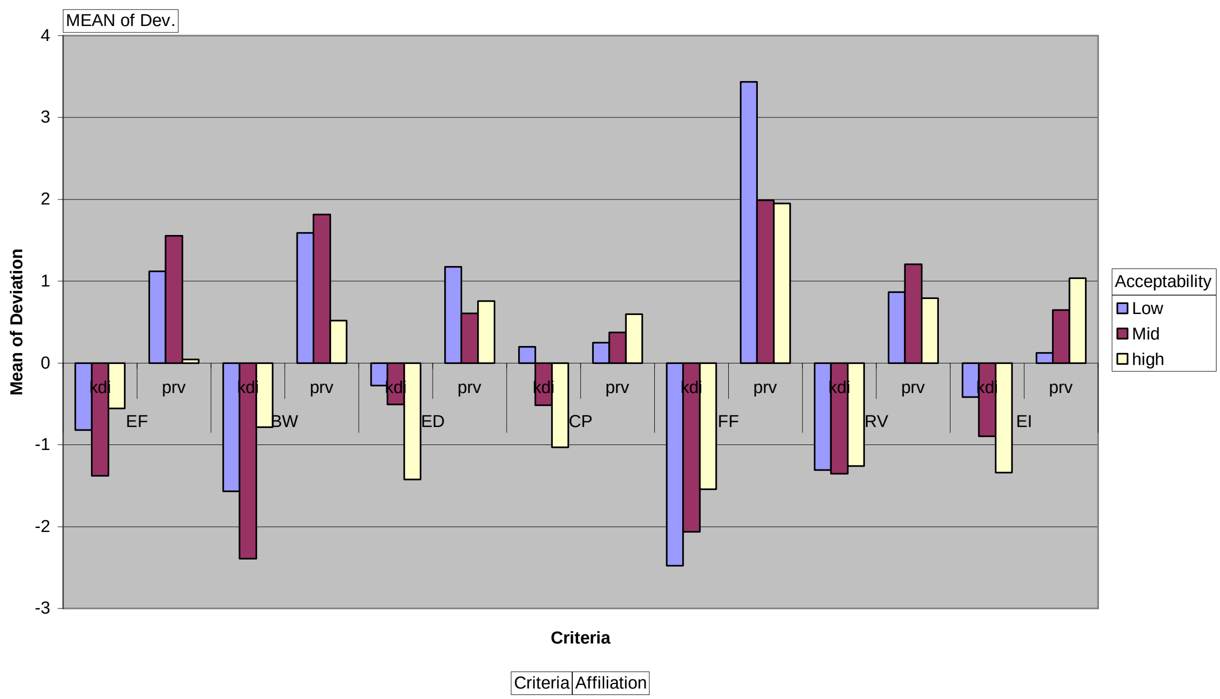


Figure 16 Deviation of Judgment and Project Acceptability (25% and 75% Quartiles as Threshold Values for Low, Medium and High Project Acceptability)

In sum, we found the existence of systematic optimistic and pessimistic scoring of private and KDI analysts and such systematic scoring patterns are highly related to project acceptability. For highly acceptable projects, both KDI and private analysts do not intentionally exaggerate their preference, which leads to small differences in scoring between them. In contrast, when projects are less likely to be accepted, analysts reveal their preference toward the direction of maximizing their interests, which cause large difference in scoring among analysts.

6.3 Association between Weighting and Scoring

In the above section, we found that the scoring of KDI and private analysts is highly affected by their self-interest. If analysts try to manipulate their judgment intentionally to maximize their self-interest, we also expect that their weighting and scoring would be associated. When the analysts' judgment of weighting and scoring is correlated, which patterns can we expect under the self-interest maximization hypothesis?

Analysts will have four possible strategies in revealing their preference: smaller weighting and smaller scoring (SS), larger weighting and smaller scoring (LS), smaller weighting and larger scoring (SL), and larger weighting and larger scoring (LL). If the analysts' interest is maximized when a project is accepted, they will prefer to use SL or LL strategies. Especially, LL will be the strongest strategy making project accepted and LS will be the worst strategy. As the intentional bias is more likely to observed in less desirable projects, we expect to observe LL more frequently than SL in less desirable projects. In contrast, if the analysts' interest is maximized when a project is rejected, they will prefer to use SS and LS strategies. If analysts want to reject projects, LS will be preferred to SS. So, we expect to observe LS more frequently than SS in less desirable projects. Unlike the assumption of self-interested analysts, if analysts make judgment in an impartial way, analysts' judgment pattern is not necessarily biased to one single strategy. So, disinterested analysts will show independent judgment between scoring and weighting. And their choice of strategy will be close to uniform distribution.

Thus, to support the argument that weighting and scoring are correlated according to analysts' interests, we need to find evidence supporting the following arguments.

i) The choice between four strategies is not uniformly distributed.

ii) KDI analysts prefer LS and SS strategy in weighting and scoring

iii) The private analysts will prefer SL and LL strategy in weighting and scoring.

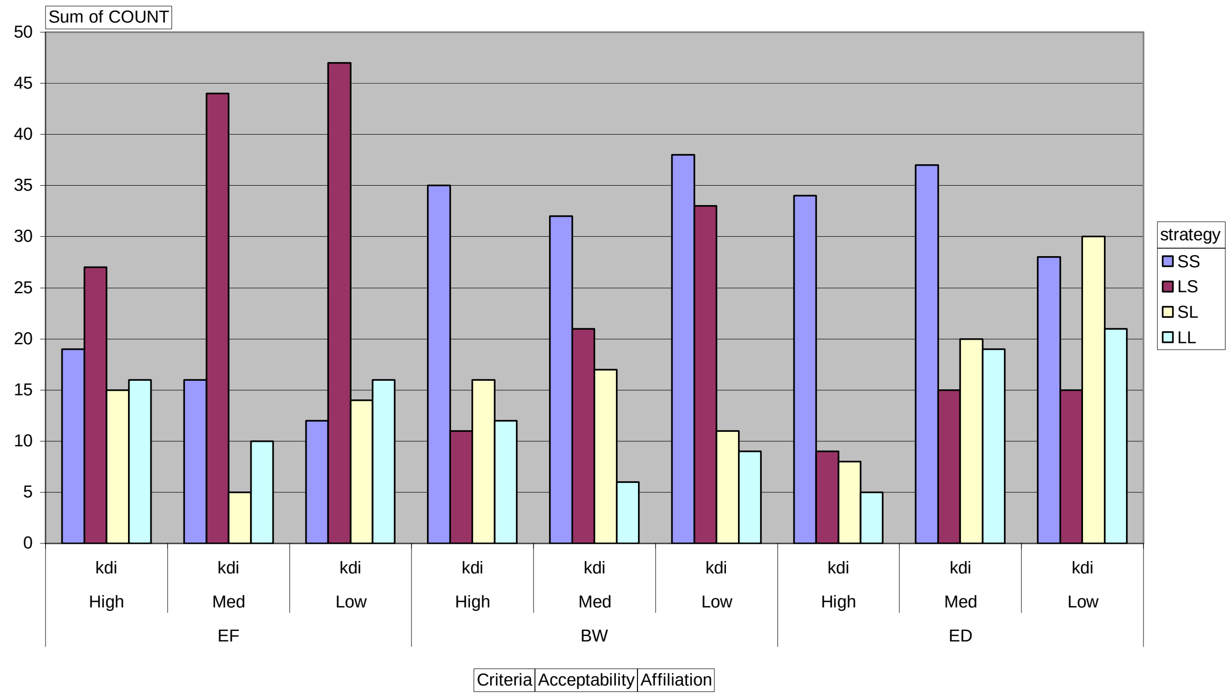
iv) KDI analysts will more frequently adopt LS than SS when the project acceptability is small.

v) The private analysts will more frequently adopt LL than SL when the project acceptability is small.

To test the arguments, each analyst's judgment is classified in one of four possible strategies: SS, LS, SL and LL. When the deviation score from project mean on each criterion is negative, I consider it as S (Small), otherwise L (Large). The project acceptability (desirability) to each criterion is decided by the 33% and 66% percentiles values of average mean scores of 146 projects. Based on the classification rule, I examine the distribution of choice on four different strategies by affiliation, and by criterion.

Figure 17 shows the KDI analysts' choice of strategies. The choice is not uniformly distributed. As we expect in the hypothesis ii), it turns out that KDI analysts prefer SS or LS than other strategies. The strong preference for SS and LS is found on EF, BW, FF, and RV. If we recall that CP, ED and EI did show smaller bias in scoring provided in the section 6.2.1, the results in the below figure is consistent with it.

We can also check whether KDI analysts adopt LS more frequently than SS, especially when the project acceptability is low. In EF, we can find that LS is more preferred to SS in medium and low project acceptability. In BW, although SS is preferred to LS, KDI analysts adopt LS more in lowly acceptable projects than highly acceptable project. FF and RV, LS is preferred to SS in all level of project acceptability. So, we can say that KDI analysts intentionally link the weighting and scoring judgment to some extent, although some criteria did not show such a strong pattern.



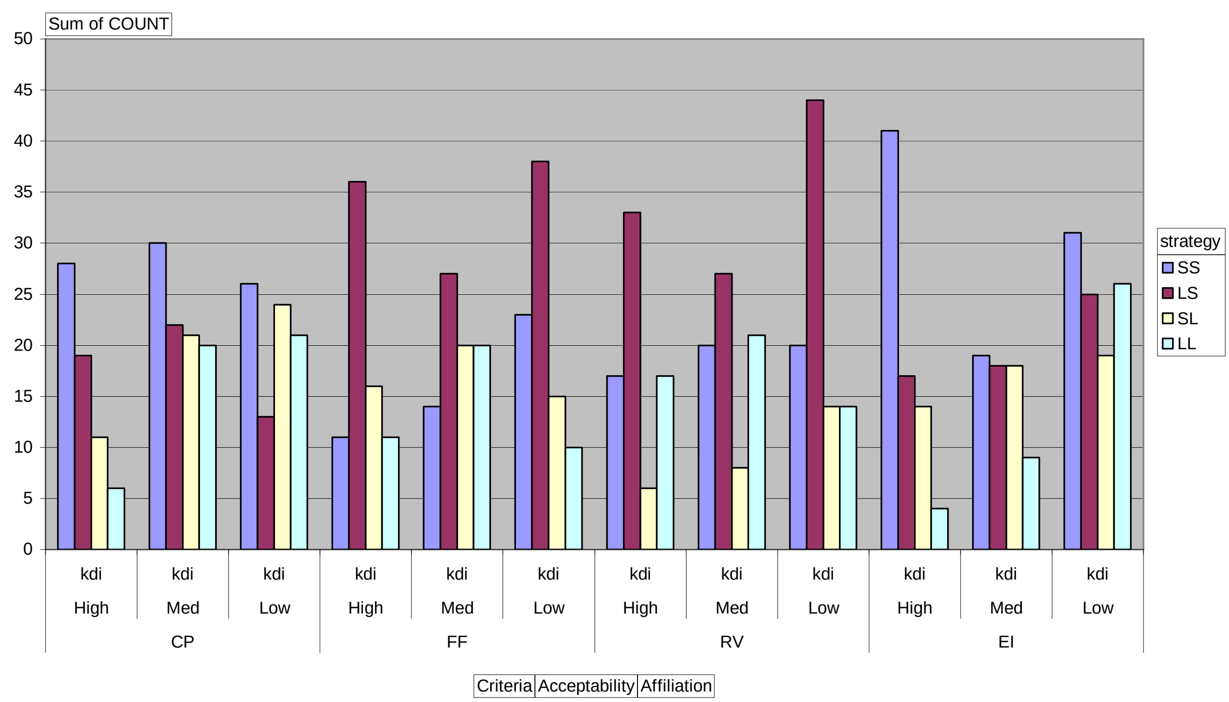
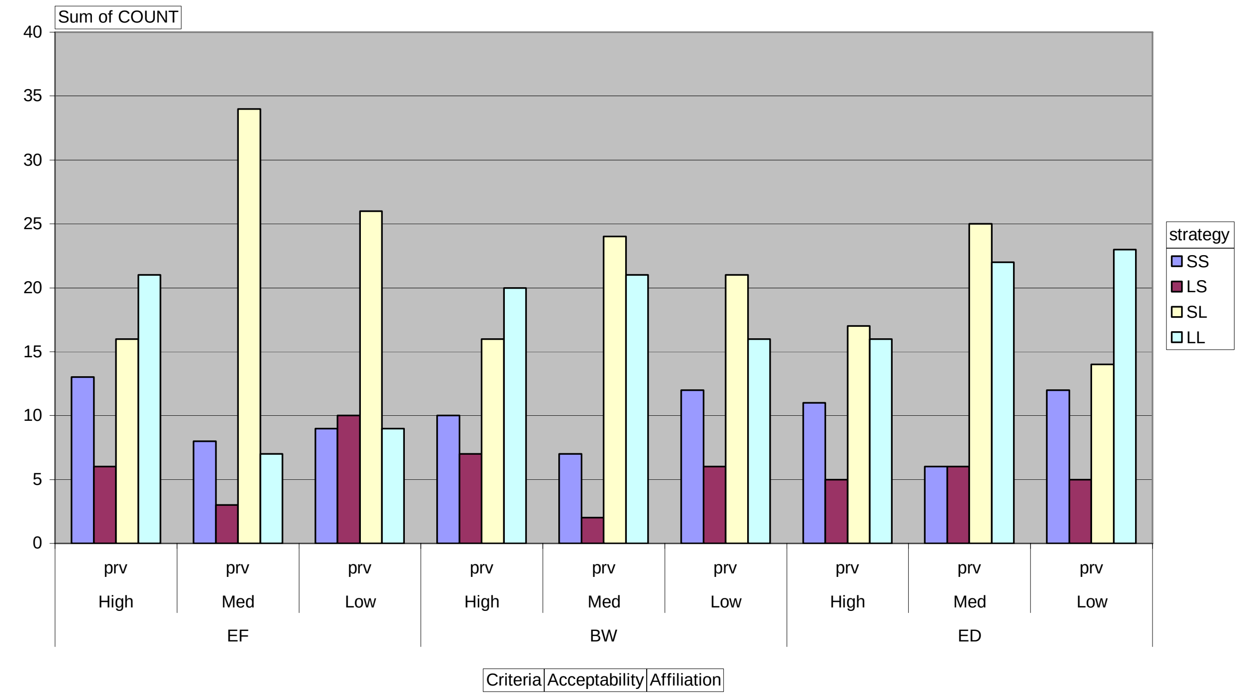


Figure 17 Choice of Weighting and Scoring, by Criteria (KDI Analysts)

In contrast to KDI analysts, private analysts highly prefer SL and LL as we expected in hypothesis iii). The private analysts' bias toward SL and LL is stronger than KDI analysts' bias toward SS and LS. In most of criteria, SL and LL are preferred to other strategies by the private analysts. Especially, the private analysts try to avoid the worst strategy (LS) to their interests (project rejection). They adopt LS less than other strategies in judgment on most criteria. Despite the supportive evidence of intentional judgment, we cannot find the private analysts adopt LL more than SL in less desirable projects, which we expected in hypothesis v). In contrast, in general, SL is more preferred to LL.



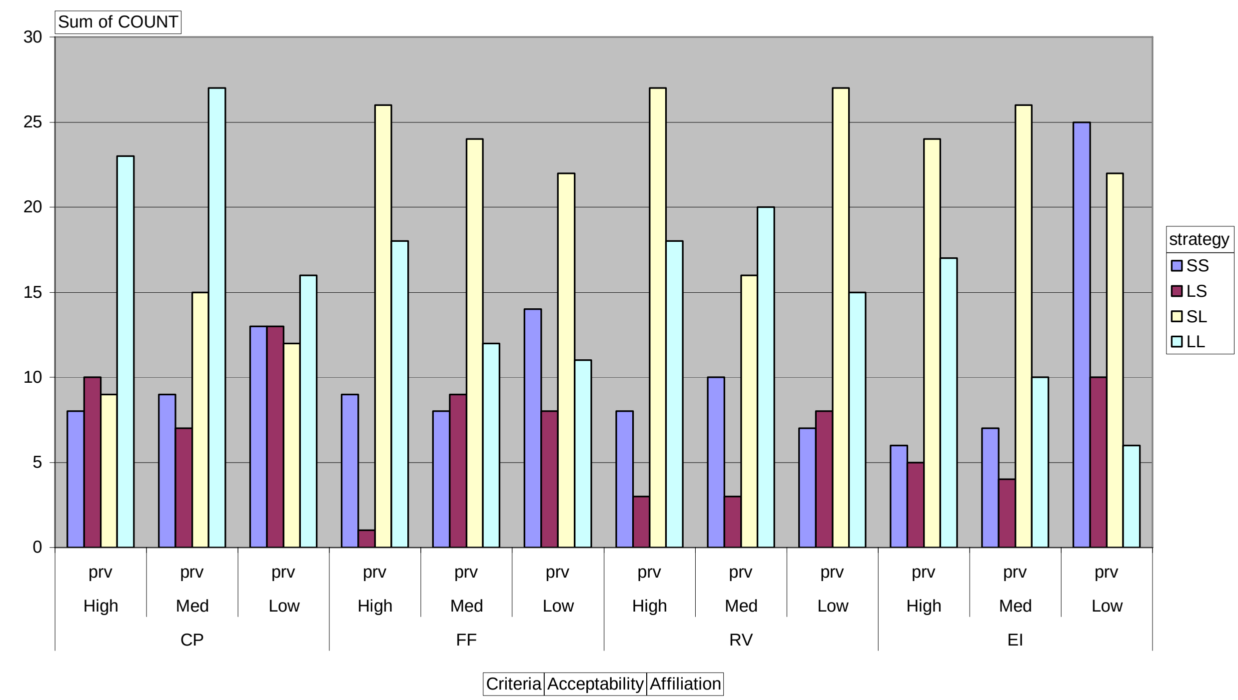


Figure 18 Choice of Weighting and Scoring, by Criteria (Private Analysts)

The analyses of association between weighting and scoring provide evidence that the judgment pattern of KDI and private analysts are different. KDI analysts usually give larger weight and smaller score on criteria (LS strategy). It implies that KDI analysts emphasize the criteria which are less desirable. In contrast, the private analysts usually give smaller weight and larger score on criteria (SL strategy). In many cases, they avoid to use the worst strategy (LS strategy) for the project acceptance. It implies that the private analysts try to underemphasize the criteria which, they think, are negative to project acceptance.

In sum, analysts do not separate the judgment on weighting (relative importance of criteria) with scoring (degree of project acceptability of given criterion). When they think a certain criterion is important, it is likely to mean that it is important because of its relation to project acceptance. In Chapter 5, we found that analysts' affiliation affects the weighting. While the difference of weighting by affiliation is somewhat related to professional background of analysts, analysis results provided in this chapter suggests that the difference of self-interest also affect analysts' weighting behavior. Thus, we can say that self-interest is significant explanatory variable in explaining analysts' judgment behaviors.

6.4 RELIABILITY OF JUDGMENT

In previous sections, we found the intentional bias of analysts' judgments, which is related to self-interests of analysts. If analysts try to manipulate their scores to alter the outcome of the decision, it may affect the reliability of their judgments. Under such conjecture, the reliability of revealed preference of KDI and private analysts should be higher than analysts of government funded research institutes or universities. At the same time, the reliability would be small when the project is less acceptable because analysts' self-interest is strong. The relationship between reliability and self-interest is important in managerial issue. As we found that analysts' judgments are related to their self-interest, how to control analysts' self-interest is an important developing decision-making process. If there is a strong relationship between reliability and self-interest, we can use the reliability measures to detect analysts' self-interests.

In this section, I measure the reliability of decisions using two different measures: the inconsistency ratio and *deviation index of policy feasibility* (DPF). The inconsistency ratio is calculated by the general AHP method explained in the section 4.1.2. The larger inconsistency ratio implies the smaller reliability of judgment. In KDI AHP model, the inconsistency ratio is calculated at the weighting stage. However, because the KDI AHP model only adopts two alternatives (accept and reject project), we are not unable to calculate the inconsistency ratio. So, to test the reliability of scoring, I included an alternative measure of the reliability for analysts' scoring by directly asking them: "how much do you think this project is acceptable from the point of non-economic policy factors?" Analysts reveal the score of project acceptability of policy factors by answering to the question. The deviation index of policy feasibility (DPF) is calculated by:

DPF=(Project acceptability of policy factors calculated by AHP)- (Project acceptability of policy factors by acquired by direct question).

If DPF is large, it can be evidence of unreliable scoring of analysts.

6.4.1 Reliability of Weighting

The following table shows the inconsistency ratio by affiliation. In general, the developer of the AHP suggests that if the inconsistency ratio is smaller than 0.15, a decision is regarded as consistent (Saaty 1980). As shown in Table 36, analysts shows pretty low inconsistency ratio from 0.01 to 0.07 in each group of analysts. It implies that analysts show a high level of consistency in weighting. According to our assumption that strong influence of self-interest may affect analysts' reliability of scoring, we have to find large inconsistency ratio for both KDI and private analysts group. Unlike the expectation, in contrast to large inconsistency ratio (0.08) of private analysts, KDI analysts show small inconsistency ratio (0.03). The degree of reliability according to affiliation is: KDI>Univ>Prv>Gov. Also, the reliability of each project field follows an order: Dam>Others>Road>Harbor ≈Rail. So, we cannot say that the inconsistency ratio captures analysts' strategic weighting behaviors.

Table 36 Inconsistency Ratio by Affiliation and Project Field

	Affiliation											
	KDI			Prv			Gov			Univ		
	Inconsistency			Inconsistency			Inconsistency			Inconsistency		
	N	Mean	StdErr	N	Mean	StdErr	N	Mean	StdErr	N	Mean	StdErr
Project field Rail (0.07)*	56	0.04	0.01	39	0.09	0.01	9	0.09	0.01	32	0.07	0.01
Road (0.06)	98	0.04	0.00	69	0.08	0.00	12	0.10	0.01	67	0.07	0.01
Dam (0.04)	22	0.01	0.00	11	0.08	0.01	1	0.07	.	11	0.07	0.01
Harbor(0.07)	10	0.02	0.01	11	0.10	0.01	6	0.08	0.01	4	0.06	0.03
Others(0.05)	55	0.03	0.00	32	0.07	0.01	3	0.06	0.01	23	0.07	0.01
All(0.06)	241	0.03	0.00	162	0.08	0.00	31	0.09	0.01	137	0.07	0.00

*: values in parenthesis are average inconsistency ratio of each project field.

6.4.2 Reliability of Scoring

In the same way that we analyzed inconsistency in weighting among the analysts group, we can analyze the reliability of scoring on policy factors using DPF. If DPF is a positive value, it implies that analysts' scoring of project acceptability with AHP method is higher than that of simple assessment with a question. As shown Table 37, analysts in all project fields, except university analysts in harbor project, gave lower score to project acceptability in AHP (negative value of DPF) than in simple scoring with a direct question. In general, analysts gave scores for project acceptability that were 8% lower in the AHP than in the simple scoring method. KDI analysts show highly reliable scoring in all project fields (i.e. statistical test cannot reject DPF=0) except road projects. The pattern that the project acceptability on policy factors measured by AHP is smaller than that measured by direct questioning can be related to the specification of decision problem. When analysts are asked to score to general policy feasibility, there are more favorable to accepting project. However, such favoritism weakens when analysts are asked to assess policy feasibility in a detailed way as the AHP does.

The degree of reliability of scoring is different by analyst groups. Private analysts and analysts from government funded research institutes show high unreliability of scoring in rail, road, dam and "Others" project fields. Such a reliability pattern of DPF in policy factor scoring among analysts group (KDI>Univ>Prv>Gov) is consistent with that of inconsistency ratio in weighting. In addition, I checked whether the degree of reliability is related to the project acceptance but I could not find out significant result.

Table 37 DPF (Deviance index of Policy Feasibility) by Affiliation and Project field

	Affiliation											
	KDI			Prv			Gov			Univ		
	DPF(Unit:%)			DPF(Unit:%)			DPF(Unit:%)			DPF(Unit:%)		
Project Field	N	Mean	StdErr	N	Mean	StdErr	N	Mean	StdErr	N	Mean	StdErr
Rail (-0.72)*	56	-3.31	2.03	39	-11.14**	1.67	9	-9.18**	3.76	32	-10.84**	2.65
Road (-10.36)	93	-7.47**	1.33	67	-12.27**	1.56	12	-11.04**	3.68	66	-12.38**	1.52
Dam (-8.49)	22	-3.28	3.37	11	-18.87**	1.5	1	-1.96	.	11	-9.11**	3.21
Harbor (-5.78)	10	-4.01	2.43	11	-5.02	4.21	6	-16.62**	4.43	4	3.96	4.85
Others (-3.02)	55	-0.71	1.92	32	-7.60**	2.41	3	-13.97**	4.42	23	-0.72	4.18
All	236	-4.37**	0.91	160	-11.02**	0.98	31	-11.57**	2.03	136	-9.30**	1.28

(-7.85)													

*: values in parenthesis are average DPF of each project field.
**: Statistically significance under 95% confidence level (Ho: DPF=0)

In sum, the reliability of weighting measured by the inconsistency ratio show both KDI and private analysts are pretty consistent in weighting. In contrast, the reliability of scoring measured by the difference between AHP and simple scoring methods shows weak reliability. Compared to other analysts, KDI analysts show better reliability both in weighting and scoring in general.

6.5 SUMMARY OF FINDINGS AND IMPLICATIONS

In this chapter, I analyzed: i) whether analysts try to underestimate cost as various authors have suggested, ii) whether the scoring is systematically biased, iii) whether the biased scoring is related to their interests, iv) whether analysts associate the weighting and scoring to maximize their self-interests, and v) whether the reliability of weighting and scoring is affected by analysts' self-interest.

First, I do not find cost underestimation to be as serious a problem as others suggested. The comparison of the planned estimated cost by line ministries or local governments and the estimated cost by pre-feasibility show cost underestimation around 12.4%. However, the cost underestimation is mainly found among dam and harbor projects. Unlike the previous studies, road, rail and "Others" projects show only a weak cost underestimation. In addition, it turns out that the project acceptability and the size of project costs, which are related to policy analyst's incentive to do cost underestimation, does not affect the size of the cost underestimation. While the finding may be the result of the Korean government' intensive cost management system, which strictly controls the cost increase in implementation, we can say that the cost underestimation is not incurable problem. Also, we should not interpret the cost underestimation as evidence of deceptive analysts' behavior.

Second, I find strong biases in judgment of analysts. The negative scoring of KDI analysts and positive scoring of private analysts are consistently found in their scoring on the criteria EF, BW, CP, FF and RV in all project fields.

Third, I find supportive evidence that the degree of bias is related to the probability of project acceptance. The frequency table analyses and multiple regression analyses provide evidence that the degree of pessimistic and optimistic scoring of KDI and private analysts is small when project acceptability is high but the degree increases as the project acceptability becomes lower in all criteria expect CP and EI. Thus, the systematic scoring bias of KDI and private analysts is highly related to the probability of project acceptance.

Fourth, self-interest affects weighting and scoring simultaneously. Among four possible choices (LL, LS, SL SS), KDI analysts adopt the higher weighting and smaller scoring approach (LS) approach frequently, which is the effective way of rejecting project. In contrast, the private analysts prefer to use smaller weighting but higher scoring approach (SL). They rarely choose (LS) strategy which is the worst to their interest.

Fifth, it is hard to generalize about the relationship between self-interest and reliability of judgment. Both KDI and private analysts show pretty high consistency in weighting, although the private analysts are less consistent than KDI analysts. In contrast, we can find the reliability of scoring is low. According to the way of measuring and specifying problem, analysts' scoring on policy factor is significantly different. Although we can find that the scoring reliability of private analysts is lower than KDI analysts, it is hard to interpret it whether is a result of self-interest.

In the previous chapter, we found that analysts' judgments in weighting and scoring have a large variation according to type of criteria, project fields, role in analysis and affiliation. In this chapter, I examined whether such variation can be understood under the self-interest hypothesis. The findings suggest that the problem of self-interest is deeply embedded in analysts' judgment. Especially, when a project has a low probability of acceptance, analysts' judgments will be more likely to be affected their self-interests. So, we have to think more about how to control such a biased judgment.

We might consider reducing analysts' discretion in weighting by making analysts use fixed weight to all projects. However, as we observed in Chapter 5, the weight of each criterion is highly related to each project's own features. So, it is not desirable to use the same weight to different projects. To prevent subjective interpretation, we might ask analysts to use more quantified information for scoring. However, our analyses show that even if we use quantitative information, it did not reduce the bias in scoring behaviors. Finally, we might use the reliability measures to detect biased judgments. But we did not find evidence that the reliability measures are correlated to the degree of biased judgment.

To control the biased judgment, first, we need to pay attention to how to organize the research team. If investment analysis is done by a certain group of analysts with a biased self-interest, it would represent their interest. So, it is recommended that analysts with different interests and expertise be included. Second, we can improve the decision model using the accumulated judgment data. From the accumulated judgment data, we can derive the probabilistic distribution of possible range of judgment variation as I showed in this dissertation.

This study provides various possible ranges of judgment in weighting and scoring under given project fields and information. For instance, our analysis reveals that analysts in rail projects have given the weight on economic efficiency within 95% confidence interval [51.5%, 55.6%]. If one project gives weight 20% on economic efficiency, we can conclude it is highly unusual judgment and need to check why his/her judgment deviates so much. This study also shows the average standard deviation of scoring of analysts on backwardness region (BW) has 95% confidence intervals [2.6, 3.4] in road projects. We can use the results in deciding whether the disagreement of analysts in a road project is within an acceptable range.

7.0 STRUCTURE OF JUDGMENT AND ANALYST GROUPS

From previous chapters, we know *how much* analysts in various project fields and affiliations exhibit different judgment patterns. Mainly, we can observe that not only are judgments different but also that they are related to their self-interests. Especially, we can find that KDI and private company analysts show stronger negative and positive scoring behaviors when the projects are less desirable. However, we do not know *what* analysts disagree about in general.

We may analyze the differences of judgment for each criterion as we did in the previous chapters. However, it is not enough to explain the relative difference of judgment in both weighting and scoring. To compare the whole judgment pattern, we need to construct a discriminant function describing similarity or dissimilarity of the analysts' judgment vector. We can perform the analysis by introducing a new latent variable, judgment, which consists of weighting and scoring to economic efficiency and the six other basic policy factors. The latent variable can be expressed as a linear combination of the weighting and scoring vector.

Discriminant analysis (Hair, et al. 1995; Lindeman, et al. 1980; Mertler and Vannatta. 2002) lends us an appropriate methodological framework to analyze the integrative comparison of judgment vector of the analysts. With the method, we can analyze how the judgment pattern is different among four different groups of analysts in different organizations such as KDI, private company, university and government-funded research institute. Major questions discussed in this chapter are as follows:

i) How much similarity or dissimilarity within and between groups exists?

ii) Can we get a statistically significant discriminant function that enables us to classify analysts into groups based on their judgment?

iii) On which judgments, does each group show significantly different behaviors?

iv) How precisely can we expect to classify analysts' groups when we get the revealed judgment information?

Each question will be separately analyzed at the project field level to control for the differences in judgment patterns we found in the earlier analyses.

7.1 DATA AND METHODS

Each project's characteristics strongly affect the absolute size of weighting and scoring. For instance, when a project A has a high benefit cost ratio, the score on economic efficiency in the project will be higher than for other projects. To control for differences in judgments due to projects' characteristics, I use the measure of the relative deviation from each project's average judgment which we adopted in chapter 6. For instance, when an analyst *i* in project A gives economic efficiency a weight of 60% and the average weight on economic efficiency in the project A is 55%, we transform the analyst's judgment by subtracting original judgment by the average of the project, i.e. (60%-55%=5%). Such a deviation score approach can help to control the impact due to between project difference and the variation due to absolute size difference.

In the following model, I include 14 variables[61] representing the revealed preference on weighting and scoring to 7 criteria. The notation rule of each variable as follows: the first prefix shows whether it is weighting (*w)* or scoring (s), DEV implies deviation score, and the last suffix represents the criteria. For instance, the variable "wDEVEF" notates the deviation score in weighting on EF (Economic efficiency) and "sDEVEF" notates the deviation score in scoring on EF. Those judgment variables will be used as predictors in the discriminant function[62].

We can transform the set of predictor variables into a latent variable with a linear combination of 14 variables. The coefficients of the linear equation for the latent variable will be estimated to maximize the variation in the between-group variation compared to the within-group variation. Based on the equation, we can calculate a probability density function of each group and estimate the likelihood function that estimates the probability of membership in a certain group with Bayesian rule when each analyst's judgment vectors are known (Hair, et al. 1995; Huberty. 1994; Mertler and Vannatta. 2002; Rencher. 2002).

In discriminant analysis, I assign the prior probability of each group membership according to the proportion of each group in the total sample. Also, for there is strong possibility that the covariance matrices of each group will be different, I choose the covariance matrix after testing the homogeneity of within-covariance matrices[63]. To assess the relative importance of variables and the explanability of the linear combination of predictor variables on the variation of

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[61] They cover the weighting and scoring judgment on economic efficiency and six basic policy factors.

[62] Discriminant analysis is used to classify observations into two or more known groups on the basis of one or more quantitative variables. The discriminant analysis is different than cluster analysis. In discriminant analysis, the groups (clusters) are determined *beforehand* and the object is to determine the linear combination of independent variables which discriminates the groups. In cluster analysis the groups (clusters) are not predetermined and in fact the object is to determine the best way in which cases may be clustered into groups. The discriminant analysis has a close relationship with logistic regression. Both approaches can be used to classify observations into groups. Discriminant analysis is also comparable to "reversing" multivariate analysis of variance (MANOVA).

[63] In SAS, I used pool=test option for this purpose. If the homogeneity assumption is rejected, we will use within-group covariance matrices instead of a pooled covariance matrix.

group, I use canonical analysis in the discriminant analysis. To control for the difference of judgment structures by project field, I perform discriminant analysis separately by project fields.

The discriminant analysis is sensitive to sample size. To get more robust results, it has been recommended to use at least 20 observations per each group of a dependent variable. Unfortunately, in our dataset, the observations of the analyst group from government research institute ('gov') are smaller than other groups and do not meet the requirement of minimum sample size. The preliminary analysis of discriminant analysis (not reported in this paper) shows unreasonable results (eg. generalized squared distance is too large and the determinant of covariance matrix was too small) when we include the 'gov' group, although I found out that 'gov' group shared the similarity with private analyst group but had the dissimilarity with KDI analysts group. Thus, I remove the 'gov' group in the following analyses.

The other important issue is the multicollinearity among predictor variables. When our purpose is to predict the analysts' group based on their judgment, multicollinearity would not be a problem because it does not cause the biased estimates. The standardized discriminant function coefficients, however, will not reliably assess the relative importance of the predictor variables. The large sample size is not useful in reducing the multicollinearity problems (Derksen and Keselman. 1992). Thus, when I assess the relative importance of variables, I use multiple measures such as discriminant loading, partial R-square and standardized discriminant coefficients.

7.2 ROAD PROJECTS

To measure the similarity and dissimilarity between groups, we can use the generalized squared Mahalanobis distance (SAS 2004). The basic idea of the measure is to compare two groups' mean vector of predictor variables after adjusting the distance with the variance and covariance. The pairwise group different between group i and j is defined as:

$D^2(i \mid j) = (\overline{X}_i - \overline{X}_j)' Cov_j (\overline{X}_i - \overline{X}_j) + \ln(\mid Cov_j \mid) + \ln(q_t)$, when the within-group covariance is used and the unequal prior probability (q_t) is assigned.

With the distance measure, we can calculate the distance from group j to group i after weighting the Euclidean distance inversely by the variation of group j, when the centroid of group j is given. If the distance is small, two groups can be considered to have a large similarity.

In road projects, according to the chi-square test for the homogeneity of within-group covariance, we cannot assume the equal covariance among groups (with Chi-square statistics=364.25 and p-value <0.0001). So, instead of using pooled covariance matrix, I used each group's covariance matrix to calculate the distance within and between groups.

The distances between groups are shown in the table below. As we can see, KDI analysts have smaller distance to university analysts than private analysts. It implies that KDI analysts are more similar to university analysts than private analysts. For the private analysts, they share more similarity to university analysts than KDI analysts. Finally, university analysts share more similarity in judgment with private analysts than KDI analysts.

Table 38 Generalized Squared Distance among Analyst Groups (Road Projects)

Generalized Squared Distance to Affiliation

From Affiliation	KDI	prv	univ
KDI	24.39121	29.73043	26.89392
prv	28.68618	22.12867	24.31977
univ	26.61609	23.30692	22.42615

We can get the discriminant function that maximizes the possibility of identifying analysts group based on their judgments. It is related to get an appropriate linear combination equation of predictor variables clarifying the difference of groups. It has been known that the eigen vector corresponding to the maximum eigen value provides the coefficient of discriminant function that maximizes the difference between groups but minimizes the differences within-group.

As shown in the below table, the discriminant function from the largest eigen value explains 44% of group variation (squared canonical correlation of the first dimension). Also, the discriminant function is statistically significant (F=6.52 and p-value<0.001).

Table 39 Canonical Discriminant Analysis (Road Projects)

The DISCRIM Procedure
Canonical Discriminant Analysis

	Canonical Correlation	Adjusted Canonical Correlation	Approximate Standard Error	Squared Canonical Correlation
1	0.663215	0.637273	0.037097	0.439854
2	0.353927	0.291984	0.057931	0.125264

Eigenvalues of Inv(E)*H = CanRsq/(1-CanRsq)

Test of H0: The canonical correlations in the current row and all that follow are zero

	Eigenvalue	Difference	Proportion	Cumulative	Likelihood Ratio	Approximate F Value	Num DF	Den DF	Pr > F
1	0.7852	0.6420	0.8458	0.8458	0.48998016	6.52	28	426	<.0001
2	0.1432		0.1542	1.0000	0.87473582	2.36	13	214	0.0058

The coefficient of discriminant function is provided in the below table. When the discriminant function transforms 14 predictor variables into a new variable, we can find interesting structure. The coefficients of scoring deviation of EF (economic efficiency), BW (Backwardness of region), RV (relatedness), and EI (environmental impact) are positive but coefficients of weighting deviations are negative[64]. It captures the pattern that KDI analysts prefer larger weighting and smaller scoring but the private analysts opposite shown in Section 6.3. The discriminant function reflects the feature in classifying analysts.

Table 40 Coefficients of Canonical Discriminant Functions (Road Projects)

Raw Canonical Coefficients

Variable	Can1	Can2
sDEVEF	0.253155224	-0.233901917
wDEVEF	-4.110974630	1.898290874
sDEVBW	0.240976997	0.031913960
wDEVBW	-0.412557799	-0.076221763
sDEVED	-0.084262810	-0.129519006
wDEVED	-0.416935567	-0.028036364
sDEVCP	-0.152331398	0.218798253
wDEVCP	-0.399017901	-0.092311394
sDEVRV	0.282268819	0.081987452
wDEVRV	-0.441424366	-0.090932685
sDEVEI	0.027155799	0.003292359
wDEVEI	-0.413105218	0.004473057
sDEVFF	-0.126920761	0.044947406
wDEVFF	-0.418513077	-0.104085180

Based on the discriminant function, we can find the group means on canonical variable, which also can be used for assessing similarity or dissimilarity among groups. As we can see in the table below, the center of a canonical variable of KDI is far away from “prv” and “univ” group, which show the same result in the generalized squared distance. Thus, we can conclude

[64] While other variables such as ED(Economic development), CP(commitment), FF(financial feasibility) do not show positive coefficient to scoring variable but negative coefficient to weighting variable, we can still find smaller coefficient to weighting but larger coefficient to scoring.

that the judgment structure of KDI analysts differs from the structure in other groups. Also, the university analysts show a pattern closer to private analysts than to KDI analysts.

Table 41 The Centroid of Each Group (Road Projects)

Class Means on Canonical Variables

Affiliation	Can1	Can2
KDI	-1.015556852	-0.106115032
prv	0.989446272	-0.395061892
univ	0.442356885	0.559774798

After we get a statistically significant discriminant function, it would be useful to check which variables contribute more for classifying analyst groups. The size of raw canonical coefficient might be useful to decide the relative importance of predictor variables but it is inappropriate when the unit of measure and variance of variables are different. For this reason, we need to use the standardized canonical coefficient. The weakness of the standardized canonical coefficient is that it usually distorts the importance of variables when the multicollinearity is found among predictor variables. It is subject to considerable instability according to the change of data, unit of measure and variance of each variable (Hair, et al. 1995:206). So, I used the R-square of each predict variable and the discriminant loading as the measures to assess the relative importance of variables. At the same time, I perform the stepwise variable selection and report the partial R-square whose size shows the relative importance among variables.

Table 42 Univariate R-Square and Discriminant Loading (Road Projects)

Variable	R-Square	Discriminant loading*	Rank of R-Square	Rank of Loading
sDEVEF	0.1722	0.480719	3	3
wDEVEF	0.1143	-0.389884	4	4
sDEVBW	0.1772	0.51391	2	2
wDEVBW	0.0274	0.173818	10	10
sDEVED	0.0312	0.201275	9	9
wDEVED	0.0581	0.222407	6	7
sDEVCP	0.0073	0.037899	14	13
wDEVCP	0.0171	0.142198	13	12
sDEVRV	0.1855	0.52983	1	1
wDEVRV	0.0631	-0.261867	5	5
sDEVEI	0.0202	0.161654	12	11
wDEVEI	0.0266	0.020007	11	14
sDEVFF	0.0378	0.22364	8	6
wDEVFF	0.0573	-0.212721	7	8

*Correlation between discriminating variable and canonical discriminant function

Table 43 Partial R-Square of Stepwise Variable Selection (Road Projects)

Stepwise Selection Summary									
Step	Number	Entered	Partial	F Value	Pr > F	Wilks'	Pr <	Average	Pr >
	In		R-Square			Lambda	Lambda	Squared Canonical Correlation	ASCC
1	1	sDEVRV	0.1855	25.74	<.0001	0.8144504	<.0001	0.0927748	<.0001
2	2	sDEVEF	0.1489	19.69	<.0001	0.6931472	<.0001	0.1578623	<.0001
3	3	sDEVBW	0.0858	10.51	<.0001	0.6336894	<.0001	0.190084	<.0001
4	4	wDEVRV	0.0501	5.88	0.0032	0.6019224	<.0001	0.2080287	<.0001
5	5	sDEVCP	0.0448	5.21	0.0061	0.5749284	<.0001	0.2229334	<.0001
6	6	wDEVEF	0.0374	4.29	0.0148	0.5534192	<.0001	0.2355686	<.0001
7	7	wDEVFF	0.0306	3.48	0.0327	0.5364685	<.0001	0.2498766	<.0001
8	8	wDEVEI	0.0218	2.44	0.0898	0.5247912	<.0001	0.259774	<.0001
9	9	sDEVFF	0.0178	1.97	0.1416	0.5154646	<.0001	0.2650496	<.0001

When we check the relative importance of variables using R-square and discriminant loading, sDEVRV, sDEVBW, sDEVEF, wDEVEF, and wDEVRV are more important variables than others in differentiating analyst groups. The partial R-square from the stepwise selection of discriminant function also shows the similar results. Compared to R-square and discriminant loading, the partial R-square analysis identifies sDEVCP as one of the most important variables.

Finally, we can assess how the discriminant analysis method accurately classifies analysts into each group using error count rate. As we can see in Table 44, the misclassification rate is 23% which means 77% of analysts are classified into the right group under our discriminant function. Most misclassified KDI or private analysts are usually assigned to university analysts.

Table 44 Classification Accuracy (Road Projects)

Number of Observations and Percent Classified into Affiliation

From Affiliation	KDI	prv	univ	Total
KDI	78	5	12	95
	82.11	5.26	12.63	100.00
prv	7	50	11	68
	10.29	73.53	16.18	100.00
univ	7	11	48	66
	10.61	16.67	72.73	100.00
Total	92	66	71	229
	40.17	28.82	31.00	100.00
Priors	0.41485	0.29694	0.28821	

Error Count Estimates for Affiliation

	KDI	prv	univ	Total
Rate	0.1789	0.2647	0.2727	0.2314
Priors	0.4148	0.2969	0.2882	

The discriminant analyses mainly suggest that the dissimilarity between KDI analysts and other analysts. The university analysts show the pattern in the middle of between KDI and private analysts. Also we find that the sign of the discriminant coefficient is consistent with the findings that the difference strategy of KDI (larger weighting and smaller scoring) and private analysts (smaller weighting and larger scoring). The major difference between groups is found in scoring on RV, BW, EF and CP in road projects, and weighting on EF and RV.

7.2.1 Rail projects

As the chi-square test for the homogeneity of within-group covariance rejects the homogeneity covariance assumption (with Chi-square statistics=273.7 and p-value <0.002) in rail project, I used the each group's covariance matrix to calculate the distance within and between groups. Other analysis process is similar to that of road projects.

In the road projects, KDI and private analysts have a long distance. In rail projects, KDI analysts have the longest distance to university analysts. Private and university analysts, however, are closer to each other than to KDI analysts.

Table 45 Generalized Squared Distance among Analyst Group (Rail Projects)

Generalized Squared Distance to Affiliation

From Affiliation	KDI	prv	univ
KDI	23.56303	32.84321	44.15878
prv	34.47543	21.87805	23.94096
univ	30.05062	23.72204	19.72715

The discriminant function that maximizes the possibility of identifying analysts group based on their judgments explains the 66% of group variation (squared canonical correlation of the first dimension), which is better explanation than road projects. Also, the discriminant function is statistically significant (F=6.63 and p-value<0.001). As the eigen value of the second dimensional discriminant function (0.1874) is so small and statistically insignificant, I use the primary discriminant function correspondent to the largest eigen value (1.9389).

Table 46 Canonical Discriminant Analysis (Rail Projects)

```
                              The DISCRIM Procedure
                          Canonical Discriminant Analysis

                                  Adjusted    Approximate       Squared
                     Canonical     Canonical       Standard     Canonical
                   Correlation   Correlation          Error   Correlation

                 1    0.812242      0.788971       0.030806      0.659736
                 2    0.397244      0.296207       0.076249      0.157803

                                              Test of H0: The canonical correlations in the
              Eigenvalues of Inv(E)*H           current row and all that follow are zero
                = CanRsq/(1-CanRsq)
                                             Likelihood Approximate
   Eigenvalue Difference Proportion Cumulative      Ratio     F Value Num DF Den DF Pr > F

 1      1.9389      1.7515      0.9119      0.9119 0.28656913        6.63      28    214 <.0001
 2      0.1874                  0.0881      1.0000 0.84219739        1.56      13    108 0.1093
```

The coefficient of discriminant function is provide in the below table. Similar to road projects, the coefficients of scoring deviation of EF (economic efficiency), BW (Backwardness of region), RV (relatedness), EI(environmental impact) and FF (Financial feasibility) are positive but coefficients of weighting deviations are negative.

Table 47 Coefficients of Canonical Discriminant Functions (Rail Projects)

Raw Canonical Coefficients

Variable	Can1	Can2
sDEVEF	0.113626879	-0.004849311
wDEVEF	-3.113101721	-2.973182623
sDEVBW	0.238365751	-0.223884857
wDEVBW	-0.295822828	0.021543313
sDEVED	-0.110789201	0.227573109
wDEVED	-0.254069528	0.138320235
sDEVCP	-0.021375496	0.229710337
wDEVCP	-0.282475037	0.080731475
sDEVRV	0.094530653	-0.102152003
wDEVRV	-0.313415866	0.052327415
sDEVEI	0.066491206	-0.105461968
wDEVEI	-0.279413086	0.074461939
sDEVFF	0.077243111	0.050610717
wDEVFF	-0.325039260	0.080370613

The group means on the canonical variable also provide useful information for the similarity or dissimilarity among groups. As we can see in the table below, the center of a canonical variable of KDI is far away from “prv” and “univ” group, which show the same result in the generalized squared distance. However, KDI analysts have a closer centroid to university groups than to private analysts, which is different to the result of the generalized squared distance matrix.

Table 48 The Centroid of Each Group (Rail Projects)

Class Means on Canonical Variables

Affiliation	Can1	Can2
KDI	-1.541026384	0.063929512
prv	1.425411293	0.461028510
univ	0.937090181	-0.676492808

We can check the relative importance of variables using R-square and discriminant loading. When we use R-square, sDEVRV, sDEVBW, sDEVFF, sDEVED, and wDEVED play important role in classifying analysts into group. In rail projects, the difference seems to be related to the scoring rather than weighting. Also when we use discriminant loading to assess the relative importance of variables, sDEVBW, sDEVRV, sDEVFF, sDEVED and wDEVFF are more important variables than others in differentiating analyst groups. The partial R-squares from the stepwise selection of discriminant function show a little bit different result. Compared to R-square and discriminant loading, the importance of wDEVFF seems small (partial R-square is 0.0364) but wDEVCP contributes large in differentiating groups (partial R-squre is 0.1231). One interest thing is that scoring to economic efficiency (sDEVEF) does not seem to a key factor in differentiating groups in rail projects. When we integrate those results, we can say that the difference of judgment among analyst group is clear in scoring on BW, RV, FF and ED.

Table 49 Univariate R-Square and Discriminant Loading (Rail Projects)

Variable	R-Square	Discriminant loading*	Rank of R-Square	Rank of Loading**
sDEVEF	0.1855	0.339723	7	6
wDEVEF	0.1602	-0.303552	8	8
sDEVBW	0.4306	0.620931	1	1
wDEVBW	0.0406	0.114252	13	13
sDEVED	0.2077	0.350501	4	4
wDEVED	0.2032	0.334344	5	7
sDEVCP	0.0949	0.190802	12	12
wDEVCP	0.1138	0.235912	11	11
sDEVRV	0.2989	0.466954	2	2
wDEVRV	0.1541	-0.30261	9	9
sDEVEI	0.1388	0.288363	10	10
wDEVEI	0.0315	0.103575	14	14
sDEVFF	0.292	0.45438	3	3
wDEVFF	0.1904	-0.347762	6	5

*Correlation between discriminating variable and canonical discriminant function

** Rank of discriminant loading is calculated by comparing the absolute size of loading coefficients.

Table 50 Partial R-Square of Stepwise Variable Selection (Rail Projects)

Stepwise Selection Summary

Step	Number In	Entered	Removed	Partial R-Square	F Value	Pr > F	Wilks' Lambda	Pr < Lambda	Average Squared Canonical Correlation	Pr > ASCC
1	1	sDEVBW		0.4306	45.38	<.0001	0.56937201	<.0001	0.21531399	<.0001
2	2	sDEVRV		0.1514	10.61	<.0001	0.48317908	<.0001	0.25843144	<.0001
3	3	wDEVED		0.1119	7.44	0.0009	0.42909436	<.0001	0.29964788	<.0001
4	4	wDEVCP		0.1231	8.21	0.0005	0.37626759	<.0001	0.33536284	<.0001
5	5	wDEVEF		0.0473	2.88	0.0603	0.35848070	<.0001	0.34539693	<.0001
6	6	sDEVED		0.0447	2.69	0.0723	0.34247217	<.0001	0.36170661	<.0001
7	7	wDEVFF		0.0364	2.15	0.1211	0.33002045	<.0001	0.37133439	<.0001
8	8	sDEVEF		0.0359	2.10	0.1269	0.31817876	<.0001	0.37858451	<.0001

Finally, the discriminant function of judgments classifies analysts into groups pretty well. As we can see, the misclassification rate is around 12.2% which means 87.8% of analysts are classified into the right groups under our discriminant function.

Table 51 Classification Accuracy (Rail Projects)

Number of Observations and Percent Classified into Affiliation

From Affiliation	KDI	prv	univ	Total
KDI	52	0	2	54
	96.30	0.00	3.70	100.00
prv	2	33	3	38
	5.26	86.84	7.89	100.00
univ	0	8	23	31
	0.00	25.81	74.19	100.00
Total	54	41	28	123
	43.90	33.33	22.76	100.00
Priors	0.43902	0.30894	0.25203	

Error Count Estimates for Affiliation

	KDI	prv	univ	Total
Rate	0.0370	0.1316	0.2581	0.1220
Priors	0.4390	0.3089	0.2520	

In rail projects, the discriminant analysis suggests that scoring on BW, RV, FF and ED seem to play a significant role. Especially, when we control the other judgments, the scoring pattern on BW is the most important in differentiating groups (partial R-square is 0.43, R-square is 0.43 and discriminant loading is 0.62). It is related to the fact that the rail projects usually cover multiple regions, analysts can use different region for the reference regions to deciding BW. Interest thing is that weighting results are not important in differentiating groups.

7.2.2 "Others" Projects

Similar to road and rail projects, we can use the generalized squared Mahalanobis distance to compare the similarity among groups. As the chi-square test for the homogeneity of within-group covariance rejects the homogeneity covariance assumption (with Chi-square statistics=210 and p-value <0.002), I used the each group's covariance matrix to calculate the distance within and between groups.

In "Others" projects, KDI analysts have the longest distance to university analysts. Private and university analysts, however, are closer to each other than to KDI analysts.

Table 52 Generalized Squared Distance among Analyst Group (Others Projects)

Generalized Squared Distance to Affiliation

From Affiliation	KDI	prv	univ
KDI	21.63212	24.84287	29.07871
prv	24.79035	20.44353	23.16569
univ	27.31614	23.56556	20.24607

The discriminant function that maximizes the possibility of identifying analysts group based on their judgments explains the 38% of group variation (squared canonical correlation of the first dimension), which is smaller than road and rail projects. Also, the discriminant function is statistically significant (F=2.15 and p-value=0.0015). As the eigenvalue of the second dimensional discriminant function (0.1271) is so small and statistically insignificant, I will use the primary discriminant function correspondent to the largest eigenvalue (0.6087). However, the small eigenvalue and the small F-statistics suggests the difference among groups is not so large.

Table 53 Canonical Discriminant Analysis (Others Projects)

The DISCRIM Procedure
Canonical Discriminant Analysis

	Canonical Correlation	Adjusted Canonical Correlation	Approximate Standard Error	Squared Canonical Correlation
1	0.615118	0.545024	0.061551	0.378370
2	0.335771	0.188628	0.087852	0.112742

Eigenvalues of Inv(E)*H = CanRsq/(1-CanRsq)

Test of H0: The canonical correlations in the current row and all that follow are zero

	Eigenvalue	Difference	Proportion	Cumulative	Likelihood Ratio	Approximate F Value	Num DF	Den DF	Pr > F
1	0.6087	0.4816	0.8273	0.8273	0.55154585	2.15	28	174	0.0015
2	0.1271		0.1727	1.0000	0.88725782	0.86	13	88	0.5967

The coefficient of discriminant function is provide in the below table. Similar to road projects, the coefficients of scoring deviation of BW (Backwardness of region), RV (relatedness), EI (environmental impact) and FF (Financial feasibility) are positive but coefficients of weighting deviations are negative.

Table 54 Coefficients of Canonical Discriminant Functions (Others Projects)

Raw Canonical Coefficients

Variable	Can1	Can2
sDEVEF	-0.122880781	0.131958219
wDEVEF	-3.281579037	-4.925936862
sDEVBW	0.256145653	0.034584293
wDEVBW	-1.231067417	-0.738112005
sDEVED	-0.066349303	0.070349298
wDEVED	-1.182176934	-0.703434807
sDEVCP	0.023581024	0.018253637
wDEVCP	-1.237383884	-0.702960544
sDEVRV	0.007960552	-0.087168156
wDEVRV	-1.223873759	-0.695763393
sDEVEI	0.112364880	-0.203974852
wDEVEI	-1.161580525	-0.742691247
sDEVFF	0.051575336	0.223203262
wDEVFF	-1.253061898	-0.701203965

The group means on the canonical variable show a relative small difference among groups compared to road and rail projects. As we can see in the table below, the center of a canonical variable of KDI is away from "univ" group, which is the same to the result of the generalized squared distance matrix. However, the distance is not so large.

Table 55 Centroid of Each Group (Others Projects)

Class Means on Canonical Variables

Affiliation	Can1	Can2
KDI	-0.756769297	-0.078918523
prv	0.536056077	0.490106364
univ	1.023343266	-0.485379375

In "Others" projects, the outstanding variables distinguishing group is not clear. sDEVBW which has the largest R-square only has a univariate R-Square 0.13. Although the stepwise selection procedure suggests four variables (sDEVBW, wDEVEI, wDEVED, and sDEVEF), the only two variable, sDEVBW and wDEVEI have partial R-squares (0.13, 0.14) greater than 0.1.

Compared to road and rail projects, analysts in "Other" projects have smaller difference between them. The distances betweens groups are small and the discriminant function explains small amount of difference between groups. We can also identify the small difference between groups in other projects in Table 31. Compared to other projects, we can see the difference of mean deviation score is small in others projects.

7.2.3 Dam and Harbor projects

In case of dam and harbor projects, as the sample size of private and university analysts are not large enough to perform the discriminant analysis, we cannot do precise analysis we did to road and rail projects. The reliability of the coefficients of discriminant function is too small because of small sample size of each group. Despite the limitation, we roughly assess the judgment structure of analysts. The difference among groups measured by generalized squared distance is similar to road and rail projects. The dissimilarity is large between KDI and university analysts in dam projects. In harbor projects, KDI and private analysts are more different than university analysts.

Table 56 Generalized Squared Distance among Analyst Group (Dam and Harbor Projects)

Generalized Squared Distance to Affiliation (DAM Projects)

From Affiliation	KDI	prv	univ
KDI	1.38629	19.21669	48.01951
prv	17.83039	2.77259	30.63683
univ	46.63321	30.63683	2.77259

Generalized Squared Distance to Affiliation (Harbor Projects)

From Affiliation	KDI	prv	univ
KDI	1.83258	22.10925	21.27347
prv	22.29987	1.64196	24.60348
univ	19.44089	22.58028	3.66516

In the dam projects, the difference among group is highly related to sDEVEF (R-square is 0.4217), sDEVEI (R-square is 0.6388), and wDEVEI(R-square is 0.3829). Even after we control the impact of other judgments, sDEVEI and wDEVEI are still important variables (each partial R-square is 0.6388 and 0.3742). Thus, we can say the significance difference exists in the judgment EI among analysts. If we recall the emphasis of the environmental impact in dam projects, we can expect that the difference of judgments on environmental impact will cause one of barriers making analysts reach to a consensus.

In harbor projects, sDEVBW(R-square is 0.5319), sDEVEF (R-square is 0.4313), and sDEVED (R-square is 0.4774) are important in explaining the group difference. Especially, sDEVBW and sDEVEF are still important variables even after controlling the impact of other judgments (partial R-square is 0.5391 and 0.4005). KDI analysts give too pessimistic scoring to BW (the average of sDEVBW is -3.99) compared to the private analysts (the average of sDEVBW is 1.85) and the university analysts (the average of sDEVBW is 1.69). The pattern is also found in scoring on EF (-1.62, 1.55 and 0.19).

7.3 SUMMARY OF FINDINGS AND DISCUSSION

With discriminant analyses, I tried to assess how the structure of analysts' judgments differs. The misclassification rate is low (12~23%) when we rely on discriminant function to classify analysts. In all project fields, the discriminant analyses show that KDI analysts are different from private and university analysts. If we consider that KDI analysts are economists rather than experts in each project field, the difference seems natural.

The discriminant analyses indicate that the scoring behavior of analysts is major identifier for their group affiliation. Expect for the weighting on EF and RV in road projects, weighting is less important indicator for discriminating analysts group by their judgments. In the section 5.2, the degree of weight is not explained by affiliation in most criteria except economic efficiency. Discriminant analysis is consistent with the finding.

Although I do not perform further analyses, we also need to pay more attention to why analysts show more different judgments to certain criteria in one project field than others. The importance of environmental impact in dam projects or the large amount of project costs of rail projects may explain why EI is important in dam projects or FF is important in rail projects. However, further study should be undertaken for more detailed analyses of why certain criteria are more distinguishable indicators for classifying analysts group than others in different project fields.

8.0 CONCLUSIONS

Policy analysis has developed rigorous methodologies to improve the quality of policy decisions. Many theories, academic programs, research organizations and experts from various disciplines produce a large amount of information relevant to policy decision-making. Despite the efforts, the linkage between analytical information and decision has been not fully studied. Analytical information measures the different aspects of a policy problem with different methods and it has different forms, qualities, and relative importance. In order to be more appropriate for policy making, analysts have to integrate and interpret the information using their contextual and expert knowledge. However, analysts have restricted their role in providing technical information and have left the interpretation and judgment in the hands of bureaucrats, politicians or other consumers of policy analysis. When analysts do not explicitly state which information is more important than others or how their analytical findings can be interpreted, the possibility of arbitrary interpretation of analysis results is large and undermines the usefulness of policy analysis in policy making.

In this study, I emphasized the importance of analysts' judgments in policy analysis. While I agree that the provision of technical information is an important role of policy analysts, their role in democratic societies is broader than that. In a democratic society, no one can dominate a policy decision. Even if politicians or bureaucrats are key decision makers for public investment, we can't underestimate the role of the mass media, other interest groups, and policy analysts. Policy decision-making is not dominated by a single decision maker or group. Rather, it is a process of interaction among related participants. Analytical information and analysts' knowledge affect other people, and they frequently join debates over policy issues and reveal their preferences. Analysts' policy recommendations can be influential alternatives that politicians and bureaucrats consider. In this sense, policy analysts are not only "technical information providers" but also active participants in the policy process having their own opinion and interests.

Also, in order to deal with multi-dimensional policy problems, analysts have to actively participate in judgments. The Korean government, which faced strong pressure for rationalizing public investment decisions, adopted intensive policy analysis called PFS (pre-feasibility studies) in 1999. When it was launched, analysts experienced difficulty in integrating different levels of information and tried to overcome the problem by integrating the judgment process within policy analysis. The application of such an integrative policy analysis generates the unique judgment database allowing us to observe the revealed preference of policy analysts. In PFS, the role of analysts is not restricted to technical information providers; analysts make judgments on their policy problems based on analytical information and their subjective expertise. By making analysts explicitly reveal their preference, we are able to analyze analysts' judgment behaviors.

The descriptive analyses on analysts' judgment provide significant findings on the analysts' judgment behavior. First, contrary to the view commonly argued by politicians, policy analysts were not obsessed by economic efficiency in evaluating investment projects. They gave a similar weight to economic efficiency (51%) as they did to policy factors. At the same time, analysts weight project-specific factors as heavily as they weight basic policy factors.

Second, analysts' judgments were influenced by the level of specification. The more project-specific, a judgment problem was, i.e. as we moved from the general investment project to individual project, the more analysts emphasized the policy factors. For instance, the weighting on basic policy factors and project-specific factors (level 3 in AHP decision hierarchy) had 2.4 times larger variation between analysts than the weighting on economic efficiency vs. policy factors (level 2 in AHP decision hierarchy). This implies that analysts show the judgment behavior that they generally agree on abstract and high level issue but the disagreement will increase as they have to deal with more specified issues. The results suggest that analysts' judgment is sensitive to the way the problem is specified.

Third, analysts' judgments in weighting vary significantly by criteria, project fields, analysts' role in analysis and affiliation. From the analyses, we get the distribution of weighting and the degree of variation among analysts by each project field. While analysts' weighting shows a considerable amount of variation, the statistical distribution allows us to detect unusual weighting behaviors of analysts. For instance, our analysis revealed that analysts in rail projects have given the weight on economic efficiency within 95% confidence interval [51.5%, 55.6%]. If one project gives weight 20% on economic efficiency, we can conclude that this is a highly unusual judgment and need to check why his/her judgment deviates so much. Such an application will increase the responsibility of analysts in their judgments and clarify the project specific issues.

Fourth, judgments on project acceptability (scoring) also show a significant variation. Although analysts within the same project use the same information acquired from their policy analysis, the variation of scoring is significantly large. Significant variation is even found in scoring on criteria using quantitative information. For instance, a BC ratio of 1.2 is strong evidence for project acceptability to some, but weak evidence to others. The findings of significant variation in judgment paradoxically create the possibility of consensual ranges of judgment. From the judgment data, we derived the statistical distribution which allows us to infer the possible range of variation of scoring. After estimating the statistical relationship between quantitative information and actual analysts' scoring results, we can get the possible ranges of score according to given quantitative information. For instance, if BC ratio 1.2 is scored by analysts within the 95% confidence interval [2.5, 3.7], analysts who gave score 7 to a project having BC ratio 1.2 would be regarded as a potential biased rater. At the same time, we also have the distribution of standard deviation of scoring by projects. For instance, we know that the standard deviation on backwardness region (BW) has 95% confidence intervals [2.6, 3.4] in road projects. We can use the result in deciding whether the disagreement of analysts in scoring on BW is within an acceptable range or not. It will give us a chance to examine the reason of large variation in judgments.

In this dissertation, I also performed the explanatory analyses for testing whether such a variation of judgment is systematically affected by analysts' self-interests. I retested the argument proposed by previous literatures that project costs are intentionally underreported by analysts. Former studies have focused on the cost variation between congressional approval and project completion, which is more likely to cause selection bias (excluding the cost variation of rejected projects), and is highly influenced by unrelated variables such as project delay or the change of economic situation. To control for such effects, I analyzed the cost variation between the planning and budgeting stages, which enabled us to control the selection bias and clarify the impact of analysts' biased intention on cost variation. The analysis result shows that while cost underestimation is found in some projects, it is not directly related to self-interest.

In contrast, I found strong evidence that analysts' judgments are related to their self-interests. In most project fields and criteria, private analysts who will have large returns when a project is accepted tend to give high scores. In contrast, KDI analysts who have a close relationship with a budget agency exhibit low scoring. In addition, such patterns are reinforced when the probability of project acceptance is low. At the same time, analysts rarely choose a combination of weighting and scoring that would work against their interests. For instance, private analysts benefit when projects are accepted than rejected, but they did not give a high weight and a low score to a given criterion. Thus, we can conclude that analysts' judgment is highly influenced by their self-interest.

Discriminant analyses showed that the differences among analyst groups is more clearly shown in their scoring on several criteria (economic efficiency, backwardness of regions, relatedness to other plans or laws) than to difference in weighting, although the criteria are different by project fields. Rather than homogeneous groups, discriminant analysis suggests that analysts judgment structures are different according to their affiliation. When we compare the similarity and dissimilarity among analysts, we found that KDI analysts are different from private analysts, and university analysts are located in between.

Analysis results provided in this dissertation have many theoretical and practical implications. First of all, this research provides empirical evidence that policy analysts can expand their role by providing technical information and judgment together. Public policy has to deal with multi-dimensional problems that need to consider multiple criteria and different levels of information to make decision. When we allow analysts to integrate such analytic information and to make judgments, analysts have a chance to deliver their findings and view clearly.

Second, it helps policy making be more transparent. To raise the quality of debate over competing arguments, participants in democratic policy making need to make their own position clear to let others know their standing. If each relies on implicit information and avoids revealing their preferences in a given policy problem, policymaking cannot be transparent and the predictability of policy decision is threatened. The experience of the Korean government shows that the explicit revelation of analysts' judgments prevented the arbitrary interpretation and increased the transparency of investment decision process.

Third, it turns out that the image of policy analysts as technical information providers and value-neutral experts is inappropriate. Analysts from different organizations show different judgments behaviors and they also consider their own self-interests in making judgments. Even when given quantitative information, analysts make different judgments.

Someone might argue that if analysts' judgments are highly influenced by self-interest, it would weaken the usefulness of allowing analysts to reveal their preference explicitly. However, this argument has weak grounds because of several reasons. First, despite the biased judgments of analysts, it reduces the uncertainty of interpretation significantly. When we assume that four "straw men" make judgments on weighting or scoring with 9 point scales in a random manner, the probability that the average standard deviation is less than 3.28 (which is largest standard deviation in actual scoring of analysts in this study) is less than 10%. It implies that at least the 90% of the possible arbitrary judgments is reduced by information of experts' explicit judgments. Second, self-interests can be controlled using the systematic decision analysis. We can detect the highly biased judgments based on the empirical judgment distribution. The accumulated revealed preferences will reduce analysts' the possibility of "hidden action" to maximize their self-interests. We can also reduce the possibility of biased judgments by including analysts that have different interests and expertise rather than relying on a certain group. Finally, the learning opportunity also helps to control the analysts' opportunistic behaviors. As we can measure the gap between analysts' judgments and actual outcomes of projects following project completion, both analysts and government will have a chance to improve and control analysts' judgments.

This study also raises a new research problem that was not analyzed in this dissertation. Our findings suggest that analysts' judgments differ even though they use the same information. The large variation of judgment might not be a unique problem to policy analysts. We might also expect larger variations of interpretation between politicians, bureaucrats or other interests groups. For instance, while politicians highly emphasize the backwardness of regions or local economic development impact in Korea, analysts in this study regarded relevancy to the related law or other plans as more important. So, for expanding our knowledge in policy decision-making, it would be worthwhile to examine how policy analysts, politicians, and bureaucrats make judgment differently with regard to the same policy problem. Thus, we need to expand decision behaviors analysis to other decision makers in the future studies.

Although I emphasize the usefulness of the integration of analysts' judgments in policy analysis process, the findings or conclusions might not be generalizable to other countries or other policy problems. In some countries, political bargaining or authoritative bureaucrats dominate the policy making process. Also, welfare or health policy decisions are different than public investment. However, regardless of the difference in political contexts or policy fields, it will not change the fact that information is less meaningful without interpretation. Although the degree of utilization will differ by country and by policy field, the efforts to integrate a decision model within policy analysis and to understanding analysts' judgment behaviors will make policy analysis contribute to improving the quality of policymaking. While the Korean government relies on AHP (Analytic Hierarchy Process) model and uses a decision hierarchy applicable to public investment context of Korea, the logic of decision model is we can construct different decision models in the U.S. or other countries. Thus, we need to develop more appropriate decision models for policy analysis and try to understand judgment behaviors in different stages of the decision process systematically.

Appendix A
Apportionment Formulas of Federal-Aid Highway Program (TEA-21)

FUND	FACTORS	WEIGHT	STATUTE
Interstate Maintenance (IM)	Interstate System lane miles	33.33%	104(b)(4)
	Vehicle miles traveled on the Interstate System	33.33%	
	Annual contributions to the Highway Account of the Highway Trust Fund attributable to commercial vehicles	33.33%	
National Highway System (NHS)	Remainder apportioned as follows:		104(b)(1)
	Lane miles on principal arterial routes (excluding the Interstate System)	25%	
	Vehicle miles traveled on principal arterial routes (excluding the Interstate System)	35%	
	Diesel fuel used on highways	30%	
	Total lane miles on principal arterials divided by the State's total population	10%	
Surface Transportation Program (STP)	Total lane miles of Federal-aid highways	25%	104(b)(3)
	Total vehicle miles traveled on Federal-aid highways	40%	
	Estimated tax payments attributable to highway users paid into the Highway Account of the Highway Trust Fund	35%	
Bridge Replacement and Rehabilitation Program (BRR)	Relative share of total cost to repair or replace deficient bridges	100%	144(e)
Congestion Mitigation and Air Quality	Weighted nonattainment and maintenance area population	100%	104(b)(2)
Improvement Program (CMAQ)			
Recreational Trails Program (RT)	Equal shares to each eligible State	50%	104(h)
	Nonhighway recreational fuel use during the preceding year	50%	
Metropolitan Planning (MP)	Urbanized area population 2/	100%	104(f)(2)
Minimum Guarantee		100%	105
State and Community Highway Safety Grants	Total population	75%	402(c)
	Public road mileage	25%	

Appendix B
The Chronology of the U.S. Transportation Investment

Andrew Jack era: Federal government would not take the lead in financing, constructing and operating transporting projects (Orenstein. 1990:54-56).

1802: The Army Corps of Engineers was established at the West Point.

1824: The General Survey Act authorized use of Army Corps of Engineers to survey made of routes for roads and canals "of national importance, in a commercial or military point of view, or necessary for the transportation of public mail."

1887: The conflict between the wheat farmers and the Southern Pacific Railroad in California lead the bloodshed. The uprising and other troubles let the federal government form the ICC (Interstate Commerce Commission) which is the first federal agency for regulating transportation. It was replaced by Surface Transportation Board in 1995.

1905: Office of Public Roads was launched in the U.S. Department of Agriculture.

1916: The auto industry and motorists were heavily lobbying for programs and funds to improve roads and Federal-Aid Road Act of 1916 was enacted to stimulate intercity highway construction. The act marked the first time the federal government was directly involved in road-building efforts.

1919: The Agriculture Appropriation Act for fiscal year 1919 changed the name of the Roads and Rural Engineering to the Bureau of Public Roads (BPR).

1921: Federal-Aid Highway Act of 1921 enacted to provide assistance for the construction of seven percent of its highways of each state with matching state funds on a 50/50 basis.

1934: Congress authorized the Federal-Aid Highway Act of 1934 that 1.5% of the amount of apportioned to any state annually for construction could be used for surveys, plans, engineering, and economic analysis for future highway construction project

1936: Congress assigned the U.S. army Corps of Engineers responsibility for flood control engineering works and later for floodplain information service. The Flood Control Act of 1936 asserted that a project should justify its benefits exceed costs. The act states that "Federal government should improve or participate in the improvement of navigable waters or their tributaries, including watersheds thereof, for flood control ***if the benefits to whomsoever they may accrue are in the excess of the estimated costs*** and if the lives and social security of the people are otherwise adversely affected [Emphasis added]".

1938: Federal-Aid Highway Act of 1938[65] seriously attempted to develop a national roadway system.

1939: BPR was transferred from the U.S. Department of Agriculture to the Federal Works Administration in the name of the Public Roads Administration.

1944: Federal-Aid Highway Act of 1944 increased the funds authorized for federal-aid highway program almost 4 times from $ 137,500 in 1942 and 1943 to $500,000 annually for the years 1946 to 1958 to meet the postwar demands. Funds were allocated using area, total population, and postal route miles for the primary systems.

1949: the Public Roads Administration was renamed the Bureau of Public Roads and placed in the Department of Commerce (DOC).

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[65] Federal Aid Highway Act has revised in 1944, 1948, 1950, 1952, 1954, 1956, 1958, 1959, 1961, 1962, 1963, 1964, 1966, 1968, 1970, 1973, 1976, 1978, 1981, 1982, and 1987.

1954: National Committee on Urban Transportation was created. The committee was consisted of experts in a wide range of fields, representing federal, state and city governments.

1955: Air Pollution Control Act of 1955 was passed. It was the first federal air pollution law and identify air pollution as a national problem.

1956: National Committee on Urban Transportation published the guidebook, "Better Transportation for Your City" to help local officials establish an orderly program of urban transportation planning.

1956: Federal-Aid Highway Act of 1956 removed gasoline tax revenue from the federal budget. The act adopted a nationwide standard design such as: a minimum of two lanes in each direction, lanes that were 12 ft in width, a 10-foot right paved shoulder, design speeds of 50–70 mph. To support the sustainable funding resource, Highway Trust Fund was established by Highway Revenue Act of 1956 (Pub. L. 84-627). Prior to the creation of the HTF, federal financial assistance to support highway programs came from the General Fund of the U.S. Treasury. The Highway Revenue Act authorized that revenues from certain highway-user taxes could be credited to the HTF to finance a greatly expanded highway program enacted in the Federal-Aid Highway Act of 1956.

1956: Transit operators were exempted from the federal excise taxes adopted to finance the Interstate Highway Program which was one of very few support to transits by federal policy makers.

1957: Thomas Fratar at Cleveland Transportation Study developed a computer model for distributing OD (origin-destination) travel data using growing factor. Before it, no systematic prediction of future traffic pattern was proposed.

1957: But for the failure of many plans for the development of new downtown-oriented rail systems in a number of cities, the five-county Bay Area Rapid Transit (BART) District was created to build, operate, and finance rapid transit.

1961: Congress authorized $75 millions for modernization loans and grants to commuter rail lines. This was the first ever direct federal aid for urban transit.

1962: Citizens of San Francisco Bay Area vote to tax themselves to build a new regional rapid transit system that opened in 1972 and is known as the BART System.

1963: Clean Air Act of 1963 was enacted and amendments to the act have occurred in 1965, 1967, 1970, and 1977. The latest amendment was singed by Bush I in 1990[66].

1964: President Lyndon Johnson signs the Urban Mass Transportation Act of 1964 that provides $375 million in transit capital assistance over three years. New program to be administered by Housing and Home Finance Agency, which itself was incorporated into the Department of Housing and Urban Development in 1965.

1965: Motor Vehicle Air Pollution Control Act set standards for auto emissions.

1967: The U.S. Department of Transportation was established. BPR was transferred from the DOC to Department of Transportation and became its agency, the Federal Highway Administration.

1967: The Federal Railroad Administration (FRA) was created by the Department of Transportation Act of 1966. The purpose of FRA is to: promulgate and enforce rail safety regulations; administer railroad assistance programs; conduct research and development in support of improved railroad safety and national rail transportation policy; provide for the rehabilitation of Northeast Corridor rail passenger service; and consolidate government support of rail transportation activities.

1968: Federal-Aid Highway Act of 1968 was enacted.

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[66] Details of amendment contents are found at http://www.co.mendocino.ca.us/aqmd/pages/CAA%20history.html

1970: Federal-Aid Highway Act of 1970 was signed by Nixon, which tangibly increased highway funding.

1970: The Highway Safety Act authorized the establishment of the National Highway Traffic Safety Administration.

1973: Federal-Aid Highway Act of 1973 included optional application of Highway Trust Funds for urban mass transit projects.

1976: Federal-aid Highway Act of 1976 established the "3R program" for resurfacing, restoring, and rehabilitating interstate highways.

1978: U.S. DOT developed the Highway Performance Management System. It is an continuing database to replace special biennial condition studies that had been conducted by the States since 1965. It includes data on the extent, condition, performance, use, and operating characteristics of the Nation's highways.

1980: Staggers Rail Act of 1980 and its implementation by the Interstate Commerce Commission remove many regulatory restraints on the railroad industry. It provides the industry increased flexibility to adjust their rates and tailor services to meet shipper needs and their own revenue requirements. This act significantly weakens the regulatory power of ICC on railroad industry, which was considered overregulated than other competing industries.

1981: Federal-Aid Highway Act of 1981 established the Interstate 4R program, providing funds for resurfacing, restoring, rehabilitating, and reconstructing the interstate system.

1991: Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991 was enacted, which gave states greater flexibility in the use of funds for mass transit, and emphasizing regional planning and efforts to reduce automobile pollution in urban areas. Considering the fact that original Highway Trust Fund is for the highway construction, ISTEA places strengthening the country’s intermodal network in the front of policy goal by requiring state governments to develop intermodal plans to improve the connectivity of the various modal systems (e.g., rail, highways, barges, etc.)[67]. The intermodalism was succeeded by TEA-21.

1992: The ISTEA of 1991 established Bureau of Transportation Statistics (BTS) for data collection, analysis, and reporting and to ensure the most cost-effective use of transportation-monitoring resources.

1993: Major Investment Study (MIS) are required[68] "where the need for a major metropolitan transportation investment is identified, and Federal funds are potentially involved" to "refine the plan and lead to decisions by the MPO". It required appropriate assessment by performing the evaluation of "the effectiveness and cost-effectiveness of alternative investments or strategies in attaining local, State and national goals and objectives. The analysis shall consider the direct and indirect costs of reasonable alternatives and such factors as mobility improvements; social, economic, and environmental effects; safety; operating efficiencies; land use and economic development; financing; and energy consumption."

1994: Executive Order 12893, "Principals for Federal Infrastructure Investments," directs that Federal infrastructure investment be based on a systematic analysis of expected benefits and costs. This order provided additional momentum for the shift toward developing investment requirement analytical tools that would perform economic analysis.

1998: Transportation Equity Act for the 21st Century (TEA-21) enacted and approved a six-year, $216+ billion surface transportation reauthorization bill.

1998: The National Transportation Library was established in 1998 through the TEA-21 and serves as a repository of materials from public, academic and private organizations.

Source: (Weiner. 1999), Office of Historian, U.S. DOT[69], (Congressional Budget Office. 1982; Levine. 1978), (U.S. Army Corps of Engineers. 1998)

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[67] http://www.nemw.org/HWtrustfund.htm

[68] U.S. Department of Transportation, Federal Highway Administration. Metropolitan Transportation Planning Regulations, 23 CFR 450 (c), October 1993.

[69] http://dotlibrary.dot.gov/Historian/chronology.htm

Appendix C
Criteria Used in Public Investment Decisions

We know that investment decision should be responsive to public interests. The normative argument, however, is very difficult to be fully considered in policy analysis because the public interests are not uniform but sometimes conflicting among people or groups. Although the Congress tries to clarify the public interests that guide the executive, it is too ambiguous to guide a investment decision. For instance, U.S. DOT's mission, as stated in Section 101 of Title 49, United States Code, is as follows:

The national objectives of general welfare, economic growth and stability, and the security of the United States require the development of transportation policies and programs that contribute to providing fast, safe, efficient, and convenient transportation at the lowest cost consistent with those and other national objectives, including the efficient use and conservation of the resources of the United States.

We can easily find out the criteria for 'fast' and 'safe' may conflict each other or efficiency may not mean the lowest costs and the efficiency of transportation may harm the efficiency of conservation of the resources of the U.S. Analysts of transportation investment has to judge the public interests and build more concrete criteria, which is as much difficult as the legislative do.

One might argue that analysts should have to consider all possible criteria and assess programs in a holistic way. It is almost impossible to consider all possible factors because of the limits of time, resources and human cognitive capacity. Such a problem in public decision-making seems to make impossible to build up systematic analysis. So, the choice of factors to be considered in policy analysis is highly related to practical constraints policy analysts face. In this appendix, I reviewed which criteria are suggested to be considered in transportation investment.

John W. Dickey(1975) studies which decision factors are used and which are considered importantly when analysts make plans in urban transportation decisions. 151 respondents report 46 factors used in their decisions. Among them, only 11 factors are cited more than 10 times as importantly considered factors. The 11 factors can be reducible too. For instance, travel time, user safety, cost, and capacity can be analyzed through the benefit-costs[70]. Other factors such as political feasibility, agency coordination, relocations have to rely on qualitative judgment. Noticeable thing in his research is that environmental factor such as noise, unusable land, and natural features are considered but not importantly by analysts as shown in the below table.

[70] Funding can be included in the benefit cost analysis but the financial analysis usually is not integrated in the traditional practice of benefit cost analysis in transportation.

Table 57 Number of Urban Transportation Decision Cases in which Each Factor Was Considered or Important

Factor	Cases considered	Cases important	Factor	Cases Considered	Cases important
User related			Nonuser-area-wide impact		
Travel time	76	14	Access to economic activities	96	33
User safety	77	13	New economic activities	51	12
Relief foot travel	20	1	Access to social, cultural, educational activities	77	9
Vehicle comfort	34	0	New social, cultural, educational activities	28	5
Weather protection	15	0	Centralization-decentralization	42	3
Signs, information	32	1	Natural features	32	0
Dependability	19	1	Other	21	0
Fares	22	3			
Variety, novelty	17	0	Transportation management and planning		
Parking	39	5	Costs	92	21
No. of travel modes	54	8	Capacity	83	19
Other	53	1	Funding	47	22
			Legal consideration	49	1
Nonuser-neighborhood impact			Agency coordination	69	14
Nonuser safety	54	6	Political feasibility	53	20
Facility appearance	69	6	Type of management	31	5
Air pollution	25	1	Other	11	0
Noise	44	5			
Taxes	37	1	Added factors		
Relocation	39	21	Emergency service	1	0
Local traffic circulation	100	19	View from facility	1	0
Unusable land	33	1	Service frequency	2	1
Geographical boundaries	41	4	Historical preservation	4	8
Land values	67	5	Temporary service	1	0
Multiple use	3 6	1	Removal	1	0
Other	31	1	Vandalism, crime	1	0
			Natural disorder	1	0
			Psychological value	1	0

Source: John W. Dickey (1975), “Metropolitan Transportation Planning”, Scripta Book Company, p.350

David J. Forkenbrock, Shauna Benshoff, and Glen E. Weisbrod (2001) performed intensive literature reviews about existing factors and methods used in transportation decision-making. Four basic factors are considered: social effects, economic effects, effects on aesthetics and livability, and distributive effects.

Table 58 Factors Used in Transportation Decisions (Considered in Current Literatures)

Factor	Analysis Subjects
Social Effects	Community cohesions, pedestrian and bicycle safety, accessibility to family, friends, and community resources, construction disruption (e.g. noise, delay of traffic during construction), need to relocate, choice of travel mode.
Economic Effects	traveler safety, vehicle operating costs, time savings, effect on the comprehensiveness on business, land and property value, Residences and Job creation,
Aesthetics and Livability	Visual quality, Traffic noise, availability and accessibility to public space, lighting, signage, and other environmental effect
Distributive effects	Effect on protected population,

Sourece: Forkenbrock, D. J., S. Benshoff, et al. (2001). *Assessing the Social and Economic Effects of Transportation Projects*, National Cooperative Highway Research Program.

Forkenbrock et. al. note that such various methods and factors are not considered in transportation decision-making. Some of them are used frequently but others are not in states and MPOs. More than 65 % of respondents of states and MPOs did not perform neighborhood survey, computer economic models, business interview, observing travel behaviors, visual impact analysis, activity analysis, spatial-demographic analysis, and integrated transportation-land use models more than twice a year.

At government level, formally some factors are required to be considered. Recently, many state agencies in the U.S. are asked to set criteria for prioritizing competing programs by the legislature. For instance, Virginia DOT suggests five criteria in prioritizing transportation programs as follows (VDOT. 2004):

- Provide a transportation system that facilitates the efficient movement of people and goods
- Provide a safe and secure transportation system
- Retain and increase business and employment opportunities
- Improve quality of life and minimize potential impacts to the environment
- Preserve the existing transportation system and promote efficient system management

Among five factors, the first two factors are generally considered in benefit cost analysis and the third one can be measured by average volume of trucks or unemployment rate. VDOT, however, did not provide concrete methods for measuring potential environmental or cultural impacts. The last factor is usually considered in route design and alternative selection process in benefit cost analysis. The situation is not so different in other states. Washington DOT, for example, provides more concrete criteria for prioritizations but most of them are overlapped to VDOT and categorize as follows (WDOT. 2004):

Table 59 Factors Used in Transportation Decisions (Considered by State Government: Washington State Case)

Economic Factors	• Cost-effective movement of people and goods • Support for the state's economy, including job creation and job preservation • Accident and accident risk reduction
Environment	• Protection of the state's natural environment • The conservation of energy resources
Public opinion	• Public views concerning proposed improvements
Relevancy	• Continuity and systematic development of the highway transportation network • Synchronization with other potential transportation projects, including transit and multi-modal projects, within the

	heavily traveled corridor • Commitments established in the previous legislative sessions • Feasibility of financing the full proposed improvement • Consistency with local comprehensive plans developed under chapter

Source: WDOT (2004). *Prioritization Process for State Highway Projects*, Washington State Department of Transportation.

In case of the U.S. federal government, FHWA categorizes submitted programs into four groups: Most promising, promising, qualified, and unqualified. However, the criteria used in categorizing programs are too abstract. For instance, Interstate Maintenance Discretionary (IMD) Program's selection criteria are[71]:

- Leveraging of private or other public funding - Because the annual requests for funding far exceed the available IMD funds, commitment of other funding sources to complement the requested IMD funds is an important factor.
- State priorities - For States that submit more than one project, consideration is given to the individual State's priorities.
- Expeditious completion of project - Preference is also given to requests that will expedite the completion of a viable project over requests for initial funding of a project that will require a long-term commitment of future IMD funding. For large-scale projects consideration is given to the State's total funding plan to expedite the completion of the project.
- Transportation benefits and advantages that will be derived upon completion of the project.

U.S. GAO (U.S. GAO. 2004) identified many factors that states and metropolitan areas are to consider in planning and deciding on surface transportation investments. As shown in table 63, these factors include environmental compliance, safety, system maintenance and operations, and land use, among others.

[71] http://www.fhwa.dot.gov/discretionary/imdinfo.htm

Table 60 Key Factors to be considered in Transportation Investment (Identified by U.S. GAO)

- Ensure compliance with provisions of the National Environmental Policy Act, Clean Air Act, and Civil Rights Act
- Support the economic vitality of the metropolitan area, especially by enabling global competitiveness, productivity, and efficiency
- Increase the safety and security of the transportation system for motorized and nonmotorized users
- Increase the accessibility and mobility options available to people and for freight
- Protect and enhance the environment, promote energy conservation, and improve quality of life
- Enhance the integration and connectivity of the transportation system, across and between modes, for people and freight
- Promote efficient system management and operation
- Emphasize the preservation of the existing transportation system
- Promote congestion relief and prevention through management strategies/systems
- Consider the likely effect of transportation policies on land use and development
- Consider using innovative mechanisms for financing projects
- Expand, enhance, and increase use of transit services
- Examine the overall social, economic, energy, and environmental effects of transportation decisions
- Consider access to ports, airports, and intermodal transportation facilities
- Preserve rights-of-way access for future transportation projects
- Consider connectivity of roads in areas outside MPO planning boundaries and in other States
- Consider recreational travel and tourism needs.

Decision factors of the Korean government are not so different from those of the U.S. In 1999, the budget agency of the Korean government, Ministry of Planning and Budget (MPB), asked KDI (Korea Development Institute) to perform experimental analyses for 17 major public investment projects. The main intention of MPB was to explore the possibility of objective decision-making based on a consistent and comparable analysis. Although submitted proposals by each line ministry usually contain economic analysis, MPB has concerned the objectiveness of the analysis. Not only do the line ministries inflate benefits, analyses results of projects are incomparable because analysts use different assumptions and criteria. For instance, among 33 projects that line ministries performed economic analyses from 1993-1998, only one project has a negative net benefits. Their discount rate, unit costs, benefit factors, or cost factors were different even within the same ministry (Kim, et al. 2000; Korea BAI. 2004).

The experimental pre-feasibility studies preformed by KDI try to increase the comparability and consistency. It preformed the analyses by inviting engineer companies, accountants, academia, other government funded research institutes and economists. Based on the studies, KDI suggests basic factors of project selections, which are accepted by the Korean government and have used until now. Those factors are shown in the below table.

Table 61 Factor Used in Transportation Decisions (the Korean Government Case)

Major Factors	Sub-Factors
Economic Factors	Benefit: traveler safety, vehicle operating costs reduction, time savings Cost: construction cost, operation cost
Policy Factors	Backwardness of the region Local economic impact Commitment of the project Relevancy to related projects or laws,

	Environmental impact Financial Feasibility

In conclusion, we can find out that analysts try to consider multiple factors at the manageable level. Not only benefit cost analysis but also political, environmental and implementation issues are considered. At the same time information considered in investment decision is not so different. However, even if we agree that economic or environmental factors, for instance, should be considered, actual contents of them are so different among analyses. Analysts will interpret the same information differently. Little is known how analysts interpret individual factors and integrate them and make judgment.

Appendix D
Game Theory Model under Strategic Situation between Analysts and Bureaucrats

One important driving force affecting analysts' judgments is their incentive structure. Analysts act strategically because of conflicting interests with their principal (bureaucrats) under information asymmetry. As we note, bureaucrats will not have enough information to make right decision because they have to get analytical information from analysts. Game theory provides a formal framework to infer the possible strategies that analysts may use. Two fundamental questions are related to strategic behaviors of analysts: whether self-interested analysts will have incentive to report honestly what they find and whether fully monopolizing information is best strategy for policy analysts. The following two propositions show the strong possibility of distortion of analysts' judgment.

Proposition 1: The strategy that policy analysts report honestly what they know to bureaucrats cannot be equilibrium if there exists a gap of preference between them.

Proof: Let's assume the following strategic situation. There exist two players: analyst (A) and bureaucrat (B)[72]. Assume that the analyst get information about the exact amount of public investment size through his analyses. Note the current state of investment as $w \in [0, 1]$. w is not 'common knowledge' but known only to the analyst. Once the analyst comes to know the w, he has to report w to bureaucrat. Note the reported amount of investment size as function of w: $r(w)$. $r(w)$ is not necessarily the same as w which the analyst finds. So, analysis can have a bias, b, in reporting. Without losing logical consistency, let's assume $r(w)= w +b$. A bureaucrat receives the report and takes an action, i.e. decide the amount of investment size. Let's note the investment size decided by the bureaucrat as y. Then, we will get the utility function of the analyst and bureaucrats as follows:

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[72] I will use the gender of analyst as male and bureaucrat as female following the Osborne(2003)'s suggestion.

Analyst's Utility: $U_A = -(y-(w+b))^2$

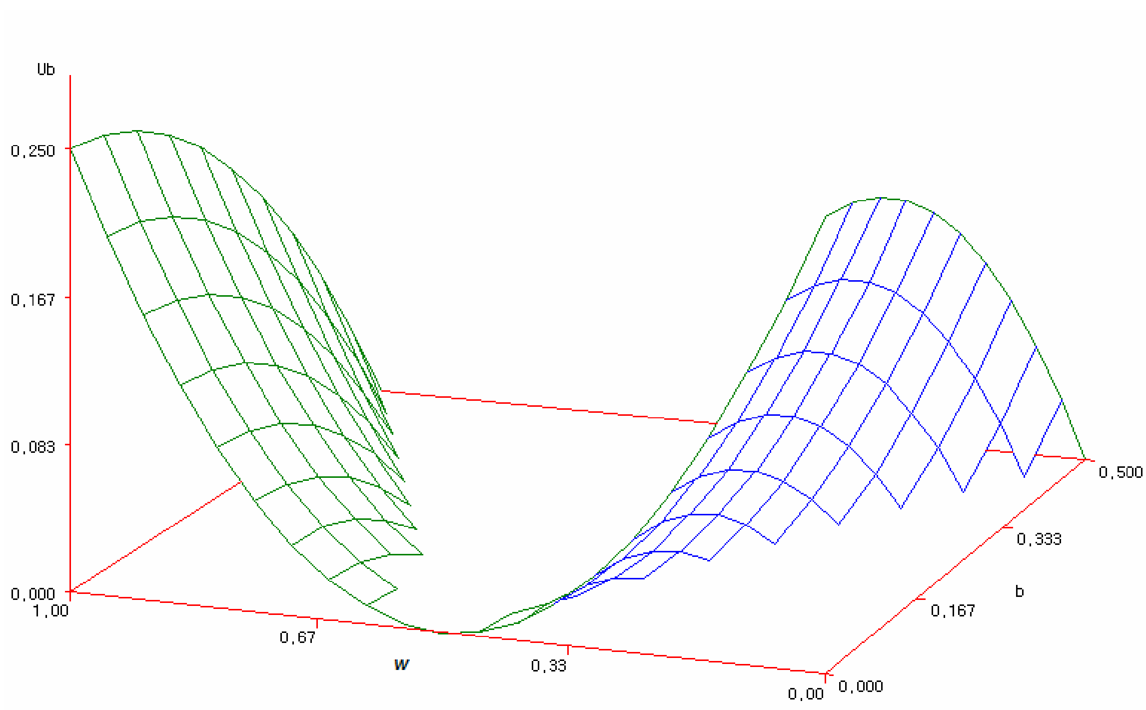
Bureaucrat's Utility: $U_B = -(y-w)^2$

The situation is a type of extensive game with imperfect information(Osborne. 2003:343-345). The bureaucrat does not know *w* and has to guess which information set she reaches. In our situation, information set will be [{*w*},{~ *w*}]. To form the sequential Nash Equilibrium, her belief on *w* should be consistent. In our situation, when analyst submits report arguing $r(w)= w$, bureaucrat has to believe he is in the information set { *w* } and make a final decision y= *w* to maximize his utility. In that case, $U_A = -(b)^2$ but it is not an equilibrium. Analyst knows that the bureaucrat will choose y= *w* when he reports r(*w*)= *w*. What if he choose his favorite amount of investment size, i.e. r(*w*)= *w* +*b* to maximize his interest? Given the suggestion, bureaucrat will decide y=b+ *w* and U_A will zero. As $-(b)^2 \leq 0$, if only b is positive number, there exist better strategies for analyst than honest report. So, if analyst has their own preference not the same to the bureaucrat, the honest report cannot be equilibrium.

Propositions 2: For the policy analyst, monopolizing information will not be the best strategy.

Proof: Let's maintain the same game structure used in the above except policy analyst provides no meaningful information to bureaucrat. In this situation, the report of policy analysis does not contain any information about status, *w*. Then, the *r*(*w*) will be a constant C. As the bureaucrats cannot infer the status *w* from the signal of analyst, his optimal action will be:

y=1/2[73]. The analyst knows the bureaucrats will take an action y=1/2 what ever C is, he has no incentive to deviate from r(*w*)=C. Under the no information transmission from analyst, U_B =-(1/2- *w*)^2 will be equilibrium. However, if the degree of bias is small, there are better strategies increasing both players' utility. Let's assume that analysts provide report including information about *w* such as r(*w*)= *w* +b. If bureaucrat takes it seriously and compare utility between U_B =-(*w* +b- *w*)^2 and U_B =-(1/2- *w*)^2. When analyst try to change the rule of game from monopolizing information to submit a certain amount of information, bureaucrats will accept the rule of game if only U_B=-(*w* +b- *w*)^2 +(1/2- *w*)^2>0. According to different *b*, and *w*, we can find out the regions both analyst and bureaucrat become better. The graph shown the below illustrates the possible improvement area with higher utility than constant y=1/2 strategy when b<1/2.



Note: Ub is the -(*w* +b- *w*)^2 +(1/2- *w*)^2.

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[73] Notice that we assume *w* is uniformly distributed in the region [0,1].

The result implies if b, i.e. the degree of self-interests deviated from socially desirable status w is not so large, it will be better for the analysts to provide meaningful information to bureaucrat. It will increase the utility of both players. So monopolizing information is not a desirable to analyst. In sum, the actual behavior of policy analyst is in between the two extremes: fully honest and monopolizing information.

We can expand the strategic situation between analyst and bureaucrat. Even if we can observe some evidence of self-interest maximization behavior of analysts, the behavior is also a result of strategic choice considering other players, especially bureaucrats. With little doubt, the utility of analysts is a function of bureaucrats' strategic choice. Even if analysts recommend accepting the project, if bureaucrats reject it, the utility of analysts will decrease. Such situation will affect the revealed preference of analysts.

We can describe the decision game between analysts and bureaucrats as follows. At the beginning, bureaucrats ask policy analysts to perform assessing the status of investment projects. Policy analysts evaluate the project feasibility through their analyses. They produce information about status quo of economic feasibility and policy feasibility. The economic feasibility is reported through benefit cost analysis which is pretty objective information. In the practice of KDI's pre-feasibility studies, the economic feasibility is assessed through well-defined manuals to minimize the possibility of manipulating benefit cost analysis. Thus, we can assume that the status quo of economic feasibility is common knowledge to both analysts and bureaucrats. In contrast, the policy feasibility is more subjective. For instance assessing the degree of commitment of the project of residents or local government is hard to quantify and rely on the analyst's personal judgment. The asymmetric information arises in the situation. The status quo of policy feasibility is known to policy analysts but not to bureaucrats. Bureaucrats may consider modifying the amount of expenditure to the project. However, if she wants to modify the size of project, she has to provide enough evidence to convince the legislative. At the same time she has to perform independent analysis to estimate new costs. So bureaucrats usually rely on the estimated cost by policy analysts and once bureaucrat decides to accept investment proposal, he will submit the estimated cost to the legislative without making significant change. This situation is called 'closed rule'(Gilligan and Krehbiel. 1987) in which bureaucrat's decision is whether to accept or not.

Such a "closed rule" (Osborne. 2003) is common if bureaucrats do not do independent analysis to modifying the costs recommended by analysts. Thus, we will have two different games: perfect information on economic feasibility and imperfect information on policy feasibility. Let's first deal with the imperfect information case. I rely on the perfect Bayesian game models describing imperfect information (Epstein and O'Halloran. 1995; Gilligan and Krehbiel. 1987; Osborne. 2003; Posner. 2001).

Imperfect Information Game

Let's assume that the current status quo of a project's policy feasibility is *w,* which is uniformly distributed in [-1,1]. Policy analyst knows the status through his own analysis. He might report the status quo *w* honestly to bureaucrat but it is not a rational choice according to proposition 1 if and only if the preference of analyst and bureaucrat is not the same. By proposition 2, submitting some amount of information to bureaucrats can increase the utility of both analyst and bureaucrat. In the situation, analyst makes recommendation *r* under information *w* and bureaucrat has to form a belief on *w* and makes a decision *d*. The utility function of bureaucrat will be defined to make her decision *d* under given *r*. This will be a form of Bayesian game under imperfect information. General form of this game was discussed at Gilligan and Krehbiel (1987) and Epstein and O'Halloran (1995).

The utility function of bureaucrats will be decided as:

$$U_B(d;r) = \int_w dU_B(r+w)\mu(w;r) + (1-d)U_B(w)\mu(w;r)dw$$

The belief function μ is about the w given analyst's recommendation r. The above utility function implies that the bureaucrats will get utility U_B if she makes decision to accept recommendation r with probability d and reject r with probability (1-r) under her belief μ on w.

Analyst will form his belief on the bureaucrat's decision d under given his recommendation r. His utility U_A will be a function of sum when his recommendation is accepted with probability d and rejected with probability (1-d).

The utility function of analyst will be formalized as:

$$U_A(r;d,w) = \int_w d(r)U_A(r+w) + (1-d(r))U_A(w)dw$$

The utility function of analyst and bureaucrat will be simplified when we assume a closed rule. When analyst perform analysis and submit its report, bureaucrat will review it. If bureaucrat thinks the recommendation of analyst is better than current status quo, they will accept the proposal. We also assume that w is uniformly distribute in the region [-1,1] and analyst's favorite status of investment as A, and the bureaucrat's favorite status B. Then, the utility function of analyst will be U_A=-(r+w-A)^2 when bureaucrat accepts r and U_A=-(w-A)^2 when bureaucrat rejects r. Like the same way, bureaucrat utility will be U_B=-(r+w-B)^2 when she accepts r and U_B=-(w-B)^2 when she rejects r. Without lose of generality, let's assume B=0 and A>0. The assumption assumes that bureaucrat prefers the status quo and analysts prefer to invest money for the project. An equilibrium to this asymmetric information situation is characterized by Perfect Bayesian game(Epstein and O'Halloran. 1995; Posner. 2001):

To form a perfect Bayesian equilibrium, the strategic inferences of analyst and bureaucrat are:

i) We need to calculate the most preferred decision of each player according to different *w*.

→ For analyst, as his favorite outcome is A, his preferred policy suggestion will be *r*=A-*w*, which will lead policy outcome *r*+*w*=A. For instance, the status quo of policy feasibility is -0.2 but analyst's favorite outcome is 0.1, then analysts will reveal the strength of policy feasibility to 0.3.

→ For bureaucrat, as her favorite outcome is 0, her preferred policy suggestion will be *r*=-*w*, which will lead policy outcome *r*+*w*=0.

ii) Of course, *r* leading the most preferred decision should not violate the condition that the utility under *r* should be greater than status quo utility of both players.

→ For analyst, his utility at the outcome when he proposes a recommendation *r* should be greater or equal than the status quo. So, his possible strategy spaces has to satisfy the condition: $-(r+w-A)^2-(w-A)^2>=0$. It will lead possible strategy space of analyst given *w* as *r* <=2A-2*w* when *r*>0 and *r*>=2A-2*w* then *r*<0.

→ For bureaucrat, she will consider to accept a recommendation *r*, when *r* satisfies: $-(r+w)^2-(w)^2>0$. We can get possible strategy space of bureaucrat as *r*<-2*w* when *r*>0 and *r*>-2*w* when *r*<0.

iii) As bureaucrat has no exact information about the status quo, *w*, she has to form beliefs- a probability distribution over the information set she is located- with given analyst's recommendation *r* noted as $\mu^*(w;r^*)$.

Let's assume bureaucrat is given r` by analyst. She has to form a belief on *w*. She knows analysts will not recommend *r*` if r`>2A-2*w* when r`>0 because it is out of possible strategy set derived in ii). Also she knows analyst has to suggest r`=A-w for his favorite outcome A. So, the possible region *w* will have is: [A-r`, (2A-r`)/2]. Considering the fact that *w* follows uniform distribution, bureaucrat will expect *w* and belief is: $\mu(w;r`) = \dfrac{A - r` + \dfrac{2A - r`}{2}}{2}$.

iv) With this belief, bureaucrat will accept r` if $r` < -2\mu(w;r`) = -2 * \dfrac{A - r` + \dfrac{2A - r`}{2}}{2}$ by the acceptance regions derived from ii). Solving the inequality, we will get r`>4A when r`>0. In this region, analyst will suggest $r^*(w) = A - w$ and bureaucrat will accept the recommendation, i.e. d*=1. If 0<r`<4A, bureaucrat will not accept the recommendation, i.e. d*=0. In the same way, when r<0, then r* will A-*w* and d*=1.

v) Final equilibrium is shown with the bold line in the below figure.

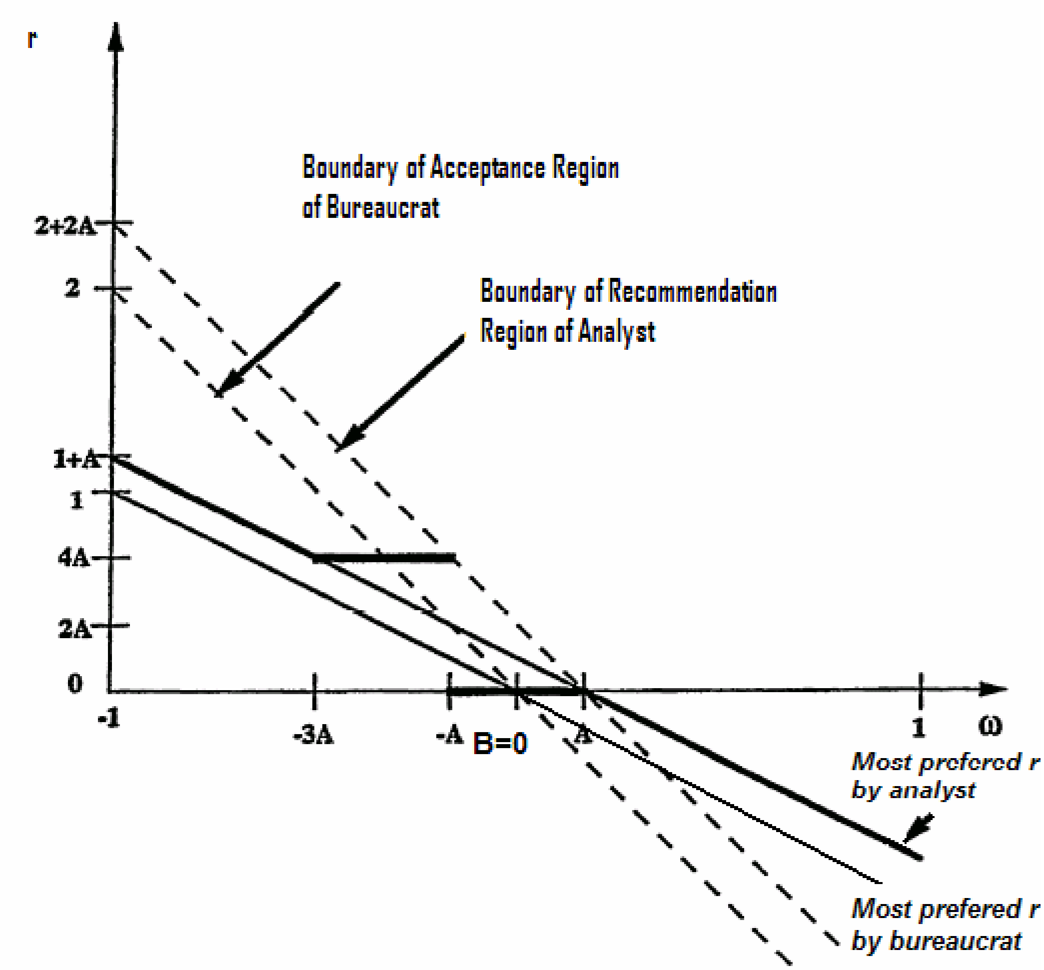

Figure 19 Equilibrium under Imperfect Information

We can classify the equilibrium regions into from region 1 to region 4 from left to right discontinuity range of equilibrium in the figure. At the region 1 and region 4, policy analysts can achieve their most preferred investment level. However, at the region 2, [-3A, -A] and region 3 [-A, A], policy analyst cannot recommend investment level making outcome to be his most preferred status A. In the region 2, analyst recommends greater investment than the level maximizing his own or bureaucrat's.

Perfect Information

Unlike the policy feasibility, the status quo of economic feasibility cannot be monopolized by analyst. Both bureaucrats and analysts will have perfect information about economic feasibility. With the same logic as we discussed in the above, we will get the equilibrium shown in the below figure.

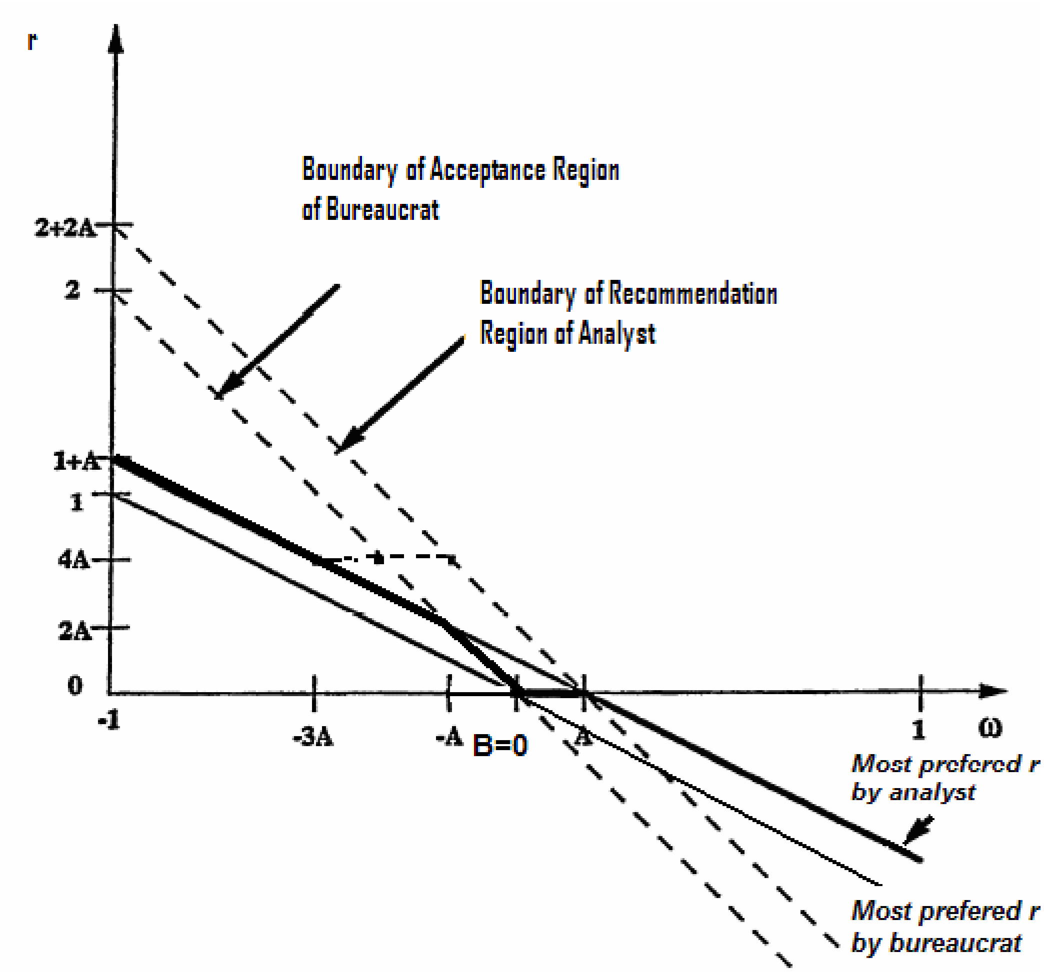

Figure 20 Equilibrium under Perfect Information

Compared to imperfect information on policy feasibility, the positive scoring of economic feasibility is smaller than that of policy feasibility in the region 2. Also in the area [-A, 0] of the region 3, we can expect the positive of scoring of economic feasibility is larger than that of policy feasibility.

Empirical Test

Among policy analysts, private company analysts prefer to more investment than bureaucrats (i.e. positive A in our model). Under the above theoretical conjecture, we can expect that private analysts will show stronger biased scoring (measured by deviation from each project's mean score) on policy than scoring on economic efficiency. However, the biased scoring behaviors are observed in most regions with large variations both in scoring on economic efficiency and policy factors.

Appendix E
Psychological Model toward Net Benefit and Net Cost

The psychological feature is also important in explaining analysts' judgments. In the rational decision-making framework, we assume that decision makers strictly follow the rule of maximizing the "expected" utility. However, people react differently weight to the return with a certainty and with a risk, even if the expected utility is the same. Kahneman and Tversky (1979) argue that an outcome received with certainty rate is overweighed relative to an uncertain outcome, which is not consistent with rational utility theory (Von Neumann and Morgenstern. 1944). For instance, if we apply the expect utility, the choice between $1000 prize with a probability 0.5 and $500 prize with a certainty should be indifference under the expected utility theory. However, people usually prefer $500 with a certainty.

The avoidance to risk is also asymmetric between do-something risk and do-nothing risk. Baron observes that parents usually perceive a death of a child with a vaccination as worse than causing its death without vaccination (Asch, et al. 1994; Baron. 2000; Ritov and Baron. 1990) and call it as "omission bias". "Omission bias" implying that more harmful act of omission is preferred to less harmful act of commission can be observed in public investment decision. For instance, if a certain dam construction has the risk of environmental destruction when government commit to the investment, government has to undertake the risk of the flood damage when it does nothing. Based on omission bias behavior, decision makers prefer do-nothing (omission) to do-something (commission) unless the do-nothing risk is too large.

The asymmetric decision between do-something and do-nothing is also found in decision on alternatives without risk. Thaler (1980) suggests an "endowment effect" which predicts the overvaluation of current possession than selling it. For the seller, selling goods is a loss and the money he will get is a gain. As the loss is overweighed, he will request more money. In contrast, the buyer will have to pay money which is a loss and goods will be a gain to her. So she will underestimate the gain and try to pay less money. The endowment effect is strongly related to “status quo bias”-individuals stick with status quo even when the potential benefits from changing are large. The status quo bias can be a result of a cognitive misperception, rational choice, or psychological commitment such as loss aversion, regret avoidance, and a desire to be consistent (Samuelson and Zeckhauser. 1988:33-41). The observed status-quo bias is also at least partly caused by a omissions bias(Ritov and Baron. 1992)[74]. Both endowment effect and status-quo bias expect the strong preference of do-nothing over do-something.

Asymmetric decision behaviors are also found toward loss and gain. The loss aversion behavior means that losses loom larger than corresponding gains (Tversky and Kahneman. 1991). The behavior leads a steeper utility function in the negative domain (loss area) than in the positive domain (gain area). The traditional application of loss aversion behavior in public investment decision is “sunk cost effect” (Arkes and Blumer. 1985; Garland. 1990). The sunk cost effect assumes that once a certain amount of money are already invested, the sunk cost is regarded a loss. Following an argument is frequently observed in public investment decision.

“Completing Tennessee-Tombigbee [Water project] is not a waste of taxpayer dollars. Termination of the project at this late stage of development would, however, represent a serious waste of funds already invested” (Senator Sasser, November 4, 1981, recited in Arkes & Blumer, 1985:124).

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[74] “Subjects reacted more strongly to adverse outcomes caused by action, whether the status quo was maintained or not, and subjects preferred inaction over action even when inaction was associated with change” (Ritov and Baron, 1992:49).

The status quo bias is reinforced when the status quo is the same to a reference point because of "reference dependence" effect in which people overweight the status close to one's reference point than the status away from it. However, the marginal sensitivity to the deviation from reference point will decrease.

Findings of experimental psychology predict that analysts will show asymmetric scoring to net benefit and net cost projects. Let's assume two projects: the net benefit of project A is -100 million dollars and that of B is 100 million dollars. If an analyst give score to project B score 5 (strongly preferred), will he give a score -5 (strongly not preferred)? According to loss aversion behaviors, he will give a lower score than -5. Also the status quo bias will make people prefer to do-nothing than do-something even if there exist a small amount of gains. Integrating those conjectures, we can expect that analysts will give a difference score according to projects' net costs or net benefits. Figure 21 shows a hypothetical distribution between projects' net costs and judgment score on economic feasibility.

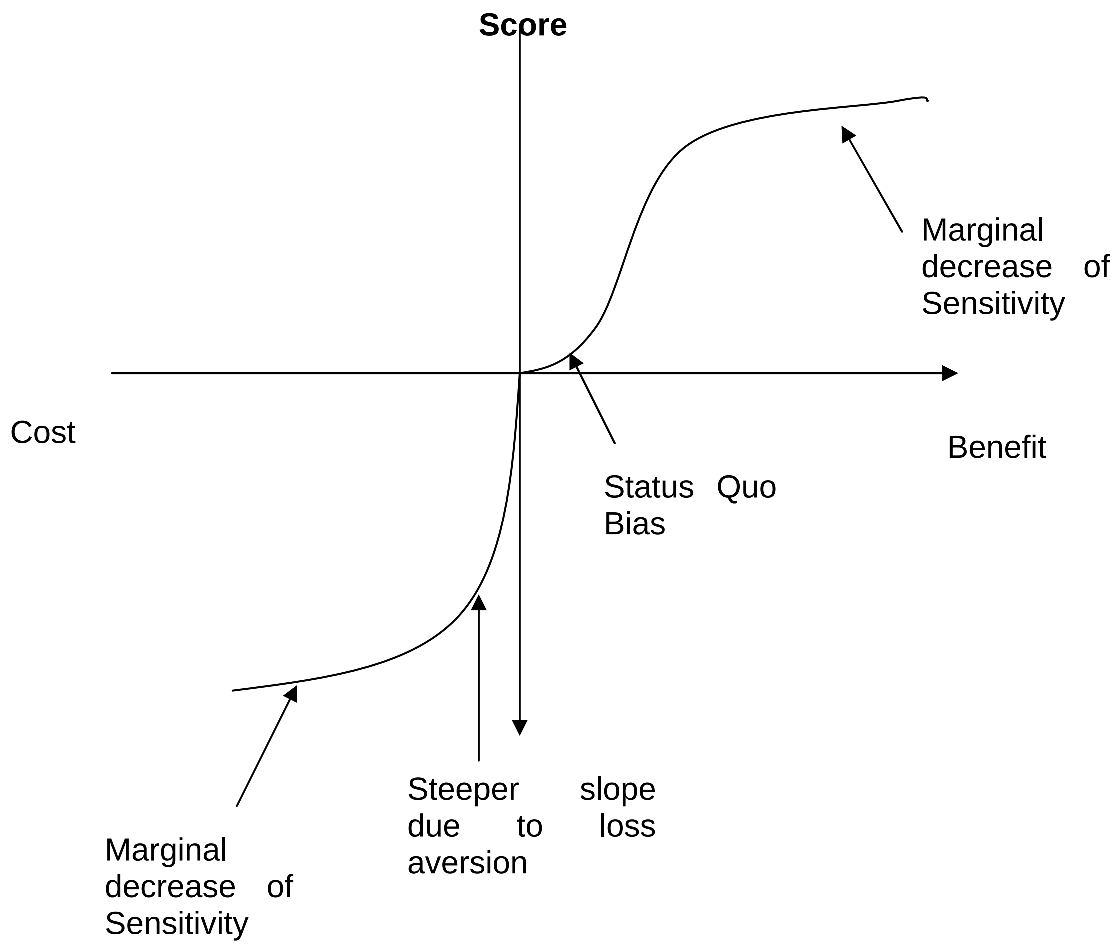

Figure 21 Hypothetical Patterns of Attitude Toward Net Costs and Benefits in Scoring Project's Acceptability

Empirical Test

First, I examined whether nonlinearity exists in scoring on economic efficiency. When I use the second order polynomial regression, the R-square increased very slightly (0.01%) compared to the linear regression. Thus, the non-linearity shown in the Figure 21 is not supported by our data. The asymmetric preference on net benefit and net cost projects can be tested by comparing the regression coefficients of each case. When I compared the slope in net cost projects and the slope in net benefit projects, I could not find a significant difference (p-value of contrast test of regression coefficient is 0.21). Instead, we can observe that the positive scoring of private analysts compared to KDI analysts.

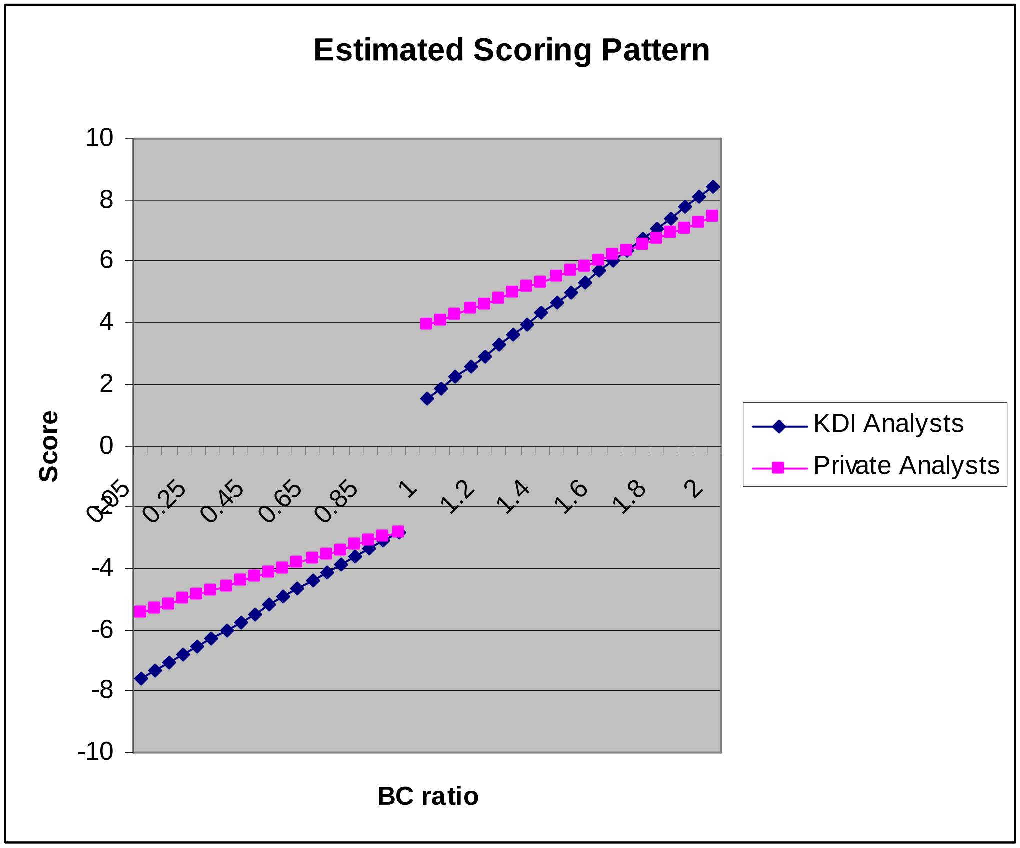

Figure 22 Estimated Scoring on Economic efficiency of KDI and Private Analysts

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