Agency and Incentive Contract in Private Investment of Transport Project: An Exploration of Fundamental Relationships

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Abstract

This thesis codifies and relates critical incentive-design and financial-contracting issue to the unique principal-agent circumstances generated from private investment of transport infrastructure and provides a framework for designing incentive contract and increasing future economic efficiency gains (or minimizing loses).

In the mathematical form, we uniquely integrated multitask agency and common agency into our modeling. The outcome could be simplified as: the equilibrium with n principals is exactly as if there is just one hypothetical principal with an objective function that is the sum of all the separate principals' objectives, but the agent's risk aversion is multiplied n-fold. Remember that the more risk averse the agent, the lower the power of the incentive scheme. Thus, the Nash equilibrium incentive scheme with n principals has, roughly speaking, only $(1/n)$-th the power of the second-best scheme that would be offered by one truly unified principal. With promotion of incentive competition among the Government and the Board the incentives can be more powerful than those in the second-best. The reason is that each must now use a positive coefficient on the component of output that is of direct concern to him in order to divert the CEO from tasks that benefit the other. This competition among the Government and the Board leads them to raise those coefficients to higher levels.

The most important predictions of the theoretical model are as follows. First, when transport service consumers view the output of tasks as complementary, CEOs should be given lower-powered incentives from the Board and higher-powered incentives from the

Government. For government, to encourage efforts allocated to primary transport service, less complementary second activity should be discouraged. Second, when uncertainty across tasks is highly correlated, CEOs should also be given lower powered incentives. Indeed, a positive relationship increases the CEO's risk and therefore her need for insurance. A negative relationship, in contrast, is a source of risk diversification. From incentive regulation perspective, higher-powered incentive should be given when the relationship is positive and lower when it is negative. All of these predictions are confirmed by the empirical data.

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Chapter 1 Introduction

After a transport infrastructure is decided to be privately delivered and produced, government and franchise board of directors must decide who the franchise chief executive officer (CEO and his executive management team) should be and what incentive contracts to offer. During the selection and the subsequent relationship with a franchise CEO, board of directors and government will have incomplete information as to his credentials for the position and (post selection) performance. Given a survey of different forms of information inefficiency, the importance of financial-agency costs in determining a transport infrastructure's overall efficiency can be put in context. This thesis then codifies and relates critical incentive-design and financial-contracting issue to the unique principal-agent circumstances created by private investment of transport infrastructure and provides a framework for designing incentive contract and increasing future economic efficiency gains (or minimizing loses).

1.1 Objective of the Research

The provision of transport services has changed dramatically during the last two decades. At the end of the 1970s, most countries relied on the public sector both to produce transport services and to build their basic infrastructure, namely, airports, railways, highways, and ports. The role of private firms in transport was secondary, and governments tackled the main tasks. This arrangement has been turned upside down. After almost two decades of privatization, the private sector has now become the main actor providing many aspects of transport infrastructures and services. Publicly owned companies have been sold and many new transport services have been concessioned to private operators. Remarkably, the private sector is also starting to build, finance, and operate basic infrastructure, although public sector financing will continue to be important, especially in activities that carry strong social implications.

While there are many important political, social, and economic questions pertaining to private sectors' production of transport infrastructure projects, the economic question receiving the most attention is whether the private investment in a transport infrastructure results in greater efficiency. In reference to the inefficiencies that prevail within the public sector production of transport infrastructure, private sector production has supported by some economists because it is seen as a way of correcting these inefficiencies. To draw a conclusion as whether private sector production increases a transport infrastructure's overall efficiency, its sources of inefficiency need to be identified and compared. Then, the next step is to determine what portion of the change in efficiency can be attributed solely to the private sector production and then a complete incentive contract can be initiated.

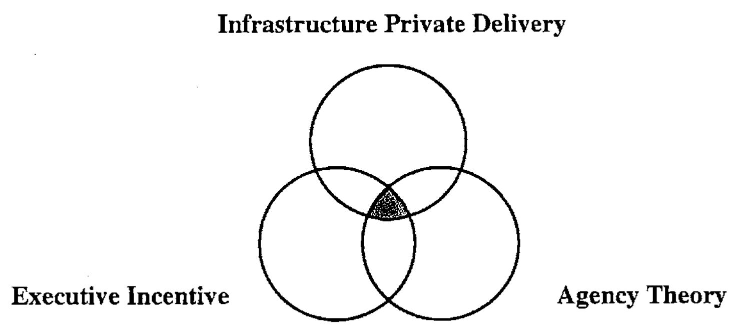


Figure 1.1 Interplay of Topics Used

The motivation to analyze the financial-contracting process is to provide insight that is useful for constructing an efficient and complete contract. The objective of this thesis is therefore to combine the topics (figure 1.1) of private delivery of transport infrastructure, (financial)-agency theory, and executive incentive to analyze the incentive designing and financial contracting issues in a two-principals-to-one-agent situation (refer as common-agency) with related infrastructure products (refer as multitask-agency), namely transport service and property development. While there are many important issues to consider in order to determine the best incentive contract, the contribution going to be made in this thesis is to codify and relate critical incentive-design and financial-contracting issues to the unique principal-agent circumstances, created by the private investment of transport project.

1.2 Research Background

In private investment of transport projects the two principals, the government and board of directors, will have incentive contracts with the agent, namely the CEO and his/her executive team of the private franchise. And, in a development type transport project the infrastructure is mainly served to anticipate real property development. Sometimes they are dependent on contributions from government or land developers. There then exists occasions where transportation service and property development could: cross subsidized to each other, change the capital structure and project returns, reverse CEO's efforts (due to different risks and returns between services), and distort the resources related to the project operation and management. The incentive contracts will then be designed on the basis of regulation, subsidy policy, investment returns, capital structure, CEO's efforts and the behavior information being exposed. Figure 1.2 illustrated the conflict interrelationship

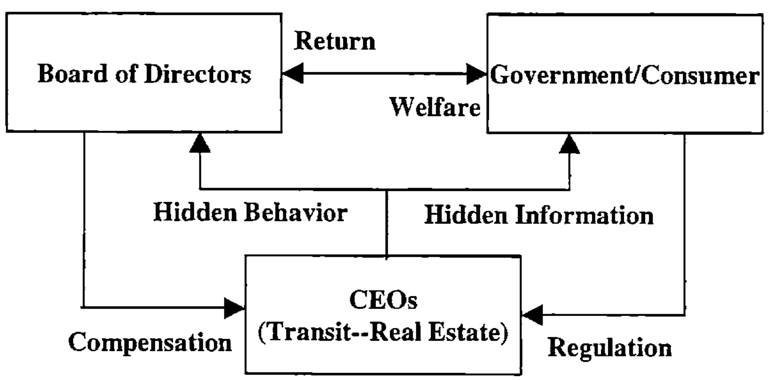


Figure 1.2 Conflict Relationships

This thesis is going to apply some basic tools from modern agency theory to gain insight into the incentive-design and financial-contracting nature of two-principals-to-one-agent interaction in private invested development transport project. To do so, we also take into account issues on regulation and cross-subsidy between products for analysis and evaluation..

1. Issues on Cross Subsidy and Its Implication

Private investment in transport projects is usually easiest when the prices charged users just cover the costs, including a normal return on investment of the private facility. The basic problem with surplus is that they are another form of societal redistribution or transfer and thus often generate controversy. Surpluses can be advantageous for governments if they can be captured and used for tax relief or other public purposes through government's regulation rules. However, users who are likely to object to such transfers and surplus retained by the private investors will usually raise even stronger objections, including charges that the government has failed to protect the public from franchise monopoly.

However, schemes where some users cross subsidize other users are often attractive. Cross subsidy eliminates the potential drain on the public treasury and makes the transfers less visible and thus less controversial. In Europe and some developing countries, private transport projects have used cross subsidies from property development within their franchises to finance the construction of unprofitable toll roads. Cross subsidy has disadvantages. A troubling administrative problem is insuring that the less lucrative as well as the more profitable products or services are both provided, since there are obvious incentives to skimp on the less lucrative. The monitoring requirements for successful cross subsidies thus can be a major strain on government. Government also has less incentive to question whether the subsidies are warranted since there is no direct burden on the public purse. More often, however, cross subsidy programs are not carefully enough designed or implemented to maintain efficiency incentives.

2. Issues on Financial Agency and Its Implication

In the intra-franchise financial contracting process, delegation of decision-making authority is an essential feature of CEO to security-holders relationship. Security-holders delegate authority to CEO who has managerial skills. Security holders differ in terms of risk sharing depending upon their mode of ownership. Shareholders in a given franchise bear more risk than debt holders of the same franchise. In finance theory, CEO is presumed to operate as a delegate to shareholders who bear residual risk. Debt holders, in turn, have recourse to shareholders. Delegation of decision-making authority may give rise to conflicts on interest between CEO and those security-holders. In this study, the security-holders are designated only as shareholders or the board of directors for its research context.

Agency problems emerge when conflicts of interest and principals (such as CEO and government or CEO and board of directors) or among the principals themselves (such as board of directors and government) affect the operation of transport projects. As incentive contracts between the franchise CEO and the principals being constructed, there are two agency problems that must be resolved: "adverse selection" and "moral hazard."

Generally, adverse selection and moral hazard refer to hidden information and hidden action, respectively. In the context of private investment of transport project each entity has a specific connotation. Adverse selection refers to the government's and board-of-directors' (the principals') problem of selecting and contracting with a CEO (the agent) who holds hidden information that, if known by the principals, could influence the final selection and contract. The moral hazard problem also has an effect on the financial contracts between the franchise CEO and his/her principals in a private transport investment; especially the different objectives between board-of-directors and government creates opportunity of hidden behaviors that hardly being observed simultaneously by both principals.

3. Issues on Agency under Regulation Environment

How should the compensation package paid to transport franchise CEOs be structured? How should CEOs' compensation be related to franchise performance? Should compensation be tied directly to performance through some quantitative relationship, or should CEOs be paid an annual salary which implicitly is based upon performance? Economists and policy-makers do not normally give advice on questions such as these, relying instead on market forces to produce the compensation plans that are most likely to bring forth efficient performance by CEOs. But there is a group of franchises, especially the exclusive transport infrastructure franchises, for which market forces do not operate in a manner that is likely to elicit efficient compensation plans.

In our research context, most of the transport infrastructure franchises are, or once were, natural monopolies. They are not free to set whatever price they choose; rather, the prices charged for their output are set by the government (or its regulatory agency) whose general objective is to allow for the franchise a reasonable opportunity to earn a fair return on its invested equity capital in the project. Because those franchises are protected from competition by government regulation, and because these economic entities do not have the opportunity to earn higher profits from more efficient performance, competition will not necessarily bring forth or produce efficient managerial techniques.

If the regulatory environment of the franchises described above were effective enough to force all such franchises to operate at minimum achievable average cost, then it would not be necessary to propose management compensation plans for these franchises. The omnipotent regulatory agency would require franchises to adopt the most efficient managerial practices if those franchises wished to earn a reasonable return on equity. If they did not adopt the very best techniques, they would fail.

While it is not the purpose of this research to assess the effectiveness of price or profit regulation, others have done so and have concluded that regulation in practice is not sufficiently effective to force franchises to minimize costs. In terms of effectiveness the actual regulatory practice in the United States lies somewhere between the ideal forcing regulation described above and simple cost plus regulation.

In cost plus regulation regulatory agencies simply determine price by adding a normal return on equity to whatever costs the franchise reports as actual or predicted costs without examining these costs to determine if they are reasonable or prudent. While the evidence on where the actual practice of regulation lies between these two extremes is incomplete, it does appear that regulators do not do much more than approve whatever costs and utility CEOs themselves sat are reasonable.

If we cannot rely upon regulators themselves to force franchises to be efficient, what other market mechanisms exist which might do so? When faced with this question, economists and regulators most often point to regulatory lag, which results from the process of regulation described above. Once regulators observe and accept an estimate of future costs and set a fixed price for the output, any savings resulting from actual costs that are below predicted costs can be retained by the regulated franchise. This leads the franchise to have an incentive to perform better than the performance estimate (cost estimate) accepted by the regulatory commission.

However, considering inflation rates and likely economic performance, regulatory agencies and franchises usually begin new rate cases every three to five years. Thus, when a franchise earns higher than predicted profits by achieving lower than predicted costs, these lower costs will then be the basis for a sequent rate or price determination in the next rate case, and the franchise will only be able to earn higher profits for the period between rate cases (three to five years). This short duration of higher profits rates for more efficient performance limits the effectiveness of regulatory lag, and, in addition, the commission may in the future incorporate the fact that the franchise's costs were somewhat less than the franchise itself estimated they would be. The commission might thus assess a "correction factor" to future estimates prepared by the franchise. Both of these factors lead us to believe that regulatory lag is a limited incentive for economic efficiency.

Where else might we look for incentives for economic efficiency? Since the franchises involved are protected monopolies, we cannot attach much importance to the forces of product market competition that generally discipline firms to be efficient in a market economy. The market for CEOs' services might offer incentives for efficient performance by management, even though the franchises employing these CEOs are protected from competition. In the market for CEOs, individuals are rewarded according to their managerial products, and competition for higher rewards leads managers to perform better. In examining this market we must first determine what attributes of managerial performance are valued most by franchise in a regulated markets.

Due to the form of regulation in these markets described above, the ability of managers to perform efficiently and keep costs low is not regarded nearly so highly as it is in unregulated firms where profits are restricted. One managerial attribute that is regarded highly is the technical ability to keep transport services operating (to avoid shutdown, delays, etc.). Another attribute that is valued highly is the ability to lead the regulatory authority to expect higher costs than will actually occur, so that regulatory lag will reward the firm with high profits. If the market for CEOs rewards these attributes (rather than efficient performance) of managerial ability, we cannot be very confident that the system of regulated franchises will operate efficiently. In Appendix B, a framework for deciding the compensation plan is proposed for discussion.

4. Driving Forces of CEOs

The CEO environment is a messy laboratory for contract analysts. CEOs do a lot of different things, influenced by a number of imprecise and implicit incentives besides those provided in a compensation contract. A priori, it is not clear which incentive problems are the most relevant ones for theory to consider. Should one worry about effort? About perks? About investment decisions? About entrenchment? About self-actualization? Empirically, the situation is similarly confused. The number of instruments used to compensate transport CEOs is bewildering. We see compensation take the form of stock, stock options, phantom stock, stock appreciation rights, bonuses, long-term performance plans, golden parachutes – to name just a few. It is particularly puzzling that the same CEO commonly receives half a dozen or more of these partly overlapping instruments. To be sure, it makes measurement of pay a major challenge.

As theoretical and empirical discussion in chapter two to three, we had our attention on incentives to transport franchise CEOs mostly devoted to formal or explicit incentives, such as piece rate wage, bonuses and stock options, based on performance. However, a broad set of insights has also been derived for the paradigm of explicit schemes under moral hazard and adverse selection. Equally important in reality are implicit incentives, in the form of CEO's career concerns, inside or outside the organization, self-actualization, and so on. These play a key role in all organizations, private and public, but are particularly strong in the government sector, where formal incentive schemes are often crude and constrained. In this sector, pride, fame, elections, promotions, and future employment in private sector are major motivations to expend effort in the current job.

Especially, what drives CEOs in public transport agencies? Which goals do they pursue? What distinguishes government agencies and private franchises? Though there is no paper comprehensively addresses these questions, Dewatripont, Jewitt, and Tirole (1999) built a simple multitask career concern model, and compares its predictions with the stylized facts on Government bureaucracies. Their paper is a first step at providing a formal model of the relation between objective function of Government agencies and their performance. A multitask career concern model provides a precise interpretation of concepts such as "missions" and their "focus" or "clarity". Their model moreover backs the sociological evidence that emphasizes the benefits of focused and clear missions in terms of agency performance. And it points to a fundamental tradeoff between their level and riskiness of performance.

The driving force behind their theoretical analysis is that an individual's actions are influenced by career concerns. They extend previous research by showing that career concerns can have important effects on incentives even in the presence of contracts. They also show that optimal compensation contracts neutralize career concern incentives by optimizing the total incentives from the contract and from career concerns: explicit contractual incentives are high when implicit career concern incentives are low, and vice versa.

This paradigm can be fruitfully expanded, for example to a dynamic perspective where effort choices are repeated and where the evolution of mission design can be analyzed. Another important extension will consider multiple labor markets when talent is multidimensional, especially, in top management. For example, an implicit incentive motivated franchise CEO may well behave differently, for example focus on different tasks, depending on whether she intends to pursue her career in politics, in civil service, or in academia. Last, in situations where there are either multiple equilibrium clear missions or fuzzy missions, it is important to understand how specific missions come out.

Wilson (1989) for instance emphasizes the role of clear statements about missions and of charismatic leaderships. A formal modeling of these selection mechanisms would substantially clarify Wilson's observations. Also, history matters, perhaps because of adaptive learning, learning by doing, or collective reputations. Again, future research should explain why observe corporate cultures that are stable with respect to mission pursuit. All these issues could in fact usefully apply in reality of transport infrastructure: several issues addressed here are clearly relevant for private franchises, at least when they are confronted with difficulties of providing explicit incentives for certain jobs. In this study, we considered private and profit-oriented franchise in provision of transport infrastructure. Due to empirical data limitation, we limit our focus on the explicit motivation to incentive designation in practical study.

5. The Use of BOT Project Delivery

Private provision/investment of transport infrastructure can assume many different options. A wide range of techniques has been developed to allow the private sector to participate, with government, in the financing, procurement and operation of transport infrastructure. The models include corporatization and the use of mixed companies, management contracts, leasing, pre-financing, and a variety of concession based methods using some private sector resources to provide some combination of design, construction, financing, operation, maintenance, and subsequent transfer to the host government. Miller

(2000) has created a matrix based on project delivery and source of financing as a means of distinguishing each of the private delivery options. Where the concession makes provision of ownership of the facility to be vested in the host government, this may occur either upon completion of the construction work or at the end of the concession period depending upon the terms of the concession agreement. Note however that, in some cases, even if legal ownership is transferred upon completion of the construction phase, the operator is frequently required to be deemed to be the owner for taxation purpose.

In many of the delivery options, Build, Operate, Transfer (BOT) is often used as a generic term for concession based agreements where the transport infrastructure is designed, financed, operated and maintained by the concessioned franchise for the period of the concession, typically between 10 and 30 years. Under the standard BOT route the franchise's involvement with the project terminates at the end of the concessioned period, and at this point all operating rights and maintenance responsibilities revert to the host government. Legal ownership of the infrastructure may or may not rest with the franchise. In many projects legal ownership of the constructed infrastructure is required to pass free of charge to the host government immediately upon completion of construction, but the franchise retains the right to operate the infrastructure for the full concession period effectively as a licensee. From the viewpoint of property right, the franchise is the residual claimer for the concession period. Though the BOT theme has several variations such as Build-Own Operate, Build-Transfer-Operate, Design-Build-Finance-Operate and there are many delivery options such as Design-Build, Design-Build-Operate, this research uses BOT projects as the sample of empirical exploration for the profit-seeking private franchise will do his best comprehensively to have all investment costs (also including operation cost and financing cost) been recouped from user fees (from primary transport services and secondary services such as real estate development in our study) and a profit turned before the end of concession.

The private provision of transport infrastructure usually arises from two primary motives. A primary motivation has been a widespread belief that the private franchise is inherently more efficient. A privately managed franchise, motivated by the possibility of profit, may have stronger incentives to be more cost conscious, efficient, and customer oriented. These efficiency gains, if real, should eventually reduce the cost to the taxpayer of supporting the formal government-provided or the contracted services. Private provision of transport infrastructure is also often motivated by a desire to tap a new source of funds to supplement the constrained resources of the public sector.

Efficiency may still be claimed as an important advantage as the private franchise is often thought to build infrastructure cheaper or faster than public counterparts. But usually the primary concern is that the public sector does not have the financial resources to build the infrastructure needed. Unlike many other government services, moreover, infrastructure can often be supported by charges levied on users. Private provision offers the potential for financing infrastructure without overt increases in taxes; in many ways of private delivery can take an activity off the political agenda. Private provision thus has particular appeal when the government faces considerable taxpayer resistance and is unable to expeditiously finance badly needed facilities or activities that the private franchise might undertake for a profit.

The debate over whether private franchise is more efficiency can be viewed from any one of the following efficiency: technological efficiency, allocative efficiency, consumer efficiency and the economic efficiency. When it is argued in the popular press that a private franchise will be more efficient, this usually refers to its productive efficiency which no more output can be produced without more input (a no waste situation). Productive efficiency can be altered in the short run. In the short run, even obsolete technology can be used more or less efficiency.

To achieve economic efficiency, a long-term strategy is needed since incentive choices and monitoring procedures are rarely made only once, and the future implications of a current incentive are often more important than its immediate requirements. Moreover, many CEO incentive choices involve staged development with agency costs occurring at each stage of the private delivery process. Therefore, though tapping into financial resource from private franchise is a key motivation to private provision of transport infrastructure, this study is going to deal with the efficiency issues pertaining to the set of agency relationships involving the infrastructure's CEOs' incentives from the Board of Directors and the Government Agency. This will have our focus putting on the efficiency issues and simplify the complication of financing agency issues linked to the debt-holders which are not the direct concern of this research. This particular set of agency cost generated from relationships among CEOs, Board of Directors and the Government is then a subset of the larger set of relationships that is affected by the private delivery process.

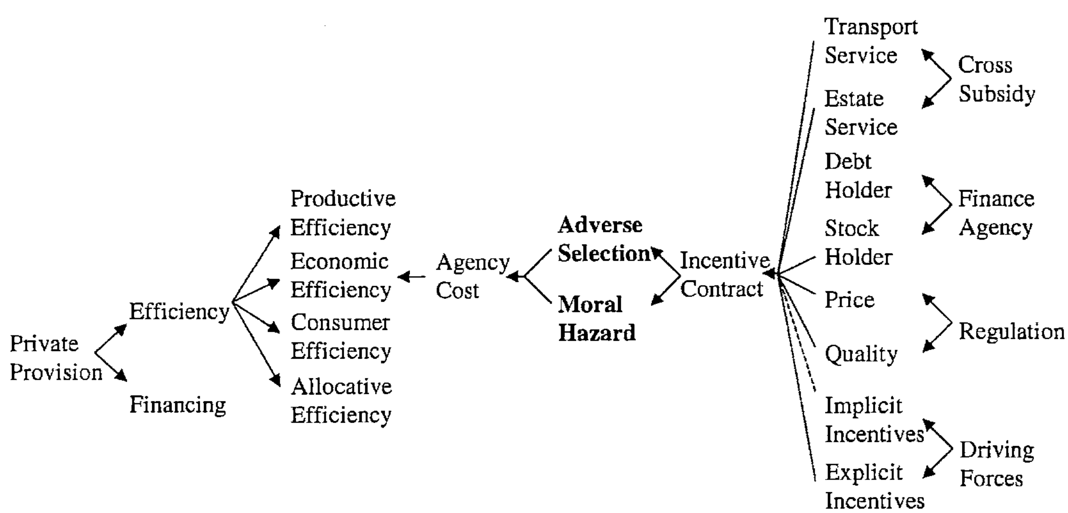
Financial-agency conflict produce associated costs that are embedded in a project's information asymmetry derived from CEOs' behavior and their information disclosure. It is the ongoing concern (evident in the literature) for achieving greater efficiency through private investment of transport infrastructure that motivates the connection that this thesis going to make between financial contracting with the franchise CEO and the mitigation of principals' conflict. An efficient contract is one that balances the marginal benefit and cost of reducing financial-agency conflict within the project investment and management. By optimally restructuring a transport project's financial contracts (with the proper incentives) during its private investment and project delivery, equilibrium outcomes should be superior (in terms of overall efficiency) to those that would result if the agency issues were handled more casually. The appropriateness and benefit of analyzing this relationship in an agency context shall become evident as the relationship is superimposed into the agency paradigm.

The key hypothesis of this research is then: designing an efficient incentive contract with CEOs will lower the agency costs from the perspectives of the Board of Directors and the Government and will then achieve economic efficiency objective in private provision of transport infrastructure. Two key questions related to this hypothesis are:

(1). How to achieve the first-best incentive contract? (The key concern of Chapter 3.)

(2). How the characteristics of activities affect the incentive contract? (The primary focus of Chapter 4.)

To answer these two questions, a methodology and research framework is designed in the following sections. As we have stated above the four dimensions of our considerations are: cross-subsidy, government regulation, financial agency, and driving forces of CEOs. In cross subsidy, we consider the activities from primary transport services and real estate development. For government regulation, we have our focus on price and quality-of-service in primary transport services. In financial agency, we limit our emphasis on stockholders and they are represented by the Board of Directors. Regarding the driving forces of CEOs in their daily operation, though we can have both implicit and explicit incentives being considered in our theoretical modeling, we only could work out with explicit incentives in empirical exploration due to data limitation and measurable cardinal number on the implicit. Figure 1.3 illustrates the sources of agency cost and the solution dimensions considered in this research.



Note: Real line indicates that is considered simultaneously in theoretical modeling and empirical exploration. Dot line indicates that is considered in theoretical modeling only.

Figure 1.3 Sources of Agency Cost and Its Resolution Dimensions

1.3 Methodology

This thesis research uses project risk and its mitigation as an organizing principle and the information collected from case and literature review is used to identify key provision aspects of current practice with private investment in transport infrastructures. Also, using the risk-mitigating strategies as principles to shape future development of franchise projects, this thesis recommends changes to incentive contracts that could mitigate project risks and justify the appropriateness of product mix from agency views.

After justification of the development type transport projects, this thesis applies concepts from economic and finance theories of agency to analyze the critical relationships among CEOs, government, and board-of-directors. The application of economic theory of agency focuses on the contractual arrangement that provide an incentive to CEO to invest appropriate amount of efforts required by the objectives of board-of-directors and government. Such arrangement is called first best when they also produce an optimal risk sharing of the risk connecting with transport and property development products. If either the principals or the agent is risk averse, or if information is limited (i.e., when the amount of effort or the state of world are not independently observable), first best contracts are not attainable. Second best contracts that utilize proxies for the missing information is then be suggested. Improvements in those contracts are possible once innovation in incentive, risk sharing structures, and monitoring schemes or more detailed and reliable information become available at reasonable costs.

This thesis tries to draw a connection between financial contracting with the CEO and the objective of creating the proper incentives for encouraging resolution of financial-agency conflict (to reduce agency costs). Measuring agency costs is an imprecise task that is receiving attention in the literature. However, in the case of a private delivery of new transport infrastructure, conducting an absolute measure of financial-agency costs is less informative than a relative measure across periods. If the fundamental economic objective for private delivery and investment is to increase an infrastructure's efficiency, then, to be consistent with this objective, the franchise should be taking steps to mitigate financial-agency costs.

This thesis discusses incentive problems on private investment of transport infrastructure (1) to gain an appreciation of the level of contracting activity, (2) to identify issues that are related to common-agency and multitask-agency conflicts, incentive/job design, and financial-contracting, and (3) to form basis for theoretical modeling and empirical exploration. For empirical exploration, a methodology for analyzing cases of private production, especially the incentive design and financial-contracting is formed and proxy variables and approaches for econometric analysis for agency are discussed and selected. The research framework is described in figure 1.4.

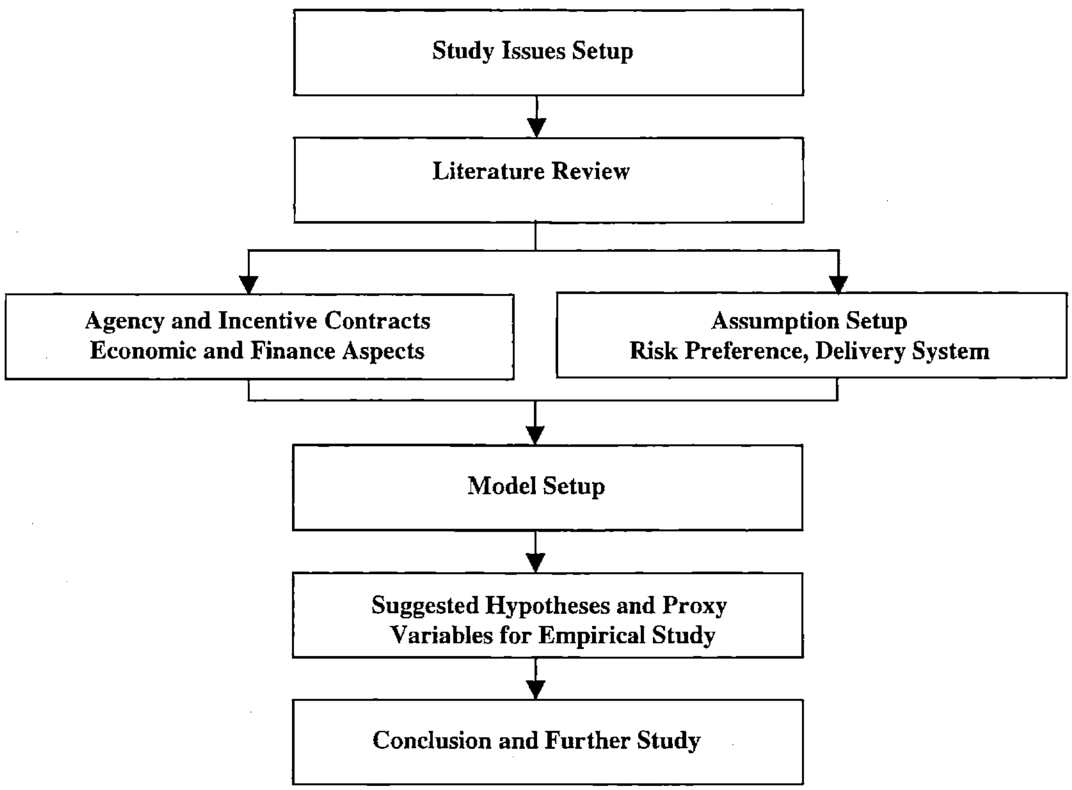


Figure 1.4 Research Framework

1.4 Organization of the thesis

The organization of the thesis monograph is described as follows. First chapter provides background and justification of agency issues on private investment of transport infrastructure. Chapter 2 discusses agency theory and relates it to issues on incentive contracts, common-agency, and multitask-agency of private investment in transport infrastructure.

Chapter 3 develops the framework and theoretical models for analyzing the critical financial-contracting issues on multitasks agency, common agency, and cross subsidy. Static and dynamic incentive models, which are designed to overcome deficiency from agency with multiple tasks and multiple principals under regulation environment, are also developed. These managerial compensation plans directly reward efficient performance, at least as we have defined. It may not operate in the board-of-directors' interest, a subject to which we will return later, so it is quite possible that the regulatory commission may have to impose it upon the regulated franchises. The common agency aspect is in some ways of quintessential feature of a process of political management of an economic activity. For multitask agency, the power of incentive can be restored if a constitutional rule can restrict each principal to base his incentives only on the dimension of the agency's tasks that is of direct concern to that principal. The purpose of the agency models is to demonstrate these propositions.

In chapter 4 a proposed framework of empirical exploration for analyzing cases of private investment is discussed and an econometric analysis presented as an empirical illustration of several incentive-design and financial-contracting issues. Finally, chapter 5 contains summary of work and suggestions for future research.

Chapter 2 Agency Theory and Incentive Contract Problem

Since an agency-theory-based paradigm is used in this thesis, this chapter expands the definition and discussion of agency presented in chapter 1. In sections 1.2 and 1.3 the connection between incentive contracting and mitigation of principal-agency conflicts was drawn. While board-of-directors and government are negotiating incentive contracts with CEOs, the opportunity exists to construct incentives that will motivate behavior consistent with mitigation and reduction of principal-agency conflicts. In the following sections, streams and literatures on agency theory, contracts, and incentive design are reviewed.

2.1 Development of Agency Theory

2.1.1 The Streams of Agency Theory

Eisenhardt's (1989, p.58) review of agency theory helps us to put the origins of this theory in its proper perspective relative to other economics literature. She explains that:

> During the 1960s and early 1970s, economists explored risk sharing among individuals or groups (such as Arrow, 1971; Wilson, 1968). This literature described the risk-sharing problem as one that arises when cooperating parties have different attitudes toward risk. Agency theory broadened this risk-sharing to include the so-called agency problem that occurs when cooperating parties have different goals and division of labor (Jensen and Meckling, 1976; Ross, 1973). Specifically, agency theory is described at the ubiquitous agency relationship, in which one party (the principal) delegates work to another (the agent), who performs the work. Agency theory attempts to describe this relationship using the metaphor of a contract (Jensen and Meckling, 1976).
>
> Agency theory is concerned with resolving two problems that can occur in agency relationships. The first is the agency problem that arises when (a) the

desires or goals of the principal and agent conflict and (b) it is difficult or expensive for the principal to verify what the agent is actually doing. The problem here is that the principal cannot verify that the agent has behaved appropriately. The second is the problem of risk sharing that arises when the principal and agent have different attitudes toward risk. The problem hare is that the principal and agent may prefer different actions because of the different risk preferences.

Research based on agency theory can be organized into two streams: one is labeled as "positive-agency theory," and the other "principal-agent-agency theory." Both streams are similar in that both identify a principal and an agent and focus on the contract between the two. At the same time, the two streams are dissimilar by virtue that application of principal-agent agency theory tends to be more mathematical than positive-agency theory; and each theory has a different style. The research of positive agency theory leads to information- and/or incentive-based resolutions to conflicts between agent and principal. The principal-agency theory leads to specific contract specifications that are most efficient under a particular scenario-not just between common business's management and shareholders, but any general principal-agent contract.

Agency theorists from both streams can contribute to the study of delivery of infrastructure. For instance, many infrastructures are monopolies. A decision that needs to be made if a monopolistic infrastructure is privately delivered is whether and how the operation should be regulated. The principal-agent stream of research has analyzed and constructed a framework for resolving regulations (such as discussion in Baron and Myerson, 1982). This framework can be applied to the private delivery of infrastructure. Analytical research focusing on financial-agency issues will likely use a positive-agency approach. Like Eisenhardt (1989, p.59) states, "Positivist researchers have focused almost exclusively on the special case of the principal-agent relationship between owners and managers of large, public corporations (Berle and Means, 1932)."

This thesis is then going to deal with the efficiency issues pertaining to the set of agency relationships involving the infrastructure's property rights. This particular set of agency relationships is a subset of the larger set of relationships that is affected by the private delivery process. The major groups that find themselves in either a principal or agent role that can be affected by private deliver of infrastructure are political decision makers, consumers, employees (including managers), shareholders, taxpayers, financial institutions responsible for handling the financing, consultants, lawyers, etc. The magnitude and significance of private delivery become apparent when we consider that contracts between these parties all need to be renegotiated or affirmed to complete the delivery process. However, to the extend of this thesis, the incentive contracts will be focused on franchise CEOs, the government (and its regulation agency), and the board-of-directors.

2.1.2 Using Agency Theory for Infrastructure Delivery

Research applying agency theory in the analysis of the economics of infrastructure delivery (mostly in defense facilities) is fairly recent. There have been several noteworthy contributions to the literature that hint to the potential for better understanding infrastructure delivery through agency-based analysis and research.

As reviewed in the literature, one application of principal-agent research that developed during the 1990s was the area of monopoly regulation. Research into the regulation of franchise is relevant to private delivery since, often, an infrastructure being considered for private delivery is a monopoly in its industry/market. Since the gain in efficiency is the primary economic justification for private delivery, there is an interest in how allocative efficiency will change as a result of private delivery. Research centers on the question of whether private delivery of an infrastructure will produce greater allocative efficiency as an infrastructure building and operating as a regulated or unregulated monopoly.

Another topic is the risk sharing and incentive contracting. The incentive contracts implemented in practice are normally with the following approach:

$\pi = \pi^* - s * (C - C^*)$

where	π	is the profits earned by the contractor
	π^*	is the expected profit
	s	is a sharing rate (where $s \in (0,1)$)
	C	is the actual cost
	C^*	is the expected cost

The above formula contains three design parameter, π, π^*, s, which are subject to negotiations or competitive bidding. The restriction $s \in (0,1)$ makes sense that if it values outside (0,1) would stimulate additional strategic considerations with respect to cost reporting. The bigger s the more sensitive is profit as a function of actual cost. Contracts with $s \in (0,1)$ would constitute a compromise between two extreme contracting approaches, namely,

1. The cost-plus-fixed-fee contract ($s = 0$) according to which any cost overrun ($C-C^*>0$) or cost underrun ($C-C^*<0$) is irrelevant for the contractor
2. The firm-fixed-price contract ($s = 1$) according to which the contractor has to bear any cost overrun to the full extent. On the other hand, he also enjoys benefits from any cost underrun to the full extent.

One obstacle to a widespread use of these contracts is the difficulty to assess the design parameters π, π^*, s appropriately. Several approaches have been discussed in the literature: bilateral bargaining links between design parameters, and competitive bidding with respect to one or several design parameters.

2.2 Contracts, Incentives and the Market for Executives

The vital function of franchise executives (CEOs) in efficiently directing the vast amounts of resources under their control in transport infrastructure makes the executive labor market an especially interesting one to study. Literature raised the fundamental contractual issue in common business by pointing out possible conflicts of interest arising from separation of ownership and control. It has taken many years for the economic profession to put these matters in proper perspective though infrastructure industry is only occasionally mentioned.

The first generation response was to identify a market for corporate control (Manne, 1965), whereby the treat of involuntary termination would provide incentives for executives to align their actions with their shareholders' interests. The remarkable level of activity in the American corporate-control market in recent years has dispelled any lingering doubts about the importance of this mechanism. Still, there remain differences of informed opinion on its efficacy for solving the problem.

Second generation debates on the managerial theory of firm (Marris, 1963; Baumol, 1967) focused attention on the firm's objective function. If executives operated the firm in the interests of shareholders' then they would maximize profits, and if they catered to their own interests then such things as sales and the amount of assets controlled would enter into the firm's objectives. An empirical question was immediately suggested: did executive earnings respond more profitability or to sales? The investigations provoked by this question were among the empirical studies of agency.

It would interesting to report that these studies provided an empirical basis for the extensive theory of agency that has been developed recently, but that is not the way it happened. Rather, much of that development paralleled theoretical research on information economics. Whatever its source, the executive labor market is one of the most important practical applications of the new theory. Theory in turn has provided a useful framework for thinking about the data and for showing precisely how various mechanisms may be devised to align the interests of control and ownership. In this literature review attempts to join the theoretical and empirical strands of them is made. It is organized around the main economic problem that the executive labor market must solve: providing performance incentives.

The following sub-sections take up the agency and incentive question, given the allocation of control. Theory predicts that the structure of pay strikes a compromise between incentives and insurance. Much evidence supports that prediction. The direct incentive component is of particular interest. The elasticity of compensation with respect to accounting rates of return is in excess of 1.0; and the elasticity with respect to stock market rate of return is approximately 0.10. However, there exists no theoretical benchmark to serve as a guide for the size of number that should be expected, and disputes remain on whether compensation mechanisms provide enough incentives to elicit efficient management behavior.

2.2.1 Incentive Payments

Great power to direct resources and the large surplus that go with it are what make the executive labor market so interesting. Power and income are related in the market economy, where remuneration is proportional to one's marginal contribution to production. Early work began to connect marginal productivity to business decisions within hierarchical control structure – see Reder's (1968) excellent survey for reference. Activities of top management are magnified geometrically because they affect recursively the productivity of all who work below them in the organization. This scale of operations effect, multiplying little bits over each of many units, accrues to more talented managers as economic rent in a competitive equilibrium, like a superstar effect (Rosen, 1991).

Top management inputs have something in common with local public goods, consisting as they do of commands and decisions affecting the productivity of the organization as a whole. What type of goods should be built and on what scale? What niche should the firm play in the market and how should its products be priced? Although a detailed theory of the division of labor in management organization is not available, a simple hierarchical model illustrates the essence of the idea – see Rosen (1982) and Miller (1982) for more detail.

A. Agency – the Nature of Problems

The interesting question is whether or not CEO efforts are directed toward the proper goals. Do CEO direct their work to serve the interests of shareholders and other stakeholders or do they work in more self-serving ways?

At heart this agency problem in the interest of this theses study represents some limitation on possibilities for decentralizing the functions of management in market economies. Specialization of knowledge and information, and the capital requirements of large transport franchise virtually dictate a managerial function that is itself specialized and separated from ownership and government audit but tied to the fortunes of one franchise and the society.

The resources controlled by such firms are so large that they must be assembled from far and wide. Individual owners and the government agency cannot shepherd their resources in that way because of lack of skill, specific production and market knowledge, and motivation. Instead, they must place a certain amount of trust in a management team to take proper actions on their behalf. Herein lies the agency problem.

The formal problem is to design contracts to induce CEOs to act in their shareholders' and the government's interest. Various mechanisms have been identified that might accomplish this task. Economists have confined their attention to an idealized problem where the technology, scope for actions and outcomes are common knowledge among principals and agents and only the action taken is private information of the agent. Principals know a great deal about the business, including what actions should be taken conditional on circumstances. They simply do not know what circumstances arose in any given realization: only the agent knows that. This is a far more constrained view than the idea of early economists, or even that of the law on principal and agent relations, where the agent typically is hired to render services of exclusive technical or other specialized knowledge that cannot be known to principals because it is not their business.

B. Penalties for Misbehavior

Incentive schemes can either penalized unwanted behavior (negative feedback) or reward desirable behavior (positive reinforcement). Ambiguity arises for poor behavior, and is resolved by adopting some norm of expected behavior. The earliest approaches to agency theory suggested penalties as efficient incentives (Mirrlees, 1976). Diminishing marginal utility of money makes the monetary reward required to induce good behavior larger than the monetary penalty needed to discourage behavior.

a. Bonding Solutions to Agency Problems

A performance bond that commonly use in project delivery is the prototype in common business, too. Malfeasance is discouraged by a potential penalty because the agent puts personal wealth in jeopardy, up-front, as the bond. If the norm of good behavior is maintained, the agent is paid opportunity costs plus interest on the bond. If malfeasance is detected, the bond is seized and the worker is fried.

The potential unraveling problem at contract termination is solved by extending the worker's horizon and not returning the bond until after retirement as a pension (Becker and Stigler, 1974, for a very clear account). There exists a locus or trade-off of bond, detection-probability combinations that motivate the agent to adopt good behavior. Since resources used for monitoring have opportunity costs, it is economical to make the bond as large as possible and the probability of detection as small as possible (Becker, 1968).

Economists have used considerable imagination in applying this model. Lazear (1979) interpreted the bond-pension scheme very broadly. In his model, workers are paid less than their value to the firm when young but more than their value when old. The negative difference between pay and value is a gradual posting of bond, with the worker effectively investing in the firm and becoming a partner for all practical purposes. This model implies a reduction in turnover. Studies of job turnover have established that, after an experimentation period at the start of life cycle, permanent attachments are made and turnover drops precipitously. Once a stable job has been found, it persists for remarkably long periods. Unfortunately, CEOs have not been singled out for study, and there are serious gaps in the executive data for this purpose. However, a few conclusions may be warranted.

CEOs in large company (such as transport infrastructures in our study and public utilities and banking services, etc., in the others.) hold their positions for fairly long intervals and have been employed by the firm for a very long time. For example, in the samples used by Kostiuk (1989) and Murphy (1995), the average top level CEOs was 55-57 years, had been in position for seven or eight years, and had worked for the company for more than 25 years. In the case studies discussed by Vancil (1987), 80 percent of retired CEOs remained on their firm's board of directors, and more show one-third served as chairman of the board. Barro and Barro (1990) show a marked increase in departure probabilities of commercial bank CEOs after 63 years of age and associated normal retirement. This is probably true of most industries.

The observations are consistent with bonding and firm-specific capital accumulation among business CEOs, but knowledge of magnitudes is not available to assess their deterrence effects. The deterrence value of a bond depends on its size compared to the value of resources at risk of mismanagement and appropriation. Since a person's rank and responsibility in an organization grow over the life cycle, it is likely that implicit bonds are more efficacious for younger CEOs who have not yet gained control of much of firm's resources. And since the value of large corporations exceeds the wealth of top managers by many orders of magnitude, bonds provide less scope for solving the agency problem at the top.

b. Loss of Reputation as Bond

Reputational considerations serve a bonding function in agency relationship, and although they lurk in the background of agency theory, formal analysis had proved elusive. An important exception is Fama (1980), who considered a model where observes use an agent's prior record and past history of performance to infer some personal trait, such as honesty. Knowing this, the agent has incentives to act in ways that affect the market's beliefs. The agency value of reputation arises because current behavior has an enduring memory when the legacy of the past is used to update current beliefs. The current actions have long-term consequences if the discount rate is not too large. Loss of reputation serves as a deterrent when the capital value of these consequences for earnings is greater than the benefit of malfeasance, sloth, and error in a current action.

Fama (1980) analyzed market equilibrium for a simple structure without discounting, which converged to first-best efficient managerial behavior. Holmstrom (1982) showed that discounting and risk aversion limit the extent to which reputation policy incentives. For example, finite life limits the extent to which the legacy of the past persists into the future (see Telser (1980) for the need for random horizons in self-enforcing agreements, and Radner (1985) on discounting in multi-agent problems). Reputation plays an even smaller role in contract enforcement as the agent gets older because there is less to lose. At the end of the contract there is nothing to lose.

This horizon difficulty is reinforced by the fact that opportunities for misconduct increase as the successful agent's control over resources increases over the life cycle. One can be sympathetic to the idea that there is much more to loss of reputation than merely financial opportunities – social opprobrium, disapproval from one's peers, and loss of self-esteem have substantial deterrence value to many people – yet remain skeptical about their overall role in enforcing agency relations. Like performance bonds, reputation is likely to be more efficacious earlier rather than later in the life cycle.

2.2.2 Rewards to Elicit Efficient Action

All of the penalty modes constraint, but do not eliminate, self-serving behavior. Hence there is scope for reward mechanisms to help align the interests of agents and principals.

1. Risk Sharing and Incentives

A fairly general approach was developed by Homstrom (1979), who examined the following problem. Suppose an agent is hired by a principal to produce good x with production function $x = f(l, \varepsilon)$, where l is effort and ε is a random variable with zero mean and known distribution. The agent is risk-averse with concave utility $u = U(c, l)$, where c is consumption. The principal is risk-neutral. All production and utility functions are common knowledge and outcome x is jointly observed by principal and agent. However, the action l and the random variable ε are exclusive private information, either controlled or observed, of the agent. The principal has full property rights in x, which has unit price, and for simplicity, supplies no inputs into the production process. The agent is paid a share $s(x)$ of the proceeds of x because l and ε are not separately observed by the principal: the goal is to characterize the equilibrium determination of $s(x)$.

The method of solution is interesting. It converts the market equilibrium problem into a two-stage maximum problem. The first step analyzes the agent's choice of l that maximizes expected utility given $s(x)$. This yields a mapping from $s(x)$ to labor supply l. The second step solves the function $s(x)$ that maximizes either the principal's expected profit or the expected utility function of the agent, given the labor supply behavior in the first step. If profit is taken as maximum, another constraint is that the worker must expect to receive the known utility level of another job. If expected utility is taken as maximum, the added constraint is that the principal receives at least the expected return in some other activities. These alternatives give two extreme points on the utility-possibility frontier. Intermediate points are similarly obtained. Competition in the labor market insures that the equilibrium contract lies on the utility-possibility frontier.

There is tension between efficient action and efficient insurance in this problem. Were everything observable, the two could be unbundled. Then the risk-neutral principal would supply full insurance to the risk-averse agent by paying a fixed salary independent of outcome. The agent would willingly supply optimal effort (expected marginal product equals marginal cost) and monitoring would eliminate shirking. If the agent is risk-neutral there are no gains from trade. The agent acquires ownership rights to x and supplies optimal effort as a residual income recipient in self-employment. In all other cases, payment based on output alone through $s(x)$ gives only one instrument to perform two real allocative functions. There are not enough independent prices and margins to do either one sufficiently: the principal has to offer less than complete insurance to give the agent incentives to put forth effort.

It is remarkable that very little more can be said, in general, to characterize $s(x)$. Payments that are decreasing in x through part of its range can not be ruled out (Grossman and Hart, 1983). This negative result provides very few restrictions on data and makes the theory difficult to apply. What is worse, the contracts actually observed in agency relationships are typically of very simple forms that are not predicted by this model.

The reason for these complications is difficult to describe. However, Holmstrom and Milgrom (1987) prove that $s(x)$ takes the simple linear form of a two-part tariff when income effects are absent in preferences and the technology shocks ε are i.i.d. An intertemporal version shows intuitively how it works. Consider an indefinitely repeated problem when ε is white noise and the action is chosen before ε is revealed in each round. With no income effects, the agent is content with the same amount of insurance each time irrespective of wealth, and similarly for the risk-neutral principal. Furthermore, i.i.d. production disturbances imply that each round looks exactly like every other from the production/incentive point of view. It is efficient for the agent to choose the same action in every period, because the agent's marginal rate of substitution between effort and consumption is independent of wealth and the expected marginal product of effort is constant. In the linear payoff schedule $s(x) = a + bx$, which implements the scheme, a serves as the insurance component and b as the incentive component (Stiglitz, 1975). If $s(x)$ were non-linear, the agent would have undesirable incentives not to take the same action each time, e.g. to accumulate work into a large pile and do it all at once in a range where $s'(x)$ is increasing.

2. The Optimal Piece Rate

Following Holmstrom and Milgrom (1989), consider the linear model a risk-averse agent with constant absolute risk aversion who produces two inputs, x_1 and x_2, for a risk-neutral principal. Labor supplied by the agent is the only input. The agent receives a total payment y consisting of a fixed lump sum and revenues from production of x_1 and x_2, each with separate piece-rates b_1 and b_2:

$$x_i = l_i + \varepsilon_i \qquad i = 1, 2$$
$$y = a + b_1 x_1 + b_2 x_2 \tag{2-1}$$
$$u = U(y - c(l_1, l_2)) = -\exp\{-R\,[y - c(l_1, l_2)]\}$$

where R is the coefficient of risk aversion, l_i is the effort devoted to activity i, y is gross income, $c(l_1, l_2)$ is the agent's (convex) cost of effort and ε_1 and ε_2 are random variables with zero means and covariance matrix $\{\sigma_{ij}\}$.

Following the two step procedure, take parameters (a, b_1, b_2) as given and calculate the agent's labor supply to each activity. Substituting from (2-1), the agent chooses l_1 and l_2 to maximize

$$Eu + EU(a + b_1 l_1 + b_2 l_2 + b_1 \varepsilon_1 + b_2 \varepsilon_2 - c(l_1, l_2)) \tag{2-2}$$

The first order condition is $\partial Eu / \partial l_i = EU' \cdot [b_i - \partial c / \partial l_i] = 0$. Consequently,

$$b_i = \partial c(l_1, l_2) / \partial l_i, \qquad \text{for } i = 1,2 \tag{2-3}$$

from which the labor supply functions $l_i = l_i(b_1, b_2)$ are obtained by inversion. Comparatively statics on (2-3) yields

$$\partial l_i / \partial b_j = (-1)^{i+j} c_{ij} / (c_{11} c_{22} - c_{12}^2) > 0. \tag{2-4}$$

It follows that $\partial l_i / \partial b_i > 0$: an increase in the payment for an output increases the effort devoted to it. Also, $\partial l_i/\partial b_j < 0$ for i $\neq$ j when $c_{ii} > 0$: an increase in the price of one good decreases the effort supplied to the other.

In the second step, the risk neutral principal has profit $\pi = p_1 x_1 + p_2 x_2 - a - b_1 x_1 - b_2 x_2$, where p_i is the relative market price of x_i. Consider the case where the expected return to the principal is driven to zero. Then (a, b_1, b_2) is constrained by

$$E\pi = 0 = (p_1 - b_1)\, l_1 + (p_2 - b_2)\, l_2 - a \tag{2-5}$$

The market equilibrium contract (a, b_1, b_2) is the one that maximizes the agent's expected utility EU, subject to the labor supply functions derived in the first step and to (2-4).

Substituting (2-4) into Eu:

$$Eu = EU(p_1 l_1 + p_2 l_2 + b_1 \varepsilon_1 + b_2 \varepsilon_2 - c\,(l_1, l_2)) \tag{2-6}$$

where $l_i = l_i(b_1, b_2)$, satisfying (2-3), is understood. Differentiating (2-5) with respect to b_i and simplifying gives, for i = 1, 2

$$\partial Eu/\partial b_i = [(p_1 - c_1)\, \partial l_1/\partial b_1 + (p_2 - c_2)\, \partial l_2/\partial b_i] EU' + EU'\varepsilon_i + 0 \tag{2-7}$$

where $\partial l_i/\partial b_i$ satisfies (2-4). Finally, substituting the utility function in (2-1) into (2-7):

$$(p_1 - c_1)\, \partial l_1/\partial b_i + (p_2 - c_2)\, \partial l_2/\partial b_i - R(b_1 \sigma_{i1} + b_{12}\ \sigma_{i2}) = 0 \qquad i = 1, 2 \tag{2-8}$$

gives two equations in two unknowns to solve for b_1 and b_2.

Equation (2-8) illustrates the balancing between incentives and insurance in the optimal contract. The marginal cost of effort, c_1 *and* c_2, would equal their marginal rewards, p_1 and p_2, in a fuesrt0best solution. In (2-8) there is a wedge between the marginal cost and marginal benefit of efforts in each good. These are weighted by the marginal response of effort to its internal price to arrive at an average deviation and balanced against risk considerations in the last term of (2-8). Relevant risk in the contract is an average of the variances of each output weighted by internal prices and the extent of risk aversion. Departures from first-best incentives increase with risk and the agent's sensitivity to it. A little more progress can be made by manipulating (2-8) to

$$b_i = [R\sigma_{ij}(c_{ij} - pc_{ij}) - R\sigma_{ij}(pc_{ii} - c_{ij}) + 1]\Delta/D \qquad (2\text{-}9)$$

where $\Delta = (c_{11}c_{22} - c_{12}^2)$ and $D = (R\sigma_{11}\Delta + c_{22})(R\sigma_{22}\Delta + c_{11}) - (R\sigma_{12}\Delta + c_{12})^2$. Even this is unwieldy, but two special cases suffice for present purposes.

First, let $c_{12} = \sigma_{12} = 0$. Then the two activities are independent of each other and (2-9) could be reads as:

$$b_i^* = p_1/(R\sigma_{ii}c_{ii} + 1) \qquad i = 1, 2 \qquad (2\text{-}10)$$

Piece rates vary inversely with risk aversion, R, the size of the risk, σ_{ii}, and the relative responsiveness of labor supply to price, c_{ii}, and vary positively with the market value of output produced, p_i.

Second, let $c_{12} > 0$ and $\sigma_{12} = 0$. Now the activities compete with each other because doing more of one increases the marginal cost of the other. Substituting into (2-9), one eventually arrives at

$b_i = b_i^*$ plus a term in $[R\sigma_{ii}(c_{12} - c_{ii}) - 1]$,

where b^* is defined in (2-10). The second term in this expression is negative as long as c_{ii}

$> c_{12}$, that is, if, from (2-4), the own-responsiveness of effort to price is larger than the cross-responsiveness, then b_i is smaller than b_i^*. Piece rates are smaller when activities compete with each other in the agent's effort. There are negative externalities between the two activities when c_{12} is positive. These are effectively taxed by reducing the marginal incentive components in the contract, so substitution between activities give rise to relatively insensitive internal incentives, to low-powered incentives in the sense of Williamson (1985).

3. Some Qualification Arguments

Another, perhaps more fundamental, reason why the optimal contract might back off from sensitive performance incentives is that output and performance of managers are often hard to measure. The services rendered by CEOs in large firm such as transport franchise cannot be assessed on a fixed scale of attributes. If the list of variable is incomplete, then scoring performance on such a scale might exaggerate the production of those attributes that are only imperfectly correlated with the true value of the service. Important intangibles would not be rewarded sufficiently. Although the point is an old one, it has been applied only recently to executive labor market incentives. Baker (1992) shows that imperfect correlation between the assessment of performance and true output acts like a reduction in p_i in the formula for b^* above. It reduces the weight of marginal incentives in determining CEO pay, and by implication increases the weight of fixed salary.

Such considerations are more appropriate for lower level managers than for those close to the top of the ladder. Contributions of lower level managers to the success of an organization are difficult to isolate, submerged as they are in the joint output of the team as a whole. Life-cycle considerations also play an important role there. Incentives cannot be so diluted for high-ranking people, who take ultimate responsibility for the success of the organization as a whole. If they are rewarded on market valuation and profitability of the firm, there is no need to assess and price out each of the many activities that contribute to it. There is no need to reduce the power of incentives to them (Lazear, 1986).

An important qualification remains. Rewards that promote good incentives must be indexed to outcomes that managers can alter. Stock market values and current profits are only partly affected by managerial decisions. They are also affected by business conditions beyond any CEOs' control. Lazear and Rosen (1991) pointed out that relative comparisons wash out common components of variance among competitors and isolate specific performance-related components. The idea is analyzed most completely by Holmstrom (1992), who showed that relative comparisons eliminate a source of extraneous risk for agents. Increasing the signal-to-noise ratio makes managerial incentives more effective and contracts more efficient.

4. The Evidence

Top CEO compensation in a large firm is set by the board of directors, often with the assistance of management consultants (Tosi and Gomez-Mejia, 1989). The contracts themselves are not public information, but there is little doubt that remuneration is tied to the fortunes of the firm. There are, however, differences of opinion about how performance is measured for compensation purposes and about the magnitude.

The earliest studies on the sales-profits debate summarized generally found a larger effect of sales than of profits (Roberts, 1956; McGuire et al., 1962). Later studies (Lewellen and Huntsman, 1970; Winn and Shoenhair, 1988) tended to find stronger effects of accounting profits on compensation, but at least an equal number have found evidence for both (Meeks and Whittington, 1975; Ciscel and Carrol, 1980; Kostiuk, 1986, 1989; Leonard, 1990), with the picture slightly clouded multicollinearity. Since size must be an important correlate of pay if more talented persons control greater resource, posing the agency question in terms of sales versus profits is not meaningful with the available data. The managerial hypothesis that size is larger than it otherwise would be is a counterfactual that cannot be answered at the moment. Looking at all the studies together it is hard to see clear winners in the earlier debate. Both performance and scale are important. We could confine attention to those studies where elasticities are presented or can be computed. All of the estimates either refer to CEO or to the top five executives. Some use salary and bonus as independent variable, others a more comprehensive definition that includes deferred compensation and option.

Kostiuk (1986) estimates a semi-elasticity of the accounting rate of return on compensation (defined as *d*log(compensation) / *d*r, where *r* is the rate of return) of about 1.25 for the United States in both the 1930s and early 1970s. This compare quite well with Cosh's (1975) estimate of 1.0 for Britain in the early 1970s. In recent years, empirical studies have tended to use the stock market rate of return as the performance measure rather than accounting rates of return. This reduces the elasticity estimate by almost a factor of 10.

Murphy (1985) estimated a semi-elasticity of compensation with respect to the rate of return to shareholders of 0.12 – 0.16 using a 73-firm sample of firms during 1968-81. Murphy (1986) produces a similar estimate on a much larger Forbes sample of about 250 large firms over 1974-84. Earlier, Masson (1971) estimated statistically significant effects of stock returns on CEO compensation from a 39-firm sample over 1947-66, though the coefficients themselves are not reported. Coughling and Schmidt (1985) estimated a semi-elasticity of 0.10 – 0.15 on a 40-firm sample from Forbes during 1978-80. This study is notable for using the abnormal stock return (estimated from Capital Asset Pricing Model, CAPM) instead of raw return. Murphy (1985) tried both abnormal and total returns in a within-firm compensation regression. Most of the estimated effect goes to the raw return, and it does not seem to matter which one is used, so long as both are not used together. Again, there is evidence that this estimate is remarkably uniform from study to study; e.g. consider that Barro and Barro (1990) report an estimate of 0.17 for bank CEOs over 1982-7.

Coughling and Schmidt (1985) were among the first to use a relative performance measure among the first to use a relative performance measure, yet Murphy's (1985) empirical competition between relative and absolute stock returns suggested that relative performance did not matter. Relative performance evaluation was principally addressed by Antle and Smith (1986) using Masson's 1947-66 sample. They found only weak evidence to support the idea. It was definitely rejected for 15 out of 37 firms studied, while wrong signs on the systematic and firm-specific components were obtained for many others. Barro and Barro (1990) find no evidence of relative performance evaluation among bank CEOs, even though there were marked differences in fortunes among regional economies and their constituent banks during the period of study.

A study by Gibbons and Murphy (1990) uses the largest (Forbes) sample and provides the most evidence supporting relative performance evaluation. They include the average rate of return on stock in the firm's industry and the firm's own rate of return in the compensation regression, rather than the abnormal performance, capital-asset-pricing-model measures. They find positive effects of own return on executive compensation and negative effects of industry average return. While it is the strongest evidence for relative performance effects found then, anomalies remain because industry effects are larger at the most aggregate level than at the firm's own four-digit level. The estimated effect may be sensitive to how relative performance is measured. Hence the overall picture on relative performance effects is somewhat more on the negative than positive side of the ledger.

Most studies so far have examined whether pay and performance have positive partial correlation. This is the natural first approximation, but there are only a few more ambitious studies that purport to examine causation. This program was begun by Masson (1971), who investigated how various components of pay affect firm performance. The method used is flawed and has not been pursue. Leonard (1990) regressed the rate of return on equity on various aspects of pay and incentives for executives within ten levels of the top in a proprietary sample. No clear general picture emerges because the effects differ in sign when estimated within and between firms. Abowd's (1990) study on these proprietary is notable for asking whether changes in the sensitivity of pay to performance affect subsequent performance. Evidence of such effects is found for stock market performance indicators, but not for accounting measures. The inventory of studies is too small to make definitive judgements on causality at the moment. Hopefully, more studies along these lines will be forthcoming.

Finally, some studies have examined the sensitivity of pay components to performance. Most studies mentioned above conclude that current performance rewards come about through adjustment of the bonus and components of compensation other than salary. Salary is a substantial part of compensation, but acts more like the fixed/constant term a in the development above. One thinks that salary adjustments should respond to longer-term components of performance and bonus to shorter-term components, but this is an understudied point. Eaton and Rosen (1983) consider the difference between long- and short-term incentives by examining the correlates of current and deferred pay components. However, Miller and Scholes (1982) argue convincingly that these forms of compensation are tied up with tax laws so it is difficult to distinguish the two. For instance, stock options were not used for components until 1950s, when upper bracket marginal tax rates were very high. Morck et al, (1988) find a curious nonmonotonic relationship between management stock ownership and firm performance measured by Tobin-Grunfeld's Q increases with stock ownership of Board member (including the CEO) when it is less than 5 percent of total stock, decreases with ownership in the 5 – 25 percent range, and perhaps increases again above that range. No compelling explanations have appeared as yet for this unusual finding.

5. Assessment

Although there is little doubt that top CEOs' incomes vary with the fortunes of their firms, the picture is mixed relative to theory. Confirming evidence from several independent studies and samples leaves us fairly secure that the effect of stock returns on log(compensation) is in the 0.10 – 0.15 range. The many estimates of accounting rates of return on compensation do not lend themselves to such ready comparisons, even though most studies do find positive effects. The best available comparable estimates are in the range 1.0 – 1.2, and quite a bit larger than for rates of return to stock ownership.

It is hard to express a clear preference between these two alternatives. Many studies simply dismiss accounting profits as too easily manipulatable by CEOs to be suitable contractual measures of performance. Such dismissal is simply less correct. Not only is it known that explicit provisions of CEO contracts are in fact tied to accounting numbers, but the deeper intellectual questions is whether market or accounting returns are more informative for CEO incentives (Lambert and Larcker, 1987). It cannot be true that accounting information is worthless in the giant firms in question, since they simply could not exist without it. Finally, accounting numbers are the main source of information not only for managerial decisions, they also inform the stock market. Top CEOs are in a repeated game, constantly observed by bird-dogs, market makers, and even worse, raiders. This limits possible misrepresentation for compensation purposes. For sure, depreciation methods and special charges can be chosen advantageously on occasion. Yet these manipulations cannot occur very often and have future costs as well as current benefits.

Undoubtedly, stock values are less easy to manipulate in this sense, but how much information about performance do they contain? The stock price of a firm changes for many reasons that are independent of its performance. Some underlying causes, such as shifts in industry demand, have similar effects on accounting profits. Others, such as changes in the market discount rate, are specific to the stock market alone. There are parallel sources of independent noise for accounting measures. Putting them side by side, which measure has the greater signal power for managerial performance? Strong findings on relative performance evaluation would have shed light on this, but only one study has found evidence for it. Bonus and other payment mechanisms are seldom explicitly triggered by stock performance in CEO contracts. Options and deferred stock appreciation rights are exceptions, but their value depends as much on the general state of the stock market, which managers cannot affect, as on firm-specific performance.

Jensen and Murphy (1990) argue that the empirical relationship between pay and performance, while positive, is too small to provide adequate incentives for managers to act in stakeholders' interest. Using the Forbes 1974-86 sample, they regress the arithmetic first difference in annual CEO compensation (including the change in personal wealth tied up in the firm) on current and lagged arithmetic changes in shareholder wealth and a few other variables. An attempt is made to eliminate the effects of market noise by using relative performance indicators, although they are unsuccessful here.

An estimate of *d*log(compensation)/*dr* of 0.1 estimated in earlier studies seems reasonable, so it comes as a considerable surprise that the estimated values in the arithmetic regression for *d*(compensation)/*dr* are extremely small. The differences are due to the fact that the ration of CEO compensation to shareholder wealth is vanishingly small in these giant corporations (on the order of $6 * 10^{-4}$ at the median and 10^{-3} at the mean). In the simplest specification, the first difference regression implies that annual salary and bonus increase by a mere \$13.5 – 21.00 when shareholder wealth changes by \$1 million. Adding the effects of own stock holdings, options and the like increases the estimates to \$32,50. Since mean compensation is more than \$0.5 million per annum and personal wealth is much larger than that, these very small sums indeed, small enough to raise questions about the role for compensation mechanism to align the interests of CEOs and owners.

Still, Jensen and Murphy's (1990) estimates are substantially smaller than those implied by other studies. Considering that both dividends and the number of shares of stock outstanding hardly change in a short time series, the rate of return on stock ownership r is approximately equal to the percentage change in total market shareholder value. Let ΔV represent the arithmetic first difference of total shareholder value and Δy the arithmetic first difference in salary and bonus. Jensen and Murphy estimate $\hat{b}_1 = \Delta y/\Delta V \cong 1.35 * 10^{-5}$. The semi-elasticity estimate discussed above is $\hat{b}_2 = \Delta logy/\Delta r = \Delta(\Delta y/y)/\Delta r$, for which 0.1 serves as lower bound. Now, since $\Delta r = \Delta V/V$, it follows that $\hat{b}_2 = \hat{b}_1 \cdot V/y$ and $\hat{b}_1 \cong \hat{b}_2 y/V$, where y and V are evaluated near the mean of the sample. Since $y/V = 10^{-3}$ at the mean, the implied estimate of $\hat{b}_1$ when $\hat{b}_2 \cong 0.1$ is 10^{-4} -- or almost eight times larger than their estimate $1.35 * 10^{-5}$. This implies a total effect of at least \$100 salary and bonus change per \$1 million change in shareholder value, compared to their estimate of \$13.5 – 20.00. Working their estimate the other way round leads to an implied elasticity near 0.014, much smaller than the direct estimate of 0.1 found by others in these data.

Functional forms must account for these differences. Most empirical economists would argue for using log rather than arithmetic differences because the latter are dominated by large firms (as Jensen and Murphy confirmed) because the risks are larger. Since the rate of return is largely independent of size, the directly estimated elasticity form (b_2) better controls statistically for size effects.

Going out on a limb, the 10^{-4} estimate of b_1 implied by the log version suggests that CEOs lose $100,000 in direct pay per $1 billion decline in stock value. Now a $1 billion is large – about 20 percent of the average firm's value in the sample. However, the $100,000 is in the range of 20 percent of average compensation. Considering that CEO personal asset holdings are almost surely less diversified than those of the average stockholder (Lewellen, 1968; Deckop, 1988), CEOs risk a considerable portion of their personal wealth from the actions they take on behalf of shareholders. What is not so clear from theory is what a reasonable benchmark would be. Is the 0.1 – 0.15 elasticity estimate too small or too large? The theory has not focused enough on that number to provide an answer.

2.2.3 Summary on Incentive Contracts

This review demonstrates great scope for fruitful empirical and theoretical research in this area. As usual, much remains to be done. On the empirical side, inquiry must dig deeper into the management hierarchy. In some ways our preoccupation with top executives is examining the tip of iceberg. However, much effort at data development will be necessary for such endeavors. Empirical investigation also must be broadened beyond the USA to other countries. How will these remarkably uniform estimates compare around the world? It is commonly alleged, for example, the Japanese business executives earn much less relative to production workers compared to their American and British counterparts. It would be very interesting to know if the compensation elasticities of 0.10 for shareholder wealth nevertheless hold true in Japanese firms. In addition, executive ranks have recently opened up to women in many countries. The marked increase in available supplies of managerial talent should have large consequences on the executive labor market, which remain to be worked out and examined empirically.

Of the many theoretical issues on the research agenda, a few stands out. First many alternative mechanisms for affecting managerial incentives have been identified. How should the effects of reputation, bonding, and compensation contracts be parceled out? To what extent do these alternatives act as substitutes for each other, or as complements? Second perhaps the idea that shareholders are the only principals in the executive contracting problem is too simple. There is much to be said for nexus of contract view, because control decisions affect the wealth of many contract holders with the firms (Fama and Jensen, 1993). For example, shouldn't debt holders be included as claimants of the firm's resources and included in the empirical estimates of wealth elasticities? Furthermore, in the context of this study, how about the government who devoted social resources in supporting and contributing transport system operation? What limits the scope of control? Labor economists have increasingly recognized the importance of firm-specific human capital; and firm-specific capital is often involved in contracts with specialty suppliers (such as property developer, government subsidy provider, etc.) and intermediaries (like risk managing institutes, third-party auditors, etc.). All of them have a stake in how the firm is managed. Evidence on this broadened stakeholder view of claimants is hardly to be found (Shlefier and Summers, 1988; Kaplan, 1989) and these issues are likely to be more generally important. They deserve more attention.

2.3 Common Agency

Mechanism design in contracting with agents has proven to be a fertile area of research for the economist and policy maker studying the role of information in economic exchange. Since the methodology was first developed by Mirrlees (1971), it has been applied to numerous contexts. Theorists have subsequently extended the use of contract's mechanism design to problems with multi-dimensional types spaces (see Rochet (1985); Laffont, Maskin, and Rochet (1987); multiple agents (see Myerson (1981); Demski and Sappington (1984); Demski, Sappington, and Spiller (1988); and Ma, Moore, and

Turnball (1988)), and informed principals (see Myerson (1983); and Maskin and Tirole (1990a, 1990b)). But to date, we know very little about the problem of mechanism design with multiple principals and a single agent – what has been termed the problem of common agency. This is the case of our two principals – security-holders and the government (and its regulation agency) and one agent – the CEOs.

2.3.1 Issues on Common Agency

Common agency refers to a broad class of problems in which a single individual, the agent, controls a decision that has consequences for many individuals with distinct preferences. The other affected parties, the principals, may attempt to influence the agent with incentives that are contingent on the action chosen by the agent. Common agency contracting under adverse selection is ubiquitous. Wherever hidden information and some degree of competition among principals exist for a set of agents, we will generally find an environment where mechanism design under common agency is appropriate. Often the assumption that a single principal completely controls the contracting environment with an agent is not realistic as the following examples illustrate:

- **Multiple regulators.** Several government agencies may have authority to promulgate regulations affecting a single agent. To the extent that each regulator (principal) wishes to extract the agent's information rents, an analysis of mechanism design under common agency is appropriate.

- **Exclusive supply contracts and joint ventures.** Firms and government agencies may decide to form joint ventures with one another to create an exclusive input supplier for members of the venture. In one sense, a joint venture allows venture members to coordinate their separate contracts into a single cooperative contract with an agent. In the absence of a joint venture the government agencies (such as transit authorities and land-use authorities) may non-cooperatively contract with the same agent and fail to take into account the externalities which they impose on one another. An analysis of common agency illuminates some of the benefits of joint ventures and exclusive supply contracts.

- **Regulated franchise.** As stated in section 1.2, most of the transport infrastructure franchises are, or once were, natural monopolies. They are not free to set whatever price they choose; rather, the prices charged for their output are set by the government (or its regulatory agency) whose general objective is to allow for the franchise a reasonable opportunity to earn a fair return on its invested equity capital in the project. Because those franchises are protected from competition by government regulation, and because these economic entities do not have the opportunity to earn higher profits from more efficient performance, competition will not necessarily bring forth or produce efficient managerial techniques. In examining this issue we must first determine what attributes of managerial performance are valued most by franchise in a regulated markets. Due to the form of regulation in these situations described above, the ability of CEOs to perform efficiently and keep costs low is not regarded nearly so highly as it is in unregulated firms where profits are restricted. One managerial attribute that is regarded highly is the technical ability to keep services operating (to avoid shutdown, delays, etc.). Another attribute that is valued highly is the ability to lead the regulatory commission to expect higher costs than will actually occur, so that regulatory lag will reward the firm with high profits. If the market for CEOs rewards these attributes (rather than efficient performance) of managerial ability, we cannot be very confident that the system of regulated franchises will operate efficiently. These conflicts create the common agency problem on private investment in transport infrastructure.

Following on the work of Bernheim and Whinston (1986) on common agency under moral hazard, we note that environments with common agency can either be delegated or intrinsic. Under delegated common agency, the choice of contractual relationship is delegated to the agent who can choose whether to contract with both, one, or none of the principals. This is natural setting for examining such phenomena as second-degree price discrimination by duopolists, where the consumer ultimately decides from whom to purchase. Alternatively, when common agency is intrinsic, the agent's choice is more limited: the agent can choose only between contracting with both principals or contracting with neither. A common example of such a setting is industrial regulation by multiple regulators. The regulated firm's only choice beside regulation is to leave the market and forego profits together.

The distinction between these two environments is less important when the contracting activities of the two principals are complementary in term's of the common agent's utility. In any equilibrium where the agent finds it attractive to contract exclusively with either principal, the agent will find it desirable to contract with both. Although this is not the case when the activities are substitutes, we choose to focus on intrinsic common agency as a first step toward a more general theory on common agency under adverse selection. Nonetheless, as the applications in this review demonstarte, a large set of interesting economic questions are addressable within this class of models.

In the cases mentioned above, the principals could potentially benefit from mutual cooperation. When principals act collectively, application of the bilateral agency framework (treating the set of principals as a single entity) is appropriate. Thus, the relationship between CEOs and security-holders/government-agencies may be treated as a traditional principal-agent problem even when principals disagree about the franchises' objectives, since institutional procedures guarantee a collective decision concerning management compensation. However, cooperation between principals is, in many cases (especially in the research context of this study), unlikely (the lack of coordination between various state and federal agencies is notorious) or impossible (when decisions are delegated to a common agent by participants from sides of government-agencies and security-holders, explicit cooperation between principals is legislatively proscribed). It is then natural to think of principals as choosing incentive schemes non-cooperatively, in which case the traditional bilateral framework is inadequate as a descriptive tool.

Two fundamental problems are encountered when one attempts to apply traditional mechanism design to common agency problems in absence of contractual independence. First, the simple characterization of incentive compatibility and participation constraints used in single principal contracts is no longer available. Instead, we might find a more complicated analog in the two-principal setting when we consider common agency implementability. With two principals, each of whom observes only the report meant for her, we then require more than that the agent finds it incentive compatible to report truthfully to principal i given he reports truthfully to principal j. It must also be the case that lying to both principals (with perhaps differing reports) is not beneficial to the agent. A significant contribution of this thesis is to explicitly characterize the set of common implementable contracts.

Second, when searching for a Nash equilibrium in contracts among principals, one cannot invoke the revelation principle without exercising care. Each principal will typically find it rational to attempt to induce the agent to report falsely to a rival and thereby extract a large share of the agent's information rents. Of course, in equilibrium, all contracts are incentive compatible so that such attempts are useless, but their possibility imposes constraints on the set of equilibrium. At times, the presence of common agency results in each principal creating a contractual externality. When the contracting activities are complementary, equilibria in the simultaneous contracting game have each principal introducing too much distortion in an effort to extract rents from the agent. With substitutes, the reverse typically occurs and too little distortion is introduced from each principal's point of view. These inferences are just in accord with the notions of Nash equilibria in prices between competing duopolists in a differentiated product market. When the goods for sale are complements, each duopolist prices excessively relative to the monopoly solution; when the goods are substitutes, each duopolist sets prices closer to marginal cost, introducing a smaller distortion.

2.3.2 Application of Common Agency

As indicated above, many contracting environments are confounded by the presence of common agency. When two or more principals find themselves contracting with the same agent, they generally find themselves worse off because of their failure to cooperate and offer a coordinated set of agency contracts. Understanding the nature of these costs is a requisite first step in our understanding of complex common agency arrangements. The interested economic problem we need to address is considering the situation of two principals with imperfectly aligned preferences and ask the welfare question of who gains and who loses from fragmented regulator and auditing authorities.

Consider the problem of two government agencies, each having power to regulate some aspect of an agent's (e.g., a public transit's) operation. This environment is the rule rather than the exception when it comes to administrative law in the United States. Nevertheless, this problem has received little study. One noteworthy exception is the work of Barron (1985). Barron considers the problem of dual regulators. In his example, the Environmental Protection Agency (EPA) regulates the level of pollution which a public tarnsit produces and a local Public Transit Commission (PTC) sets rates and production levels for bus trips. The EPA has the ability to move first, promulgating some regulation before the PTC has an opportunity to set rates. We consider a simplified version of the same problem, but with simultaneous contracts.

Let x_1 be the level of pollution abatement which the firm achieves. The EPA has simple preferences:

$$U^{EPA}(x_1) = (\sqrt{x_1}) - t_1.$$

Analogously, the PTC has preferences in accord with local consumers who essentially are unaffected by the transit firm's pollution (e.g., acid rain has no effect on local consumers).

$$U^{PTC}(x_2) = (\sqrt{x_2}) - t_2.$$

We could of course make the preferences of the EPA and the PTC each has a function of the firm's profit as well (i.e., makes them partially accountable to the industry), but we have not done this so as to keep the preferences completely independent.

It is natural to assume that the marginal cost of reducing pollution increases the level of output. In this case, the contract activities are substitutes. The agent's final production of x_i is $e_i + 1/2\,\theta$, where θ is some unknown cost-reducing productivity parameter. We assume that θ is uniformly distributed on [1, 2]. The agent's preferences are

$$U = t_1 + t_2 + \mu(x_1, x_2, \theta) = t_1 + t_2 - 1/2(x_1 + x_2 - \theta)^2.$$

In a cooperative regulatory regime, x_i are chosen to satisfy

$$1/2\, x_i^{-1/2} - (x_1 + x_2 - \theta)^2 - (1 - \theta) = 0$$

In a symmetric equilibrium with fragmented regulation, the EPA and the local PTC choose each x_i in excess of what they would choose with coordinated regulation (i.e., with joint preferences of $U(x_1, x_2) = (\sqrt{x_1}) + (\sqrt{x_2}) - t)$. They each choose x_i to satisfy

$$d\,x_i(\theta)\,/\,d\theta = -\,(1/2\, x_i^{-1/2} - (x_1 + x_2 - \theta)^2 - (1 - \theta))\,/\,(1/2\, x_i^{-1/2} - (x_1 + x_2 - \theta)^2 - 2(1 - \theta)).$$

From the results above, we find that common agency reduces the distortion in the decision variables which coordinated regulators would otherwise implement. This has several interesting implications for the problem we are examining. First, local consumers and the national constituency for the EPA are worse off. This is due to the costs of common agency. Second, both the firm and environmentalists are better off from the high-powered incentive schemes. The firm enjoys more information rents; environmentalists (who we suppose prefer less pollution than the EPA's constituency, perhaps because they pay less taxes) enjoy a more efficient (i.e., lower) level of pollution. This preserve alliance corresponds to that in Laffont and Tirole (1991) where lower-powered incentives schemes result from regulatory capture by environmentalists and the regulated firm. In that case both parties gain from collusive arrangements with the regulator to hide information about firm's costs

2.3.3 Summary on Common Agency

The main focus of this review has been to discuss frameworks studying common agency and to consider the economic effects of common agency on contractual relationships. We have shown that in such environments, if the agent has private information regarding his gain from the contracting activity and the contracting activities in each possible principal-agent relationship are substitutable (complementary), the principals will typically extract less (more) information rents in total and induce less (more) productive inefficiency in the contracting equilibrium than if there were a single principal contracting over the same activities.

The underlying theme of the results presented is that common agency entails costs for the principals. These costs, in turn, can help explain many economic phenomena which we observe. Additionally, as the analysis on issue of substitutes has suggested, common agency may resulted in high-powered contracts which extract very little of the agent's information rents. Since typical contracting environments have multiple principals, when contracting activities are substitutes we should expect to see little use of distortionary contracting to reduce information rents. Consequently, even though an environment might be ideal for selection contracts, such contracts may not be observed due to competition.

2.4 Multitask Agency

As mentioned earlier, the provision of incentives to individuals and groups in organization is one of the central problems in the economics of firm. A long and varied literature considers the question of what optimal incentive contracts look like (see Gibbons 1998, for a review). Most of this literature focuses in the use of risky performance measures, and as a result focuses on what Gibbons calls "the much studied trade-off between incentives and insurance." Yet, incentive contracts in the real world rarely like those predicted by theory. The main inconsistency between the theory and most real world incentive contracts is that most real incentive contracts, with the exception of stock-based plans for top executives, in fact contain very little risk. That is, payments under most incentive contracts do not seem vary very much, and the employees covered by them seem to bear little risk associated with variation in outcomes.

A smaller number of papers in the last decades have begun to explore another aspect of the incentive provision problem. This issue has variously been called "multi-tasking", "congruity", or "distortion." These terms all refer to a problem, identify by Kerr in 1975, as "The folly of rewarding for A while hoping for B." In these models, the problem with paying for performance is not that the agent will bear too much risk, but rather the principal will pay for the wrong thing, indicting behavior that is either wasteful or dysfunctional. In all of these papers, the firm's response is to reduce the weight placed on such distortionary performance measures.

2.4.1 Issues Review and Discussion on Multitask Agency

In early discussion of the standard economic treatment of the principal-agent problem, compensation systems serve the dual function of allocating risks and rewarding productive work. A tension between these two functions arises when the agent is risk averse, for providing the agent with effective work incentives often forces him to bear unwanted risks. Existing formal models that have analyzed this tension, however, have produced only limited results (Holmstrom and Milgrom, 1990). It remains a puzzle for this theory that contracts so often specify fixed remuneration and more generally that incentives within firms appear to be so muted, especially compared to those of the market. Also, models have remained too intractable to effectively address broader organizational issues as job design and allocation of authority.

In this review the specific mark is that the agent has several different tasks from his/her principals (in our study contend, transport service and property development service). As Holmstrom and Milgrom (1990) pointed out, some of the issues raised by this modeling are well illustrated by the current controversy over the use of incentive pay for teachers based on their students' test scores. Proponents of the system, guided by a conception very like the standard one-dimensional incentive model, argue that these incentives will lead teachers to work harder at teaching and to take great interest in their students' success. Opponents counter that the principal effect of the proposed reform would be that teachers would sacrifice such activities as promoting curiosity and creative thinking and refining students' oral and written communication skills in order to teach the narrowly defined basic skills that are tested on standardized test. It would be better, these critics argue, to pay a fixed wage without any incentive scheme than to base teachers' compensation only on the limited dimensions of student achievement that can be effective measured.

Multi-dimensional tasks are ubiquitous in the world of business. As simple examples, CEOs may be responsible for producing a high volume of good quality transit services, or they may be required both to produce services and to care the society they serve. In the first case, if volume of service is easy to measure but the quality is not, then a system of piece rates for services may lead CEOs to increase the volume of output at the expense of quality. In general, when there are multiple tasks, incentive pay serves not only to allocate risks and to motivate hard work, it also serves to direct the allocation of the agents' attention among their various duties. This represents the first fundamental difference between the multidimensional theory and the more common one-dimensional principal-agent models.

There is a second fundamental difference as well, and it, too, can be illustrated by reference to the problem of CEOs' allocation his/her duties. If the task of CEOs' management could be separated from that transit services and non-transit services, then these tasks could be carried out by different CEOs at different job contents; and the problem that piece rate system would lead to inadequate care can be mitigated or even eliminated. In general, multitask principal-agent problem, job design is an important instrument for the control of incentives. In the standard model, when each agent can engage in only one task, the grouping of tasks into jobs is not a relevant issue.

In their modeling, Holmstrom and Milgrom (1987) utilize a linear principal-agent model to illustrate the case where the agent's costs depend only on the total effort or attention the agent devotes to all of his tasks. That modeling assures that an increase in an agent's compensation in any one task will cause some reallocation of attention away from other tasks. First, they show that an optimal incentive contract can be to pay a fixed wage independent of measured performance, just as the opponents of incentives based on educational testing have argued. More generally, the desirability of providing incentives for any one activity that makes competing demands on the agent's time and attention. That result explains a substantial part of the puzzle of why incentive clauses are so much less common than one-dimensional theories would predict.

Second, they specialize their model to the case where the unmeasurable aspect of performance is how the value of a productive asset/resource changes over time. The difficulties of valuing assets/resources are well recognized, and the cast majority of accounting systems value assets/resources using fixed depreciation schedules based on historical costs, deviating from this procedure only in exceptional circumstances. Under these conditions, when the principals own the returns from the asset/resource, the optimal incentive contract will provide only muted incentives for the agent to produce output, in order to mitigate any abuse of the asset/resource or any substitution of effort away from asset/resource enhancement. However, when the agent owns the asset/resource returns, the optimal incentive contract will provide more intensive incentives to engage in production, in order to alleviate the reverse problem that the agent may use the asset/resource too cautiously or devote too much attention to its care and improvement. Their analysis supports Williamson's (1985) observation that "high-powered" incentives are more common in market arrangements than within firms, without relying on any assumptions about specific investments. Moreover, it provides a rudimentary theory of ownership, according to which the conditions that favor the agent owning the assets/resources are (1) that the agent is too risk averse, (2) that the variance of asset/resource returns is low, and (3) that the variance of measurement error in other aspects of the agent's performance is low. Thus, it emphasizes measurement cost as an important determinant of integration in contrast to the approaches which stress asset specificity led by Alchian and Demsetz (1972). Their result can also help explain why franchisees face steep performance incentives, while CEOs of identical company-owned stores receive no incentive pay at all (Krueger, 1991; Brickley and Dark, 1987).

Finally, they obtain a series of results in the theory of job design, using a model in which the employer can divide responsibility for many small tasks between two agents and can determine how performance in each task will be compensated. The resulting optimization problem is a fundamentally nonconvex one, and they have had to make some extra assumptions to keep the analysis tractable. Nevertheless, the results they obtain seem intriguing and suggestive. First, each task should be made the responsibility of just one agent. To my knowledge, this is the first derivation in the incentive literature of the principle of unity of responsibility, which underlies the theory of hierarchy. Second, tasks should be grouped into jobs in such a way that the tasks in which performance is most easily measured are assigned to one CEO and the remaining tasks are assigned to the other CEO. This conclusion squares nicely with the institution that it is the differences between measurabiliy of quantity and quality in production, or the so-called "basic skills" and "higher-order thinking skills" in education, that make those incentive problems difficult. The theory indicates that even when the agents have identical ex ante characteristics, the principal should still design their jobs to have measurement characteristics that differ as widely as possible. The principal should then provide more intensive incentives and require more work effort from the jobholder whose performance is more easily measured.

Their results are variations on the general themes of second best, which stresses that when prices cannot allocate inputs efficiently, then optimal incentives will typically be provided by subsidizing or taxing all inputs. For instance, Greenward and Stiglitz (1986), in a valid metaphor, point out the value of a government subsidy for home fire extinguishers, since homeowners with fire insurance have too little incentive to invest in all forms of fire prevention and to fight fires once they have started. This mechanism ahs been most extensively analyzed in the theory of optimal taxation and in welfare theory.

However, the study of interdependencies among incentives and the use of instruments other than compensation to alleviate incentive problems have entered agency analyses more fruitful. Lazear (1989) argues that where cooperation among workers is important, we should expect to see less wage differentiation, that is, "lower-powered" incentives. Holmstrom and Ricart i Costa (1986) have observed how a firm's capital budgeting policy, including the hurdle rate and the way assesses idiosyncratic risks, can affect the willingness of risk averse CEOs to propose risky investment projects. Milgrom (1988) and Milgrom and Roberts (1988) have studied how organizational decision process affects the allocation of effort between politicking and directly productive work. Farrel and Shaprio (1989) show that a price clause may be worse than no contract at all, because it reduces incentives to supply quality; this is similar to result of Holmstrom and Milgrom (1987) that it may be optimal to provide no quantity incentives when quality is poorly measured.

Some articles containing related ideas have been developed contemporaneously. Laffont and Tirole (1989) show that concerns for quality help explain the use of cost-plus contracting in procurement. Baker (1989) investigates a model in which observable proxies of marginal product are imperfect in a way that causes the agent to misallocate effort across contingencies and therefore leads to incentives that are not as powerful as standard theory would suggest.

2.4.2 Summary on Multitask Agency

The problem of providing incentives to agent is far more intricate than is represented in standard principal-agent models. The performance measures upon which rewards based may aggregate highly disparate aspects of performance into a single number and omit other aspects of performance that is essential if the firm is to achieve its goal. Commonly, the principal-agent problem boils down to this: Given a highly incomplete set of performance measures and a highly complex set of potential responses from the agent, how can the agent be motivated to act in social interest? Nevertheless, incentive problem must be analyzed in totality; one cannot make correct inferences about the proper incentives for an activity by studying the attributes of that activity alone. Moreover, the range of instruments that can be used to control an agent's performance is one activity is much wider than just deciding how to pay for performance. One can also shift ownership of related assets/resources, vary restrictions on the ways a job can be done, vary limits and incentives for competing activities, group related tasks into a single job, and so on.

In their article, Holmstrom and Milgrom (1991) study the simultaneous use of various instruments for controlling agents to derive new, testable results from the theory of organization. Their emphasis is on how cross-sectional variations in the parameters that determine the optimal design of jobs, the optimal intensity of incentives, and the optimal allocation of ownership lead to covariations among endogenous variables that are similar to the patterns found in actual firms. Most past models of organization focus on one instrument at a time for determining incentives and a single activity to be motivated. Newer theories that explicitly recognize connections between instruments and activities must offer new promise to explain the richer patterns of actual practice.

In the following of this thesis, a specific CEOs compensation contract which is designed to jointly overcome above deficiencies will be described. This managerial compensation plan will directly reward efficient performance, at least as we have defined. It may not operate in the security-holders' interest, a subject to which we will return later, so it is quite possible that the government (and its regulatory agency) may have to impose it upon the regulated transport infrastructure franchises.

2.5 Multiproduct/Multitask Cross-Subsidization

2.5.1 Basic Model of Cross-Subsidization

Most transport infrastructure franchises supply a range of products/tasks. Railroads offer freight and passenger services at different times of day or seasons of the year and for both economy and business-class customers. Highway and mass-transit systems at times serve joint development with transit and real estate services.

The multiproduct/multitask framework is also relevant when the franchise supplies a single product with a variable and verifiable quality. For instance, contracts for weapon acquisition include provisions for delivery time and performance at the delivery date such as the speed or fuel efficiency of an airplane. Regulatory examples include attempts to tie railroads' and transits' rewards to the timeliness of trains, the highways' and airports' experiments with quality incentives. Verifiable dimensions of quality can be treated as quantities of fictitious outputs and are thus amenable to the multiproduct analysis.

Not surprisingly over the last 20 years in several infrastructure industries policy discussion has emphasized multiproduct/multitask issues in the regulation of natural monopolies. Take the move from cost-of-service regulation to price caps. This move has witnessed debates about whether it would promote incentives, reduce prices, remove cross-subsidization, or influenced the regulated franchises' competition. Concurrently the theory of multiproduct cost functions and sustainability of natural monopolies developed, culminating in the book by Baumol, Panzar, and Willig (1982). By and large this theoretical literature has ignored the government'/regulator's informational environment.

There are one main issue related to our study in the regulation of multiproduct franchise: incentives; and there are three important topics:

1. Should distorted market efficiency--cross subsidization between transportation service and property development--be allowed?
2. How should one account for the franchise's task allocation among its product lines or activities?
3. Should subcosts of some activities, if observable, be used in the incentive scheme, or should the franchise face uniform incentive schemes across all activities?

In their paper, Laffont and Tirole (Laffont and Tirole, 1991) consider a multiproduct franchise with private information about its technology and exerting effort to reduce cost to illustrate interaction between incentive and cross-subsidization. They consider a regulated franchise with aggregate cost function:

$$C = C(\beta, e, \boldsymbol{q}) \tag{2-11}$$

where β is a technological parameter or franchise's type ($C_\beta \equiv \partial C/\partial\beta > 0$)

e is its managers' cost reducing effort ($C_e \equiv \partial C/\partial e < 0$)

$\boldsymbol{q} \equiv (q_1, q_2, \ldots, q_n)$ is the franchise's output vector ($C\mathbf{q}_k \equiv \partial C/\partial \mathbf{q}_k > 0$)

The technological parameter β and the effort level e are one-dimensional. In their model, they let $E(\beta$, C, $\mathbf{q})$ denote the effort required for a franchise of technology type β to produce $\mathbf{q}$ at cost C:

$$C \equiv C\,(\beta, E(\beta, C, \boldsymbol{q}), \boldsymbol{q}) \tag{2-12}$$

The partial derivatives of this effort function with respect to its arguments are denoted E_β, E_C, and $E\mathbf{q}_k$ ($E_\beta > 0$, $E_C < 0$, $E\mathbf{q}_k > 0$). From accounting convention the revenue R($\mathbf{q}$) (if any) generated by the service of the outputs is received by the government and that cost is reimbursed to the franchise. Letting t denote the net monetary transfer from the government to the franchise and ψ (•) denote the disutility of effort, the franchise's objective function is

$$U = t - \psi\,(e). \tag{2-13}$$

The franchise is willing to participate in the regulatory process if and only if $U \geq 0$.

They denote V($\mathbf{q}$) as the social value associated with the production of vector q. This value is assumed increasing and concave. For example, if the goods are private goods, and if S($\mathbf{q}$), the gross consumer surplus attached to their consumption, then V($\mathbf{q}$) is equal to the sum of net consumer surplus [S($\mathbf{q}$) – R($\mathbf{q}$)] and of the social value of tax savings for taxpayers generated by the sale of the goods, $(1+\lambda)R(q)$ (where λ is the shadow cost of public funds). That is, $V(\mathbf{q}) = S(\mathbf{q}) + \lambda R(\mathbf{q})$.

The utilitarian social welfare function is the sum of consumer welfare and the franchise's welfare:

$$W = [V(\mathbf{q}) - (1+\lambda)(t + C(\beta, e, \mathbf{q}))] + U \tag{2-14}$$

or using (2-13)

$$W = V(\mathbf{q}) - (1+\lambda)(\psi(e) + C(\beta, e, \mathbf{q})) - \lambda U \tag{2-15}$$

Equation (2-15) shows that W can be decomposed into three terms: the social value V of outputs, the total cost $\psi + C$ of operating the franchise times the shadow price of this cost, and social cost λU of leaving a rent to the franchise.

The regulator observes the franchise's cost C and quantities q [or, equivalently, price $\mathbf{p} \equiv [(p_1, p_2,\ldots,p_n)]$. The government regulates the franchise's n output. The franchise has private information about its technology parameter β, which from the government's viewpoint is drawn from a cumulative distribution $F(\bullet)$ on $[\underline{\beta}, \overline{\beta}]$ with density $f(\bullet)$. The cost-reducing effort e is also unobservable by the regulator.

The government maximizes the expectation over β of the social welfare function given by (2-15), over $\{\mathbf{q}(\beta), e(\beta), U(\beta)\}$(which amounts to maximizing with respect to$\{\mathbf{q}(\beta), e(\beta), t(\beta)\}$):

$$E_\beta W = \int_{\underline{\beta}}^{\overline{\beta}} [V(q) - (1+\lambda)(\psi(e) + C(\beta, e, \mathbf{q})) - \lambda U] f(\beta) d\beta \tag{2-16}$$

subject to the individual rationality and incentive constraints. Because the franchise's rent is necessarily decreasing in β and because [from (2-15)], the government does not wish to leave rents to franchise, the individual rationality constraint can be written:

$$U(\bar{\beta}) = 0. \tag{2-17}$$

The derivation of the incentive constraint is standard. An intuitive is as follows: A franchise with technology type β - $d\beta$ ($d\beta > 0$) can produce the same output vector at the same cost as a franchise with type β and therefore obtains the same revenue and transfer by reducing its effort relative to that of type β by $de = E_\beta(\beta, C(\beta, e, \mathbf{q}), \mathbf{q})d\beta$. This implies that the gradient of the franchise's rent with respect to β, $\hat{U}(\beta) \equiv dU/d\beta = -\psi'(e)\, de/d\beta$, is given by

$$\hat{U}(\beta) = -\psi'(e)\, E_\beta(\beta, C(\beta, e, \mathbf{q}), \mathbf{q}). \tag{2-18}$$

Equation (2-18) is the first-order condition of incentive compatibility for the franchise; it gives the rate at which the franchise's rent must grow to elicit its information.

Taking $e(\beta)$ and $\mathbf{q}(\beta)$ as control variables and $U(\beta)$ as a s state variable, the government maximizes (2-16) subject to (2-17) and (2-18).

They derive the first-order conditions of the government's program with respect to effort e and output q_k are:

$$\psi'(e) = -C_e - (\lambda/(1+\lambda))(F(\beta)/f(\beta))[\psi''(e)E_\beta + \psi'(e)E_{\beta C}C_e], \tag{2-19}$$

$$Vq_k = (1+\lambda)Cq_k + \lambda(F(\beta)/f(\beta))\psi'(e)(dE_\beta/dq_k). \tag{2-20}$$

To understand equation (2-19), note that in a symmetry information (first-best) world the marginal disutility of effort $\psi'(e)$ should be equal to the marginal cost savings ($-C_e$). The last term in equation (2-19) is due to the government's desire to extract the franchise's informational rent. The term in brackets

$$A \equiv \psi''(e)E_\beta + \psi'(e)E_{\beta C}C_e$$

is the derivative with respect to e of $|\hat{U}(\beta)|$. A sufficient condition for $\boldsymbol{A}$ to be positive is that $C_{ee} \geq 0$ (there are decreasing returns in the cost reducing technology) and that $C_{\beta e} \geq 0$ (the marginal cost reduction is not higher for inefficient type of technology franchise). From equation (2-18), $\boldsymbol{A}$ is also the increase in the rent of all types in $[\underline{\beta}, \beta]$ (which have probability of $F(\beta)$), when the effort of type β is increased by one.

From equation (2-16), the social cost of the extra rent for the types in $[\underline{\beta}, \beta]$ is $\lambda F(\beta)\boldsymbol{A}$. On the other hand, the distortion in effort for type β relative to the first-best level $[\psi'(e) + C_e]$ has social cost $(1+\lambda)(\psi'(e) + C_e)$ from equation (2-15) and occurs with probability $f(\beta)$. The trade-off between rent extraction and efficient effort thus yields equation (2-19). An implication of equation (2-19) is that the government can use cost-reimbursement rules that are intermediate between the cost-plus contract [which induces $\psi'(e) = 0$] and fixed-price contract [which induces $\psi'(e) = -C_e$].

Of particular interest from the above model is the "modified Ramsey equation" expressed in equation (2-20). Under symmetric information the marginal generalized gross surplus $\partial V/\partial q_k$ is equal to the marginal social cost of production $\partial((1+\lambda)C)/\partial q_k$. Under asymmetric information there may exist an incentive correction associated with the government's desire to extract the franchise's rent. From equation (2-18) a unit increase in output K affects the rent by $\psi'(e)[dE_\beta/dq_k]$, where

$$d(E_\beta)/dq_k = E_{\beta C} C q_k + E_\beta q_k \tag{2-21}$$

is a total derivative and is a measure of how output k affects the potential effort savings associated with an increase in efficiency. As in equation (2-19) the gain in reducing $|\hat{U}|$ is proportional to the probability $F(\beta)$ that the franchise is more efficient than type β, and the cost of the distortion relative to the first best is proportional to the probability $f(\beta)$ that the franchise has type β, which explains equation (2-20).

2.5.2 Classification of Cross-Subsidization

The above model assumes that regulatory instruments are the franchise' total costs and prices; in particular the government cannot fully distribute costs to particular products, except through an arbitrary accounting procedure. The government chooses an optimal regulatory policy subject to his or her informational gap. The optimal cost-reimbursement rule and gives sufficient conditions for the optimal regulatory allocation would then be implementable through a menu of linear contracts.

Suppose that the social value $V(\mathbf{q})$ is simply the consumers' gross plus the social value of revenue, $S(\mathbf{q}) + \lambda R(\mathbf{q})$, and that liner pricing is used. Then the revenue function is $R(\mathbf{q}) = \Sigma_k p_k q_k = \Sigma_k S'_k(\mathbf{q})q_k$, where $S'_k(\mathbf{q})$ is the partial derivative of S with respect to q_k. Let $q_k(\mathbf{p})$ be the demand function [defined by $p_k = S'_k(\boldsymbol{q})$], and let $\eta_{kl} \equiv (\partial q_k/\partial p_l)(p_l/q_k)$ and $\eta_k \equiv -(\partial q_k/\partial p_k)(p_k/q_k) = -\eta_{kk}$ denote the cross and own elasticities of demand.

From above, it demonstrates that the regulated price of good k could be rewritten from equation (2-20) as

$$p_k + \lambda[\, p_k + \Sigma_l\, (\partial p_l/\partial q_k)q_l] - (1+\lambda)Cq_k - \lambda[F(\beta)/f(\beta)]\psi'(e)[d(E_\beta)/dq_k] = 0, \qquad (2\text{-}22)$$

or $\quad L_k = R_k + I_k \qquad\qquad$ (2-23)

where $\quad L_k \equiv (p_k - Cqk)/p_k \quad$ (good k's Lerner index (price-cost margin))

$R_k \equiv -[\lambda/(1+\lambda)][\Sigma_l\, (\partial p_l/\partial q_k)(q_l/p_k)] \quad$ (good k's Ramsey index), and

$I_k \equiv \{[\lambda F(\beta)\psi'(e)]/[(1+\lambda)f(\beta)]\}[d(E_\beta)/dq_k] \quad$ (good k's incentive correction).

The incentive correction, if any, reflects the government's desire to limit the franchise's rent without destroying incentives and, more specifically, depends on whether an increase in good k's price helps raise incentive. A fundamental theoretical question is whether the incentive and pricing issues can be disconnected ($I_k = 0$) or not ($I_k \neq 0$); that is, is the optimal rate-of-return regulation (which under some assumptions turns out to be linear in the franchise's performance) a sufficient instrument to promote incentives?

The above equation sheds light on two alternative viewpoints on cross-subsidization. The first point of view is normative. The characterization of optimal prices defines, by comparison with reference prices, optimal cross-subsidizations. If the reference prices are marginal cost prices Cq_k, they say that good k must be cross-subsidized if and only if $L_k = R_k + I_k < 0$. If the reference prices are the prices given by (2-23), which are optimal in the absence of redistributive concern, they say that good k is cross-subsidized if and only if $L_k - R_k = I_k < 0$. As shown in their paper, this kind of cross-subsidization is optimal when prices are distorted to favor a targeted class of consumers (demand-side cross-subsidization). Formally, what Posner (1971) has dubbed "taxation by regulation" would correspond to a discrepancy between a good's Lerner index and the Lerner index that emerges from a regulatory policy that maximizes the unweighted sum of consumers' surpluses and the franchise's utility. Demand-side cross-subsidization may also stem from the different powers of various interest groups, as emphasized by the political science literature.

The second definition of cross-subsidization encountered in the literature is positive or strategic. It relates to the existence of prices that are viable for the franchise and that prevent the entry by an unregulated competitor with an identical technology. Cross-taxation is said to occur for a subset of goods if the cost of producing those goods only (the stand-alone cost) is lower than the revenue associated with that subset of goods. Then there is a danger of entry on the associated markets. The definition of cross-subsidization is thus related to the possibility for entrants to make money when the franchise cannot change its price in the face of entry.

This point of view has been taken in the contestability literature. Faulhaber (1975) asks whether a given production plan and given (inflexible) prices for a franchise may trigger (hit and run) entry by a competitor who faces the same technology. If they do, the production plan and the prices exhibits competitive cross-subsidization.

The work of Baumol et al. (1982) is an attempt to combine the positive and normative approaches. They investigate when Ramsey pricing (presumed to be optimal) is consistent with the absence of competitive cross-subsidization (sustainability). Then optimal prices are robust to the threat of entry (for this particular entry game), and this obviates the need for regulating entry.

Another important category is the so-called cost-side cross-subsidization. Such cross-subsidization occurs when the franchise's managers allocate investments and their time and energy inefficiently among the franchise's product lines. In effect, when the marginal productivity of a cost-reducing activity applied to some product exceed that for another product, the former product subsidizes the latter. Any regulation based on aggregate cost avoids cost-side cross-subsidization, as it induces managers to allocate (given levels of) investment and effort so as to minimize cost. It contrast, fully distributed cost pricing, which allocates joint costs to services in an arbitrary accounting manner, is a natural breeding ground for such cross-subsidies (see Brennan, 1987).

But fully distributed cost pricing is only one cause of cost-side cross subsidization. An alternative and common cause of such cross-subsidization is the coexistence of two activities with different cost-reimbursement rules. This franchise then has an incentive to manipulate accounting so as to charge costs incurred for the activity with high-powered incentives (e.g., under a fixed-price contract) to the activity with low-powered incentives (e.g., under a cost-plus contract). The franchise also has an incentive to allocate its best engineers and the attention of the general office to the activity with high-powered incentives.

Chapter 3 Incentive Framework and Theoretical Modeling

In this chapter simplified static and dynamic models of agency with multiple tasks and multiple principals in infrastructure delivery are developed. In the former chapters we concluded that the latter, or common agency, aspects is in some ways of quintessential feature of a process of incentive management of an infrastructure delivery activity. We shall claim that the result is low-powered incentives, and that the power incentives can be restored if a constitutional rule in infrastructure delivery can restrict each principal to base principal's incentives only on the dimension of the agency's tasks that is of direct concern to that him. The purpose of the theoretical modeling is to demonstrate these propositions. The analysis in section 3.1 integrates the multitask agency model of Holmstrom and Milgrom (1990, 1991), and the common agency model of Bernheim and Winston (1986). Section 3.2 presents the static model and 3.3 the dynamic model.

3.1 The Low Power of Incentives in Decision Making

The review in chapter 2 dealt with incentive schemes that can be implemented by a benevolent dictator to elicit some information or effort from private infrastructure franchises in an attempt to implement a better economic outcome to the society. Incentive schemes can influence the information and efforts of the administrative institutions or private-franchises themselves. These differ from corresponding schemes that we see in pure private economic trans-efforts in some important ways: the rewards or penalties from host government are often nonmonetary, and the incentives are often low-powered to franchise CEOs.

Even in economic contexts, rewards or penalties may be financial or non-monetary. The former category must be interpreted broadly to include career concerns, that is, future material rewards as well as the immediate payoff; similarly, a broad interpretation of nonmonetary incentives includes status, power, and job satisfaction. In regulation contexts of infrastructure delivery, the nonfinancial aspects are likely more important than in economics. Even with this understanding, however, it is commonly observed that regulatory incentives for franchise CEOs are quite low-powered; the marginal rewards for producing an outcome of great value to society, or the marginal penalties for doing worse, are generally a very low percentage of the value added or lost. A franchise CEO can take efforts that benefit or hurt the consumer to the tune of millions of dollars, but the effect on his own compensation from government, monetary or otherwise, is at most a very tiny fraction of this. Much of the commonly held belief that government institutions or its authorized agency cope poorly with agency problems in infrastructure delivery can be attributed to the low power of their incentives to franchise CEOs. Previous analysis in study fields other than infrastructure delivery have offered several reasons for this; I will now discuss them and add another that seems to me to be of even greater importance in this thesis study.

The discussion can be organized by reference to Wilson's (1989) excellent observation about agency relationships. He identifies two key features: (1) agents typically have several dimensions of effort (input) and result (output), and each of these is only imperfectly observable or verifiable (pp. 129-131); (2) each agent deals with several principals who simultaneously trying to influence its decisions – the board, the executive and legislative branches of government, the courts, interest groups, media, and so on (pp. 236-37, 300). Wilson argues that, as a result, the principals impose a variety of constraints on the agency, instead of the kind powerful incentive schemes that are commonly suggested in economic agency problems (pp. 115, 125, 133, 322). The outcome, according to Wilson, is that principals can stop things from happening but find it difficult to get anything positive done (p. 137). Wilson's argument is informal in our case, but sufficiently intriguing to be worth formal exploration using the modern theories of multitask and common agencies.

3.1.1 Multitask Agencies

Holmstroml and Milgrom (1991) have developed a model of multitask agencies that helps us understand some of the features of government agencies stressed by Wilson. The agent has to perform several tasks, which at least are partly competing for the agent's attention and effort. The agency's priorities over these tasks do not coincide with those of the principal, perhaps because they require different qualities of effort, or because new tasks have less value to the agency in terms of its original mission. In any case, the principal must devise an incentive scheme to alter the effort allocation of the agent. The choice will depend on the degree of observability of different inputs and outputs, as well as on the differences in values between the two parties.

Holmstrom and Milgrom find two important results. First, if the result of one task is very poorly observable, then the incentive scheme for a competing task must have lower power in order to avoid excessive diversion of effort away from this task to more observable ones. Second, if some tasks are primarily of value to the agent, and can be controlled in an all-or-nothing fashion, then it may be desirable for the principal to simply prohibit these, rather than try to give extra incentives for others. This point is especially important if the incentives for other tasks must be low-powered in conformity with the first result.

An example in infrastructure delivery will make the point clear. Infrastructure Franchise CEOs have two tasks, making profit and producing quality service. The output of profit making is relatively easily measurable in terms of Rate of Return on Investments and Rate of Return on Assets; that of quality producing is more nebulous because the real effects are long term, and the consumers' evaluation have their own biases. If the government considered each task and its incentive in isolation, it would recognize the different precisions of information and set up a high-powered reward scheme for profit-making and a low-powered one for quality-producing; but that would induce CEOs to divert effort away from quality-producing and into profit-making. Therefore, considering the two together, the government is forced to reduce the power of its scheme for rewarding profit-making, too.

Now introducing a third activity, outside business, that is primarily of value to the CEO rather than to the government. If the reward schemes for quality-producing and profit-making are low-powered for the reasons explained above, then CEOs will divert their effort into outside-business. The government could cope with this by increasing the power of the incentives for quality-producing and profit-making together, but that is costly alternative because quality-making effort is not easily observable. (The reward must be based on observables such as workers' performance or consumers' evaluations of service; therefore CEOs may get rewarded for their luck in having better workers, or for gimmicks that appeal to consumers and raise the evaluations without really improving the quality of the service.) The government therefore instead prohibits outside-business, or at least restricts the time allowed for it. Some outside-business will be allowed if that makes it easier to ensure that the CEOs gets enough utility from the whole bundle of activities to be willing to work for the franchised infrastructure, that is, to satisfy the CEO's individual rationality (participation) constraint. But this calculation will involve comparing the average product of outside-business time and the managerial reward for quality-producing and profit-making. A full social optimum would equate the marginal products of the two. This departure from the ideal is the unavoidable cost of the information asymmetry in this case.

Laffont and Tirole (1993, pp. 225-226) and Tirole (1994, pp. 6-7) develop this similar view further. When the product of the agent's effort is an experienced good whose quality will be revealed only with a delay, then the immediate incentive scheme must be low-powered so as not to destroy the incentive to maintain quality.

3.1.2 Common Agency

Now I return to the second important feature of agency that was pointed out by Wilson, namely, the existence of common agency/multiple principals, all principals have some power to influence the efforts of the agency. Their interests in the outputs of the agency are at least partly conflict, and the agent's efforts taken on behalf of different principals are substitutes. How do incentive schemes fare in such situation? The general conclusion is that the power of incentives in equilibrium among several such principals is weakened, sometimes dramatically.

Let us begin by asking why common agency in franchised infrastructure delivery is so prevalent. The government and the Board clearly stand to gain by getting together: the scheme that results from their noncooperative efforts remains feasible, so a cooperative scheme cannot do worse and in general will do better. At least two problems may preclude such collusion. First, the Government and the Board may not share the same information, most naturally so in the case of adverse selection. Although this seems to force noncooperative behavior, I will argue later that the compartmentalization of information may actually be beneficial. Second, the Government and the Board may find it difficult to agree on the split of the total gain from cooperation, or be unable or legally to make the internal transfers necessary to implement an agree-upon split. This is particularly important in the private-public partnership of infrastructure delivery context, where the benefits of public principals (such as government authorities or their regulation agencies) are often nonmonetary and are measured in noncomparable, nontransferable units, whereas monetary compensations are often illegal.

In Section 3.2 I shall construct a simple model of common agency with moral hazard to show that the multiplicity of conflicting between the Government and the Board is a powerful additional reason for the incentive schemes to be low-powered. The institution is that each principal tries to free ride on the incentives provided by the others.

To illustrate the mathematics in simple terms, suppose two principals: the Board (denoted as **A**) and the Government (denoted as **B**) are trying to influence the agent (the CEOs), who controls two tasks: profit-making (denoted as ***a***) and quality-producing (denoted as ***b***). Principal **A** is primarily interested in the outcome of ***a***, and principal **B** in that of ***b***. The amount of effort the CEO devotes to the tasks is not observable, but the outcomes are commonly observable to all.

Since the CEO's time or effort is scare, more spent on ***a*** will necessarily mean less spent on ***b*** and vice versa. Therefore principal **A** will offer an incentive scheme that responds positively to ***a***-output and negatively to ***b***-output, that is, one that gives the CEO a marginal reward for producing more ***a*** and a marginal fine or penalty for producing more

b. The scheme also has a constant term, or a sure payment, whose level can be adjusted to make sure that the agent is willing to work, that is, to satisfy the CEO's participation constraint. Similarly, principal **B** offers a scheme that rewards the CEO for producing more ***b*** and penalizes him for producing more ***a***.

Now suppose principal **A** offers a high-powered scheme, that is, one with larger marginal reward for producing an extra unit of ***a***. When the CEO responds by making more effort on task ***a***, he gets more money from principal **A**; but because principal **B** employs a negative marginal payment for this task, the CEOs pays more to principal **B**. In other words, some of **A**'s money simply passes to **B** via the CEO. Recognizing this, principal **A** will not find it desirable to offer such a high-powered scheme. The leakage of one principal's money to the other is less than one-for-one, so each principal continues to find it desirable to offer some incentives to the CEO; but in the final outcome of the whole calculation, that is, the Nash equilibrium of the game of strategy between the principals, the overall power of the incentives received by the CEO is quite low.

In the mathematical form, the outcome is very simple: the equilibrium with n principals is exactly as if there is just one hypothetical principal with an objective function that is the sum of all the separate principals' objectives, but the agent's risk aversion is multiplied n-fold. Remember that the more risk averse the agent, the lower the power of the incentive scheme. Thus, the Nash equilibrium incentive scheme with n principals has, roughly speaking, only $(1/n)$-th the power of the second-best scheme that would be offered by one truly unified principal.

The low power of the incentives in turn makes the second result of Holmstrom and Milgrom even more important. The agent's efforts may often be influenced better by prohibiting some activities than by rewarding others with conventional marginal incentives.

One must distinguish different levels of efficiency in the outcomes. The hypothetical ideal with observable efforts and Coasean bargaining between all principals and the agent would be the first-best. Respecting the information asymmetry but allowing all principals to get together and offer a combined incentive scheme would give the second-best. If the principals cannot be so united, their Nash equilibrium is in general a third-best (see Bernheim and Winston 1986 for the exact relationships among these). In these formal terms, the result above says that the third-best outcome that is achieved has very low-powered incentives.

To do better that the Nash equilibrium, one would have to allow some explicit cooperation among the multiple principals. This may not be feasible in the context of franchised infrastructure's day-to-day interaction; but we may be able to think of some improvements. One such device would restrict each principal to basing his incentive scheme only on the dimension of the CEO's effort that is of primary concern to that principal, and would prohibit any attempts to penalize the CEO for efforts in other dimensions. In the example above, this means that the Board cannot condition his payment to the CEO on the output of quality-producing nor the Government on that of profit-making. This could be done by preventing each from observing the other's outcome, or forbidding each to act on any such observation. Now each principal, in order to attempt to induce the CEO to put more effort into task that concerns him (principal), offers a higher-powered incentive scheme. In the resulting equilibrium, the overall incentives scheme is actually higher power than the one that would be offered by a single unified principal who aggregates the interest of **A** and **B**. It will be showed in the next section that in the limiting case where the CEO's actions on behalf of the different principals become perfect substitutes, the equilibrium where the principals are so restricted in their scheme is actually first-best! Thus a constitutional restriction on the efforts of principals can improve the power of incentives and can lead to a socially preferable outcome. Of course, as usual, the enforcement of such a constitutional restriction is problematic, given the desire of politically powerful government principals in their policy acts to influence every dimension of the franchise CEO's activity.

Note that even if each of the Government and the Board can observe the outputs of both profit-making and quality-producing, it may be beneficial to forbid each to take the other into account in setting his own incentive scheme, just as if he could not observe the outcome of the other task. Thus an improvement can result from making the information asymmetry apparently worse. This is like the Lipsey-Lancaster general theory of the second-best: if some market failure precludes the attainment of an ideal first-best, then it is no longer necessarily desirable to let the rest of the markets function without any interference.

Tirole (1994, section 8) suggests that compartmentalization of responsibilities across different principals can perform a useful function by placing the onus to create, disclose, and defend each item of information necessary for decision making on the party who is particularly interested in that dimension of control/auditing. This argument for checks and balances is similar to that behind the adversarial mode of judicial procedures in common law. This idea is formally modeled and further developed by Dewatripont and Tirole (1995). My argument in infrastructure delivery above is different, but it supports the same conclusion.

A similar phenomenon arises in common agencies with adverse selection; these are studied by Martimort (1995) and Stole (1990). They assume (as seems appropriate in the context of adverse selection) that each principal can observe only that dimension of the outcome which concerns his payoff. Each offers a rent-sharing schedule that makes his payment to the agent a function of that dimension of output. If the two principals collaborate, they will offer a second-best joint schedule that reduces their loss of rent by distorting the agent's actions below their first-best level. When they cannot cooperate, for example, when each cannot observe or act upon the other's outcome, there arises an externality between them. When one principal increases the distortion of his dimension, the agent shifts his effort at the margin to the other dimension, to the benefit of the other principal. This is positive externality, so in the noncooperative equilibrium each principal carries out too little of it. In other words, the noncooperative equilibrium is less distortion than the cooperative one, and so the former is closer to the full-information first-best than the latter. As in the case of moral hazard, the compartmentalization of information increases the power of the incentives toward the first-best.

3.1.3 Lack of Competition and Transparency

Tirole (1994, pp. 4) offers another explanation for the low-powered incentives in decision making. If there are several agents performing similar tasks and subject to common risks, then each agent's performance can be compared with that of the others to get a better estimate of his effort or skills that were not directly observable. Therefore an incentive scheme based on comparative performance or yardstick competition, can be effective and high-powered. In infrastructure delivery, such competition is often limited or even non-existent; therefore, incentives must have lower power. In some cases, for example, provision of some urban utility services, competition can exist or even be created for the specific purpose of allowing better incentive schemes. We observe increasingly examples of this in garbage collection, mail delivery, and even in policing and prison management; Britain years ago set up an internal market mechanism in its National Health Service. However, the multitask nature of these activities often precludes the use of such devices to their full extent; there exist other principals who are more interested in other dimensions of these agencies such as equity and accountability, and their influence limits the use of competition to promote efficiency (see Wilson 1989, chapter 19).

Transparency is generally regarded as a good thing in decision making (see Krueger 1990 for a good statement of arguments in its favor). Greater transparency often makes information more accurate and more symmetric; therefore it reduces or even eliminates some transaction costs in infrastructure delivery. To this extent the argument is clearly valid, but sometimes transparency may matters worse. Some mechanisms (Spiller, 1990), such as employment links between the public sector and private franchise, may be relatively good ways of coping with transaction costs, but making them more transparent may simply lead to a prohibition on their use, either on moral grounds or because it is a visible symptom of the underlying inefficiency. So long as that basic problem persists, these mechanisms will merely be substituted by other, even less efficient ones.

If it is desirable to preserve some opaqueness for such strategic reasons, the observations of outcomes will not be as informative as they could be, and incentive schemes based on these observables will have to be lower-powered. We saw earlier that diversion of effort into a nonobservable activity lowers the power of incentives based on observable outcomes of other activities; here some other considerations make it desirable to keep some activities unobservable, thus reinforcing that phenomenon.

To sum up, the formal analysis gives some support to assertion that infrastructure franchise agencies with multiple-tasks and multiple-principals will have lower-powered incentives and are subjected to constraints on their behavior. The analysis also casts some new light on the phenomenon. The lack of incentives and the proliferation of the constraints are often claimed to be proof of inefficiency. Agencies often have to say no. Nothing gets done, or at least requires long delays to ensure that all the constraints have been met. In the analysis, however, the weak incentives and the prohibitions or constraints can emerge as a part of the Nash equilibrium. In other words, they may be a reasonable way for the system to cope with the transaction costs resulted from private infrastructure delivery. I would not claim that what one finds in reality is always a constrained optimum, but at least the result should suggest that we should not jump to the opposite conclusion either. In next section, a simple model based on above analysis will clarify these issues.

3.2 Static Modeling of Multiprincipal and Multitask Agency

Here I shall develop a simple model of an agency in infrastructure delivery with multiple tasks and multiple principals. The franchise CEO controls an m-dimensional vector e, to be interpreted as the effort. This yields an m-dimensional output vector x, which is most simply modeled as effort plus an error term such as

$$x = e + \varepsilon \qquad (3\text{-}1)$$

where the random vector is normally distributed with zero mean and diagonal variance matrix Ω.

This setup can easily be generalized, allowing different dimensions for CEOs' effort and output with a rectangular matrix linking the two, and error covariances (nondiagonal Ω), but these are not necessary for my present purpose.

There are n principals, who, stand to benefit from the output x. It is important here that all the principals observe the same outcome vector x. This seems reasonable in many public infrastructure delivery policy contexts where there is a great deal of stress on openness of procedures and outcomes, but we will find that such openness is not without its cost.

I assume that the principals (in our case mainly the Government and the Board) are all risk-neutral; so their benefit functions are linear. (Risk-aversion can be introduced at the cost of some notational complexity, but makes no difference for my purpose.) Write $b^{j\,'} x$ for the benefit function of the j-th principal; the superscript j identifies the principal, and the prime denotes the transpose of the vector. Let b be the sum of the b^j, so the aggregate benefit of all the principals is $b'x$.

A special case that I will take up later is one where the number of principals n equals the number of tasks m, and each principal benefits from only one dimension of the tasks, so that the j-th component of b^j is positive and all other components are zero. More generally, any differences among the b^j correspond to conflicts of interest among the principals and lead to similar results.

It is even possible for some components of some of the vectors b^j to be negative, that is, some principals may be harmed by some dimensions of the output, but I will assume that output from franchised infrastructure is beneficial for the group of principals as a whole, that is, $b \gg 0$.

The CEO's utility function has constant risk-aversion r:

$$u(y) = -exp(-ry) \tag{3-2}$$

where y equals money income minus a quadratic cost of effort, ½ $e' C e$. The matrix C is assumed to be positive definite, and with positive cross-partials (supermodular). Thus, the marginal cost of making one type of effort increases with the level of any type of effort. Therefore, an inducement to increase one type of effort causes substitution away from other types. This creates for each principal an interest in all dimensions of the effort of the CEO, even if he has no direct interest in (benefit from) the outcome of those dimensions.

Let Γ denote the matrix inverse of C. It is positive definite, so its diagonal terms are positive. If $m = 2$, it is easy to verify that the off-diagonal terms in Γ are negative. If $m > 2$, some off-diagonal terms may be positive, but the general tendency is for them to be negative. This is exactly like the well-known relationship in consumer-choice theory between complements and substitutes in the quantity (Allen) sense and the price (Hicks) sense. When discussing the results below, I will proceed treating the off-diagonal terms in Γ as negative.

An extreme case is one where the matrix C has the same scalar entry k in all positions, so efforts are perfect substitutes and

$$e' C e = k \left[\Sigma_{j=1}^{m} e_j \right]^2 .$$

The analysis below does not formally apply in this case because the matrix C is singular whereas we need C^{-1}, but we can consider the case as a limit.

3.2.1 First-Best with Observable Effort

If effort can be monitored directly, the principals and the CEO can write a contract contingent on the CEO's making a stipulated effort e in return for a payment z. The expected return to the principals will be

$$E\ [b'(e + \varepsilon)] - z = b'e - z$$

and the CEO's utility will be $-exp\{-r(z - ½\ e'C\ e)\}$.

Then, the CEO maximizes z - ½ $e'C\ e$, which is in units of income, and can therefore be thought of as an income-equivalent of the CEO's utility. The z merely acts to transfer income between the Government and the Board, for example to make sure that the CEO gets enough utility to make it worth his while to participate in this activity. The interests of all principals are best served by choosing e to maximize the sum of the principals' benefit and the CEO's equivalent income, or the *total surplus*, $b'e$ - ½ $e'C\ e$.

The first-order condition for the maximization is $b = C\ e$, yielding

$$e = \Gamma\ b. \tag{3-3}$$

3.2.2 Second-Best with the Government and the Board Being United

Now suppose the effort cannot be observed, and incentive schemes for the CEO must be conditioned on the observable outcome x. I will restrict attention to a linear reward scheme. Holmstrom and Milgrom (1987) have shown that this is without loss of generality if the quadratic payoffs arise in a reduced form of a continuous-time dynamic model where the error ε cumulates as a Brownian motion. Even otherwise, linear schemes can be justified as approximations or on grounds of simplicity; they go naturally with quadratic payoffs; and are similarly used in Holmstrtom and Milgrom (1988, 1990, and 1991) without formally specifying an underlying continuous-time dynamic model. I shall proceed on a similar basis.

We continue to suppose that all the Government and the Board act together as a benevolent dictator, such as cases in public-private-partnership. Of course they remain constrained by the unobservability of effort. Suppose they contract to pay the CEO $\alpha + \beta' x$ when the outcome is x. The CEO's expected utility from making effort e is.

$$-exp\{-r(\alpha + \beta' x - ½\, e' C\, e)\} = -exp\{-r\beta' e + ½ r^2 \beta'\Omega\beta - r\alpha + ½ r e' C e\},$$

using the standard formula for the expectation of the exponential (moment generating function) of a normally distributed variable, for example, Billingsley 1986, p. 286. This can be written as $exp(-ry)$ where

$$y = \alpha + \beta' x - ½\, r\, \beta'\Omega\beta - ½\, e' C e.$$

This much sure income will give the CEO the same utility as the actual uncertain prospect, and it can therefore be thought of as the CEO's *certainty-equivalent income.* The CEO's decision then consists of maximizing this certainty-equivalent income. The first-order condition for that is

$$\beta - Ce = 0, \text{ or } e = \Gamma\beta. \tag{3-4}$$

Remember that diagonal terms in Γ are positive, while its off-diagonal terms are generally negative. Therefore an increase in one component of β will increase that component of the CEO's effort and generally decrease the other components. Substituting for the CEO's effort, his certainty-equivalent income becomes

$$y = \beta'\Gamma\beta + \alpha - ½\beta'\Gamma\beta - ½ r\beta'\Omega\beta = ½\beta'\Gamma\beta - ½ r\beta'\Omega\beta + \alpha \tag{3-5}$$

The unified Government and Board's expected income is

$$E[b' x - \beta' x - \alpha] = (b - \beta)' e - \alpha = (b - \beta)'\Gamma\beta - \alpha. \tag{3-6}$$

The unified principals' optimal policy is to choose β to maximize the sum of (3-5) and

(3-6), or the joint surplus

$$(b - \beta)'\Gamma\beta + \tfrac{1}{2}\beta'\Gamma\beta - \tfrac{1}{2}r\beta'\Omega\beta = b'\Gamma\beta - \tfrac{1}{2}\beta'(\Gamma + r\Omega)\beta,$$

and then choose α to transfer enough to the CEO to meet his participation constraint. The first-order condition for β is

$$\Gamma b - (\Gamma + r\Omega)\beta = 0$$

or, multiplying by C, $b = (I + rC\Omega)\beta$, (3-7)

where I is the m-dimensional identity matrix.

We can compare this outcome with the first-best above. If $r = 0$, (3-7) becomes $b = \beta$, and then (3-4) yields $e = \Gamma b$, the same as in the first-best. Now let $r > 0$, and recall that C has all positive elements because it is positive-definite and supermodular, and that Ω has positive entries on its diagonal and zeros elsewhere. Further, so long as negative values of e are economically irrelevant, we can set $\beta > 0$. Combining all this information, we have

$$b - \beta = rC\Omega\beta > 0,$$

or $b > \beta$. Thus the incentive scheme based only on observables gives the CEO less than the marginal contribution of his effort in each dimension. This in turn leads to less effort, and a smaller total surplus. The outcome is a second-best. This reflects the usual trade-off between efficiency and risk-sharing, and it was mentioned in chapter 2 as a transaction cost arising from moral hazard.

3.2.3 Third-Best with the Government and the Board Being Separated

Here the Government and the Board do not act cooperatively. Each chooses an incentive scheme, the CEO responds to the whole set of incentives he faces, and we look for the Nash equilibrium of the principals' choices. CEO's effort remains unobservable, so each principal's scheme must be based on the observable outcome x. Once again I restrict attention to linear schemes. The role of linearity was discussed earlier. In the present context of the game between multiprincipals, there is an added point. With quadratic payoffs, when all other principals are using linear schemes, CEO's best response can be achieved using a linear scheme without further loss of generality. Thus there is an equilibrium in which linear strategies are used. However, there may be other equilibria involving more complex schemes, which I do not consider. Holmstrbm and Milgrom do likewise in their two-dimensional multiprincipal model (1988).

Denote principal j's linear schemes by $\alpha^j + \beta^{j'} x$, and let $\alpha + \beta' x$ be the aggregate of these scheme. The CEO's choice is as in the second-best, namely, $e = \Gamma\beta$, and his certainty-equivalent income is again given by (3-5). But now we must examine separately the relationship between each principal and the CEO. For this, we have to ask what *difference* it makes when the CEO deals with the j-th principal.

For this, let us define the parameters of the incentives schemes aggregated over all the CEOs except j,

$$A^j = \sum_{k \neq j} \alpha^k, \quad B^j = \sum_{k \neq j} \beta^k,$$

If principal j did not exist, the CEO would choose $e = \Gamma B^j$. His resulting certainty-equivalent income can be calculated as in (3-5), and it equals

$$\tfrac{1}{2} B^{j'} (\Gamma - r\Omega)\, B^j + A^j$$

Including principal j, the CEO's certainty-equivalent income is given by (3-5). Recognizing that

$$\alpha = A^j + \alpha^j \text{ and } \beta = B^j + \beta^j,$$

we can write this as

$$\tfrac{1}{2}(B^j + \beta^j)'(\Gamma - r\Omega)(B^j + \beta^j) + A^j + \alpha^j$$

Therefore the *addition* to the CEO's surplus that arises from his relationship with principal *j* is

$$B^{j\,\prime}(\Gamma - r\Omega)\,\beta^j + \tfrac{1}{2}\,\beta^{j\,\prime}(\Gamma - r\Omega)\,\beta^j + \alpha^j\,.$$

Principal *j's* expected surplus is

$$b^{j\,\prime} e - \beta^{j\,\prime} e - \alpha^j = (b^j - \beta^j)'\,\Gamma(B^j + \beta^j) - \alpha^j\,.$$

His surplus in the absence of the relationship with the CEO would have been $b^{j\,\prime}\Gamma B^j$, so the difference,

$$b^{j\,\prime}\Gamma\beta^j - \beta^{j\,\prime}\Gamma\beta^j - B^j\Gamma\beta^j - \alpha^j\,.$$

is attributable to the relationship.

Once again, the β^j merely serves to transfer the surplus between the parties, and principal *j* will optimally choose β^j to maximize the total bilateral surplus

$$b^{j\,\prime}\Gamma\beta^j - \mathrm{r}\,\mathrm{B}^{j\,\prime}\Omega\,\beta^j - \tfrac{1}{2}\beta^{j\,\prime}(\Gamma + \mathrm{r}\,\Omega)\,\beta^j\,. \tag{3-8}$$

Principal *j*, who is acting noncooperatively with respect to the other principals, will make this choice of β^j treating B^j as given. The first-order condition is

$$\Gamma b^{j\,\prime} - \mathrm{r}\,\Omega B^{j\,\prime} - (\Gamma + \mathrm{r}\,\Omega)\,\beta^{j} = 0,$$

or, multiplying by C,

$$b^{j} = (I + rC\Omega)\beta^{j} + rC\Omega B^{j} \tag{3-9}$$

This implicitly defines β^{j} given B^{j}; in other words, it is principal j's best response to the choices of the other principals. In the Nash equilibrium, such relationships must hold simultaneously for all j. Adding them over and recognizing that $B^{j} = \beta - \beta^{j}$ sum to $(n - 1)\,\beta$ where n is the number of principals involved, we have

$$b = (I + n\,rC\Omega)\beta \tag{3-10}$$

This defines the aggregate incentive scheme in equilibrium. Bernheim and Whinston (1986) provide a more direct way of finding the aggregate scheme. The advantage of the approach here is that we can go back to (3-9) and find the individual principals' incentive schemes in equilibrium. I will do that in a moment, but first we can obtain some useful results from the aggregate.

Compare the second-best incentive scheme defined by (3-7), where all the principals are united, and the aggregate scheme (3-10) that emerges from the Nash equilibrium, where they are not. The two expressions are remarkably alike, except for the factor n that multiplies a term on the right-hand side. In other words, the effect of the lack of cooperation between the Government and the Board is exactly as if the risk-aversion of the CEO were multiplied by a factor equal to the number of principals. Recall that the need for risk-sharing is what leads to a lower-powered scheme in the second-best as compared to the first-best. Therefore in the present "third-best" Nash equilibrium between the competing principals, the overall incentives are even less powerful than those in the second-best. Moreover, the effect is proportional to the number of principals and therefore can be quite dramatic when several of these are involved. Roughly speaking, we can say that the power of the incentive scheme becomes inversely proportional to the number of principals.

To understand the reason for this dampening of incentives, let us find an explicit expression for the equilibrium incentive scheme of an individual principal. Noting that (3-9) can be written

$$b^j = \beta^j + rC\Omega\beta$$

and substituting from (3-10), we find

$$\beta^j = b^j - rC\Omega(I + nrC\Omega)^{-1}b. \tag{3-11}$$

Consider the case where $n = m$, and principal j has direct concern only for the output of task j. Then all components of b^j except the j-th are zero, but that does not hold for β^j. The second term in (3-11) contributes to all the other components of β^j. In the normal case, we expect all these other components to be negative. In other words, principal j will typically penalize all other dimensions of the CEO's effort. Of course this taken by itself lowers the CEO's utility, but the constant term α^j in the scheme can always be adjusted to ensure that the CEO gets non-negative surplus from his relationship with principal j and therefore remains willing to participate.

The point is that even though principal j is not directly concerned with any other components of output, he would like the CEO to exert less effort in those dimensions because that will induce the CEO to make more effort in the dimension that benefits principal j. This effect actually comes about through two avenues, which we see from a closer examination of the expression (3-8) for the bilateral surplus between the CEO and principal j.

The first effect comes from the second term in this expression. For simplicity, suppose that only the j-th component of b^j in principal j's benefit is nonzero. (So long as the principals' interests are not perfectly aligned, that is, the vectors b^j are linearly independent, we can make this true by a change of the coordinate system.) Then the term is

$$b^j_j \; \Sigma_i \; \Gamma_{ji} \, \beta^j_i \; .$$

When the CEO's efforts on behalf of principals i and j are substitutes in the appropriate sense, $\Gamma_{ji} < 0$, so principal j benefits from making β^j_i negative. This is an obvious direct effect.

Another effect, less obvious and indirect, comes from the third term in the expression (3-8). The other principals' schemes B^j affect principal j's marginal choice through the risk-premium term, $- rB^{j\,\prime}\,\Omega\,\beta^j$. Because the matrix Ω has been assumed to be diagonal, this is simply $-r \; \Sigma_i B^j_i \, \Omega_{ji} \, \beta^j_i$.

Let us ask if a situation where each principal chooses a scheme based only on his dimension of output can be an equilibrium. Suppose for a moment that each principal $i \neq j$ offers a positive incentive for the CEO's effort in dimension i and zero incentive for other dimensions. This implies $B^j_j = 0$, and $B^j_i > 0$ for all $i \neq j$ (remember that the B^j are the vectors of coefficients summed over all the principals *except* j). Now look at principal j's best response. In the above sum, all the coefficients of β^j_i for $i \neq j$ are negative, so principal j benefits by making his own β^j_i negative. The reason is that these negative components induce the CEO to work less hard for the other principals, which makes his income from them less risky. Then principal j need only pay a smaller risk premium to induce the CEO to work harder at the margin on his own behalf. The same argument applies to all the principals, so the initial supposition of independence of their incentive schemes ($B^j_j = 0$) cannot remain true in equilibrium. This effect persists even when the marginal cost of the CEO's effort for one principal is independent of that for others, because even when C is diagonal and therefore so is its inverse Γ, we have

$$e_i = \Gamma_{ii} \; \Sigma_j \beta^j_i \; .$$

Of course when the CEO's cost of effort is not separable, the matrix Γ has off-diagonal terms, and the other principals' interests affect the bilateral surplus through the more direct effect that was discussed earlier.

Such conditioning of each principal's incentives on the outcomes of direct interest to the other principals has repercussions for the Nash equilibrium. If principal j increases the j-th component of his β^{j}, the CEO will increase e_j, the j-th component of effort. This raises the expected value of the j-th component of output, and therefore the CEO's receipt from principal j. But the other principals k have negative j-th coefficients of their incentive parameters β^k, so the CEO's payment to them increases as well. In other words, some of Government's money passes to the Board via the CEO, and vice versa. This leakage is not complete, because as (3-9) shows, the reaction functions do not have slope *-1*; but it is significant. For principal j, the leakage to other principals makes it much less desirable to offer a powerful incentive scheme. That is why the equilibrium ends up with substantially lower-powered aggregate incentives.

3.2.4 Effect of Restrictions on Principals

If the Government and the Board could get together and make a binding agreement to offer a jointly agreed-upon incentive scheme and divide up the proceeds with suitable transfer payments among themselves, they could achieve the second-best. However, the necessary ongoing cooperation may not be possible in the infrastructure delivery's political context, and the Government or the Board each has an incentive to cheat on the agreement and offer a scheme that gets him some extra benefit. In such a situation, a constitutional provision that limits such cheating, if enforceable, can be mutually beneficial. We have seen that the problem is each principal's provision of a negative marginal incentive for the CEO's effort on behalf of the other principals. Therefore it may be desirable to have a constitutional rule that prevents such actions. This can be done either by restricting observation so that the Government and the Board cannot see the dimensions of the outcome that pertain to the other, or by forbidding effort based on such other dimensions even when they are observable. Let us examine the consequences of this.

For this, consider the case where now $n = m$, and each principal j benefits from only the j-th component of output, so $b^k_j = 0$ for all $k \neq j$. We also restrict every vector β_j have zero coefficients β^k_j for all $k \neq j$. Then the expression (3-8) for the bilateral surplus between the j-th principal and the CEO becomes

$$b^{j\,\prime}\, \Gamma B^j + b^j_j\ \Gamma_{jj}\, \beta^j - ½\,(\Gamma_{jj} + r\,\Omega_{jj})(\beta^j_j)^2. \tag{3-12}$$

Choosing β^j_j to maximize this gives the first-order condition

$$\Gamma_{jj}\, b^j_j = (\Gamma_{jj} + r\,\Omega_{jj})\,\beta^j_j. \tag{3-13}$$

The Nash equilibrium of the principals' interaction with their constrained choices is defined by these equations for all j.

Note that the number of principals no longer multiplies the agent's risk-aversion; thus that major source of weakness of incentives is missing. In fact, the incentives in this equilibrium can be more powerful than those in the second-best. The reason is that the Government or the Board each must now use a positive coefficient on the component of output that is of direct concern to him in order to divert the CEO from tasks that benefit the other. This competition among the Government and the Board leads them to raise those coefficients to higher levels.

The effect on infrastructure delivery is seen most dramatically in the limiting case where the different components of CEO's effort become perfect substitutes in the CEO's utility function. Then the determinant of C goes to zero, and all entries in the inverse matrix Γ go to infinity. Using this in (3-13) above, we have

$\beta^j_j = b^j_j$ for all j, or $\beta = b$.

The resulting aggregate incentive scheme reproduces the first-best! More generally, if different components of the effort are close substitutes, then the constrained Nash equilibrium is better than the second-best. Therefore, instead of uniting the Government and the Board, society as a whole does better to force each to compete fiercely using positive incentive for matters of direct concern to him, but prohibit them from competing by using negative incentives for matters of concern to others.

3.3 Dynamic Modeling

In this section I presents a simplified dynamic multitask-common agency framework. I consider a general model of dynamic common agency with symmetric information. The focus is on Markov perfect equilibria and the equilibrium set for a refinement of the Markov perfect equilibria. Particular attention is given to the existence of a marginal contribution equilibrium where each principal receives her contribution to the coalition of agent and remaining principals. The structure of the intertemporal payoffs is analyzed in terms of the flow marginal contribution.

I extend the common agency model of Bernheim and Whinston (1986) and the static model developed in section 3.2 to a dynamic setting. The set of players (the government, board of directors, and the CEO) is the same in all periods, but efforts available to them as well as payoffs resulting from the efforts may change from period to period.

In our study context, the main principals are the government and board of directors; however, for a general illustration purpose, the principals are indexed by $j \in I\{1, \ldots, \mathrm{I}\}$. Time is discrete and is denoted by $t = 0, 1 \ldots \mathrm{T}$, where T is finite or infinite. The agent can select in each period an effort $e_t \in E(h_t)$, where $\mathrm{E}(h_t)$ is a finite set for every h_t, and without loss of generality $\mathrm{n} = |E(h_t)|$ for all h_t. Each principal j offers a reward scheme $z_j(e_t, h_t) \in \Re^{\mathrm{n}}_{+}$, which can depend on the history h_t and the effort e_t chosen by the agent in period t. Let $z_t \triangleq (z_1(\cdot, \cdot), \ldots, z_I(\cdot, \cdot))$, $e \triangleq (e_0, \ldots, e_t, \ldots)$ and $z \triangleq (z_0, \ldots, z_t, \ldots)$. The future in period t is the sequence of future efforts $(e^t, z^t) = (e_{t+1}, \ldots, z_{t+1}, \ldots)$. We denote by $H(h_t)$ the set of all possible histories h_{t+1} which are accessible from history h_t, and similarly $H(e_t, h_t)$ the set of all possible histories h_{t+1} generated by h_t and e_t.

We want the efforts in all periods to be sequentially rational from all players' point of view. In other words, we do not allow the agent to commit to strings of efforts and accordingly, current period payments depend only on current period efforts. The stage game is not necessarily stationary and the transition may be deterministic or stochastic. The payoff relevant state of the world (in the sense of Maskin and Tirole (1997)) in period t is θ_t. The cost of effort e_t in period t to the agent is given by $c(e_t, \theta_t)$. The benefit to principal j is $b_I(e_t, \theta_t)$, which may again depend θ_t. The sum of the contributions by a subset of principals $S \subset I$ is:

$$z_S(e_t, h_t) \triangleq \sum_{j \in S} z_i(e_t, h_t),$$

and the sum of the benefits is

$$b_S(e_t, \theta_t) \triangleq \sum_{j \in S} b_i(e_t, \theta_t).$$

The aggregate benefits are denoted by $b(e_t, \theta_t) \triangleq b_I(e_t, \theta_t)$ and the aggregate rewards similarly by $z(e_t, \theta_t) \triangleq z_I(e_t, \theta_t)$. Without loss of generality we shall assume that $b_I(e_t, \theta_t) \geq 0$ and $c(e_t, \theta_t) \geq 0$ for all e_t and θ_t. We also assume the existence of a (default) effort $e_t \in E_t(\theta_t)$ such that $c(e_t, \theta_t) = 0$ for all θ_t.

The history of the game is $h_t \triangleq (e_0, \ldots, e_{t-1}, z_0, \ldots, z_{t-1}, \theta_0, \ldots, \theta_t)$. The transition function, $q(\theta_{t+1} \mid e_t, \theta_t)$ is assumed to be Markovian in the sense that the probability of the payoff relevant state being θ_{t+1} in period $t+1$ depends only on current efforts, e_t and the current state θ_t. Let H_t be the set of all possible t period histories. CEO maximize expected discounted value and the discount factor for future periods is ρ.

With transferable utility between the CEO and the principals, Pareto efficiency coincides with surplus maximization. The value of the socially efficient program is denoted by

$$W(\theta_t) \triangleq W_I(\theta_t)$$

and the value of the efficient program with a subset S of principals and the agent is denoted by $W_S(\theta_t)$. These values are obtained from a familiar dynamic programming equation:

$$W_S(\theta_t) = \max_{e_t \in E(\theta_t)} E\{b_S(e_t, \theta_t) - c(e_t, \theta_t) + \rho W_S(\theta_{t+1})\}$$

Similarly the value of a set of firms $I\backslash S$ is denoted by $W_{-S}(\theta_t)$. In this game, it is relatively easy to assign values to coalitions other than the grand coalition. In all of the value calculations, we include the possibility of CEO in the coalition of principals under study. The excluded set of principals cannot affect the value to the coalition under study and thus we avoid some of the usual problems in finding the characteristic function of a normal form game.

The marginal contribution of principal j is given by

$$M_j(\theta_t) \triangleq W(\theta_t) - W_{-j}(\theta_t) \tag{3-14}$$

The marginal contribution of a subset of principals $S \subset I$ to the value of the program is defined by:

$$M_S(\theta_t) \triangleq W(\theta_t) - W_{-S}(\theta_t) \tag{3-15}$$

In words, the marginal contributions of an individual principal or of a coalition of principals measure the increase in the total value of the grand coalition from adding a, particular principal or a coalition of principals respectively.

A strategy for principal j is a reward function $z_j : A \rightarrow \Re^+$ by which the principal offers a reward to the CEO contingent on the effort chosen by him. The net benefit from effort e to principal j is $\pi_j(e) \triangleq b_j(e) - z_j(e)$. The vector of net benefits is $\boldsymbol{\pi}(e) = (\pi_1(e), ..., \pi_I(e))$ and the aggregate benefits for a subset S *is* $\pi_S(e) = \sum_{j \in S} \pi_j(e)$. The net benefit to the agent is given by $z(e) - c(e)$.

A CEO can process a finite number of tasks in each period. The principals compete for the services of the CEO and their aggregate demand exceeds the total number of tasks the CEO can perform in a single period. The principals then try to influence the scheduling of the task by the CEO through the transfer payments. Consider CEO who offers his services over time to principals. Each principal has a finite or infinite number of tasks she wishes to complete. The realization of each task requires the services of the CEO. The CEO can supervise at most n tasks in every period. The supervision of any one of the tasks is costless for him, as long as the total number of tasks under supervision does not exceed n per period. As a consequence the CEO has to decide the order in which he services the competing principals.

The undiscounted value of any particular task of principal j is denoted by $b_j(T_j) \geq 0$, where T_j is indexing the tasks of each principal. The tasks are ordered inversely by the index T_j, i.e. $b_j(T_j) \geq b_j(T_j + 1)$ for all j and all T_j. We refer to this set-up as the decreasing returns model. Denote by $T_j(t)$ the number of services provided to principal j until and including period t. The state θ_t in period t is then simply the vector of counting times

$$\theta_t = (T_1(t-1), T_2(t-1), ..., T_I(t-1)). \quad (3\text{-}16)$$

An effort allocation policy is given by

$$e: \Theta \rightarrow E,$$

where the effort associates to every state θ a subset of principals whose asked tasks are realized in t, which in turn generates a new vector $\theta_{t+1} = (T_1(t), T_2(t), \ldots, T_I(t))$. The CEO is free to supervise more than one task of any given principal at any given period. An effort allocation strategy $e(\cdot)$ is socially efficient if it maximizes the discounted payoff over time (with discount factor ρ):

$$\max_{e(\cdot)} \sum_{t=0}^{\infty} \rho_t \left(\sum_{j=1}^{I} \sum_{T_j = T_j(t-1)+1}^{T_j(t)} b_j(T_j) \right)$$

The socially optimal policy in this environment is simply to select in every period among the remaining tasks the n tasks which yield the highest payoff. And, the optimal strategy assigns every task T_j by principal j its rank τ in the sequence of all realized tasks:

$$\tau_j : \mathrm{N} \rightarrow \mathrm{N} \cup \{\infty\}, \tag{3-17}$$

where $\tau_j(T_j) = \infty$ means that asked task T_j of principal j is never realized by the optimal strategy. The assignment τ_j for every j implies that the value b_τ of a task of rank τ is equal to $b(T_j)$ if and only if $\tau_j(T_j) = \tau$:

$$b_\tau = b_j(T_j) \quad \Leftrightarrow \quad \tau_j(T_j) = \tau.$$

In the following it will be more convenient to use the one-dimensional order τ and the associated value b_τ, induced by the optimal path, rather than the I dimensional vector of counting times $(T_1, \ldots, T_I)$. Since the CEO can employ up to n tasks in each period, the index τ runs at n times the speed of real time.

To write the value functions using the ranks given by τ but respecting the true discounting, we need to introduce the function of $t(\tau)$ that gives the real time period in which the task with rank τ is employed under the allocation strategy that always chooses the n tasks with the lowest rank. To this end, let

$$t(\tau) = \max \{t \mid t \in \mathrm{N}, t < \tau/n\}$$

The social value under the new clock τ is then given by

$$\mathrm{W}(\tau) = \sum_{s=\tau}^{\infty} \rho^{t(s)-t(\tau)} b_s \tag{3-18}$$

Define the counter $T_j(\tau)$ to keep track of how many times principal j has obtained the services of the CEO under this new and faster clock τ:

$$T_j(\tau) \triangleq \{s \mid b_s = b_j(\cdot), s \leq \tau\}.$$

Associated with each counter $T_i(\tau)$, is an accelerated counter:

$$\mu_j(\tau) \triangleq \min \{s \mid s - T_j(s) = \tau\}.$$

The counter $\mu_j(\tau)$ associates with to τ and b_τ another time $\mu_j(\tau)$ and corresponding allocation $b_{\mu_j(\tau)}$. The counter $\mu_j(\tau)$ accelerates τ by excluding principal j from the set of alternatives. It is needed when calculating the marginal contribution of principal j. The counters $T_j(\tau)$ and $\mu_j(\tau)$ can be localized by starting them at an arbitrary $\gamma > 0$:

$$T_j(\tau / \gamma) \triangleq \{s \mid b_s = b_j(\cdot), s \leq \tau\}.$$

and

$$\mu_j(\tau \mid \gamma) \triangleq \min \{\mathrm{s} \mid \mathrm{s} - T_j(s / \gamma) = \tau\}. \tag{3-19}$$

Consider then the optimal policy in the absence of principal j. As the rewards are decreasing over time, the optimal strategy is simply to accelerate the original strategy. By scheduling alternative $\mu_j(\tau)$ instead of τ, the value of the remaining program is

$$W^{-j}(\tau) = \sum_{s=\tau}^{\infty} \beta^{t(s)-t(\tau)} b_{\mu_j(s|\tau)}$$

The marginal contribution of principal j is given by

$$M_i(\tau) = \sum_{s=\tau}^{\infty} \beta^{t(s)-t(\tau)} (b_s - b_{\mu_j(s|\tau)}) \tag{3-20}$$

and the flow marginal contribution is

$$m_j(\tau) = \sum_{s=\tau}^{\infty} \beta^{t(s)-t(\tau)} (b_{\mu_j(s|\tau+1)} - b_{\mu_j(s|\tau)}) \tag{3-21}$$

with the convention that

$$b_{\mu_j(\tau|\tau+1)} = b_{\tau}.$$

Consider first the situation where $n = 1$ and each principal has a single task requiring the assistance of the CEO. With $n = 1$, we have $t(\tau) = \tau$ for all τ. The socially optimal arrangement is to order the principals according to the value of their asked task. We identify principal j with the time τ_j at which the task is realized optimally. Since each principal has only one task we have $\mu_j(s \mid \tau+1) = s$ and $\mu_j(s \mid \tau+1) = s+1$ for all s $> \tau$ if $\tau = \tau_j$. The flow marginal contribution can then simply be written as

$$m_j(\tau) = \sum_{s=\tau_j}^{\infty} \beta^{s-\tau_j} (b_s - b_{s+1})$$

if $\tau = \tau_j$, and zero otherwise. The immediate contribution of principal j is the difference in value between b_{τ_j} and the next best task $b_{\tau_{j+1}}$. But the availability of task b_{τ_j} also allows to postpone all future realizations by exactly one period. As these benefits only occur in the future, they are appropriately discounted, but they have to be attributed to principal j in τ_j, since after its realization in τ_j its benefit is sunk. The marginal contribution of principal j is then simply $M_j(\tau) = \beta^{\tau_j - \tau} m_j(\tau_j)$ for $\tau \leq \tau_j$, $M_j(\tau) = 0$ for $\tau > \tau_j$.

The question is then whether principal j is able to realize her marginal contribution in equilibrium. This is equivalent to satisfying the inequality

$$\mathrm{W}(\tau) - \mathrm{W}(\tau \mid k) \geq \sum_{j \in S} (M_j(\tau) - M_j(\tau \mid k)) \qquad (3\text{-}22)$$

Without loss of generality, assume $\tau = 0$. The realization of task k in period 0 entails delaying the efficient plan by one period until period k. After k, the two plans are identical. The net change in the social value is thus:

$$\mathrm{W}(0) - \mathrm{W}(0 \mid \mathrm{k}) = (1 - \beta) \sum_{s=0}^{k-1} \beta^s b_s - (1 - \beta_k) b_k \qquad (3\text{-}23)$$

The change in the marginal contribution for principal j is due to the postponement of its realization, and we have

$$\mathrm{M_j}(0) - \mathrm{M_j}(0 \mid \mathrm{k}) = (1 - \beta) \beta^{\tau_j} \sum_{s=\tau_j}^{k-1} \beta^s (b_s - b_{s+1}) \qquad (3\text{-}24)$$

The early realization of b_k has no private benefit to principal j. Notice that the marginal contribution of principal j with $\tau_j > \mathrm{k}$ is not affected by the change from the optimal policy to the modification by k, as the time of its realization remains unchanged. Since $M_j(0) - M_j(0 \mid \mathrm{k}) \geq 0$, the inequality (3-22) is most demanding for $S = \{0, 1, 2, \ldots, \mathrm{k} - 1\}$. After inserting (3-23) and (3-24) and dividing by $(1 - \beta)$ we can write (3-22) as:

$$\sum_{s=0}^{k-1} (\beta^s b_s - \beta^k b_k) \geq \sum_{\tau_j=0}^{k-1} \sum_{s=\tau_j}^{k-1} \beta^s (b_s - b_{s+1}) \qquad (3\text{-}25)$$

The left-hand-side of (3-25) expresses for every b, with $s < k$, the value difference between b_s and b_k in the optimal program:

$$(\beta^s b_s - \beta^k b_k) \geq 0.$$

The right-hand-side of (3-25) also presents for every b_s a differential expression between b_s and b_k, but it proceeds in steps $b_\tau - b_{\tau+1}$, which accumulates less value as they are increasingly discounted. This reflects the value difference between b_s and b_k in terms of the marginal contribution. Since the marginal contribution only picks up the inframarginal differences in every period, it follows directly that the inequality (3-22) holds.

The equilibrium payoffs are computed with the assistance of the marginal contribution. Principal j receives in τ_j his marginal contribution $m_j(\tau_j)$. The CEO receives in τ_j the residual:

$$b_{\tau_j} - m_j(\tau_j) = b_{\tau_{j+1}} - \sum_{s=\tau_{j+1}}^{\infty} \rho^{s-\tau_j}(b_s - b_{s+1})$$

$$= (1-\rho) - \sum_{s=\tau_{j+1}}^{\infty} \rho^{s-\tau_j} b_s$$

which is the value of the next best task minus the future marginal contribution of this alternative. Equivalently, it is the average flow value of the sequence of all future tasks. The truthful equilibrium strategies are also represented with the assistance of the marginal contribution. We restrict ourselves to the on-the-equilibrium-path strategies and the state θ_t can simply be represented by time t itself. Consider first principal j who already realized her task along the equilibrium path and $\tau_j < t$. Her future payoff is $m_j(t + 1 \mid v) = 0$ for all current allocations v, not necessarily equal to t, and hence the requirement for a truthful strategy is $z_j(t, t) = z_j(v, t)$ and the only best response is to set the rewards $z_j(t, t) = z_j(v, t) = 0$. Consider then any principal who along the equilibrium path realizes their task after t, or $\tau_j > t$. A truthful strategy requires that

$$- z_j(v, t) + \beta m_j(t+1 \mid v) \leq - z_j(t, t) + \beta m_j(t+1 \mid t) \text{ for } v \neq \tau_j$$

and

$$b_{\tau_j} - z_j(\tau_j, t) \leq - z_j(t, t) + \beta m_j(t+1 \mid t), \text{ for } v = \tau_j.$$

For all $v < \tau_j$, we showed earlier that $M_j(t+1 \mid v) = M_j(t+1 \mid t)$, and hence $z_j(v, t) = z_j(t, t)$, and the only best response is again to set $z_j(v, t) - z_j(t, t) = 0$. Finally, the direct reward offered to the CEO for the realization of task j is given by

$$z_j(\tau_j, t) = b_{\tau_j} - \beta^{\tau_j - t} m_j(\tau_j) \tag{3-26}$$

in which principal j offers the CEO the entire difference between her marginal contribution $m_j(\tau_j)$ which she receives in τ_j and the value of the task to day. It follows that in equilibrium, each principal offers transfers only for the realization of her own task, and no other transfers.

The rewards offered by (3-26) allow us to verify that the CEO is in equilibrium indifferent only between tasks t and $t + 1$, and the indifference is resolved in equilibrium in favor of task t. Thus, while the principals can offer general reward schemes, in equilibrium they offer non-trivial rewards only for the realization of their own tasks. It follows that the marginal contribution equilibrium is also an equilibrium in a more restricted incentive game where each principal can only induce incentive for services provided directly to her. We summarize the results for the general model.

1. The multi-task game has a unique truthful equilibrium.

2. Each principal j receives in period t:

$$\sum_{\{\tau \mid t(\tau) = t,\ T_j(\tau) \neq T_j(\tau-1)\}} M_i(T)$$

3. The CEO receives in period t:

$$\sum_{\{\tau \mid t(\tau) = t\}} \{ b_\tau - \sum_{j \in I} [\sum_{\{\tau \mid T_j(\tau) \neq T_j(\tau-1)\}} M_j(T)] \}$$

Naturally, the summation in period t extends over all tasks τ which are realized in period t. As the marginal contribution by principal j is different from zero only if one of her tasks is realized, the summation for j only needs to account for tasks τ which increase the counter $T_j(\cdot)$ of principal j.

The extension to many principals with many tasks faces at least one potential difficulty, which we briefly illustrate. With a single task, each individual principal receives the marginal contribution of the task as her payoff. When one principal has multiple tasks, the marginal contribution of all her tasks generally exceeds the sum of the marginal contributions of the individual tasks. Consider, e.g. a model with two principals, one with a single task of value 1, the other with two-task of values 2 and 1, respectively. The marginal contributions of the tasks are then ρ^2, $1 + \rho^2$ and ρ^2 respectively, but the marginal contribution of the second principal is $1 + \rho + \rho^2 > 1 + 2\rho^2$. The first principal is willing to pay the agent $1 - \rho^2$ in the first period. In the unique truthful equilibrium of this game, the second principal pays only $1 - \rho$, but the agent accepts this lower payment since scheduling the first principal's task would make it impossible to obtain any future payments as principal 2 would face no competing tasks and thus extracts all surplus. By scheduling the second principal's task first, the agent makes sure that she receives a payment of $1 - \rho$ in the next period as well. Thus, even though the marginal contributions of the tasks of principal j do not satisfy weak superadditivity, a marginal contribution equilibrium exists. We can conjecture that the theorem can be generalized to an arbitrary and not necessarily decreasing return model, as long as the returns $b_j(T_j)$ for principal j depend only the history of her own tasks.

Chapter 4 Contract Choice and Empirical Exploration

In this chapter, the agency problem is examined empirically. Contracts of infrastructure projects are collected by means of interview, questionnaire, and from major journals that cover news or events of private provision of transport infrastructure as well as secondary sources from case studies. Each observation consists of the identity of the country group classified by the World Bank, the nature of the financial contract between the CEO and the Board and the incentive regulation designed by the government, and a comprehensive set of project characteristics. Each country group chooses one of several standard contracts for each of its awarded projects. It is therefore possible to use these data to assess the relationship between contract choice and the tasks that the agent performs. In particular, since many projects are multitask operations, the data can be used to analyze interactions between the characteristics of non-transport activities, such as different types of estate development and the choice of incentive contracts.

Due to very few projects are having unified monitoring committee, empirical exploration on common agency issue is very difficult to be conducted. Therefore, only multitask agency is empirically explored. To verify our argument in low powered incentive in situation integrated with multitask agency and common agency, samples for multitask agency contracts are selected both from the viewpoints of the Board and the Government. Econometric study results are then compared.

Section 4.1 modified the theoretical model into its empirical exploration content; section 4.2 introduced incentive contract designation, section 4.3 identified the incentive designated by this study; and section 4.4 discussed the result and summary from the empirical exploration.

4.1 Static Incentive Model Modification

The choice of contractual arrangement involves many aspects of a relationship including risk and uncertainty (Knight, 1921), monitoring and control of the activity (Alchian and

Demsetz 1972), asset-specific investments (Williamson 1971, Grossman and Hart 1986), and, in infrastructure franchise, the value of the government inputs.

In infrastructure, there are some asset-specific assets, such as long-term, large-scale investment in fixed assets. In addition, although the value of the government inputs are valuable, the importance of these inputs do not vary substantially across infrastructures. This leaves insurance against risk and provision of effort incentives as the principal determinants of incentive form. It is relatively easy to monitor infrastructure demand, at least within the boundaries of a service area. For example, one can drive by to see if a transit station is open and make periodic trips to cheek if service is prompt and courteous.

Given the case of monitoring infrastructure services and the uniformity of the monitoring technology across infrastructures, it is perhaps surprising that such a wide variety of contractual arrangements coexist. My approach to explaining these variations is to focus on the secondary activity. In particular, I ask how the characteristics of the secondary activity affect the optimal contract for prime transport infrastructure service.

The model developed below considers the agency problem in a setting where secondary activities involve varying degrees of complementarity with the primary transport service. As we shall noted, changes in variables are complementary if making one increases the return to making the others. There are three potential sources of complementarity among tasks in the model developed below. First, if the outputs of two activities are demand complements, increasing the level of one activity lowers its price, which shifts out the demand for the second. Second, if the covariation in uncertainty across tasks is positive, a random increase in one activity due to a positive demand shock also shifts out the demand and raises the expected return to increasing the other. Finally, complementarity can occur if performing one task lowers the marginal cost of performing the other.

The monitoring technology is assumed to be unaffected by contract choice. In other words, there are no changes in information flows due to organization. Nevertheless, due to the multitask nature of the problem the optimal payment scheme for the primary activity (transport service) varies across projects.

This section begins by developing a multitask model that, in contrast to previous models, has endogenous prices. Unfortunately, the model may yield few unambiguous comparative statics. It is therefore restrict the model in ways that are consistent with the institutional realities of transport services. The restricted version of the model, in contrast, may yield a rich set of testable hypotheses.

As most incentive contracts in the project sample are linear, attention is put onto this class (Holmstrom and Milgrom, 1987, provide a theoretical justification for the use of linear contracts). Within this class, it is simple to formalize the notion of high and low-powered incentives. Suppose that the CEO's incentive (monetary or non-monetary) is of the form $\alpha + \beta x$, where x is output, β is a variable incentive depending on the performance, and α is a fixed incentive (a wage or a medal). If we compare two contracts that have the same expected value, the one with a higher β and lower α is higher powered. Indeed, when β is zero the CEO is completely insured, whereas when α is zero and β is piece-rate net of effort input cost, the transaction occurs in a market and the CEO is one of the residual claimants. The principal prediction of the multitask model developed below is that a high degree of' complementarity, whether systematic (high cross-price elasticity of demand), random (high covariance of shocks), or in the cost-of-effort function (low effort substitutability), should be associated with low-powered incentives.

While apply this model to quality oriented government in regulating franchise, the government must recreate the incentives of regulated franchise to provide quality without throwing away the benefits of regulation. First, it must reward the regulated franchise on the basis of primary transport services. Second, the threat of nonrenewal of the franchise license or of liberalization makes the CEOs concerned about its reputation as supplier of quality. The focus of our analysis in the Government's incentive regulation is the relationship between quality concern and power of optimal incentive schemes. An incentive scheme is low- (high-) powered if the CEO bears a low (high) fraction of her realized costs in providing high quality of service. The link between quality and the power of incentive schemes has been much discussed. For instance, there have been accounts that the switch to a incentive regulation (as noted as high-powered incentive schemes) for British Telcom (price caps) after its privatisation produced a poor record on the quality front (Vickers and Yarrow, 1988, p. 228). Similarly, under pure cost-of-service regulation (a very low-powered incentive scheme), the regulated firm does not gain from providing costly services, so that a low perceived cost of supplying quality does not imply a high incentive to supply quality.

The theoretical model here is a modified version of the one developed in chapter three. In the model, the CEO has two tasks: she produces transport infrastructure services and either provides estate development or non-estate development. Formally, suppose that CEO must choose the quantity of effort, e_i, to exert in two activities, i = 1, 2. Effort results in two outputs, x_i, that are sold at prices p_i. Each infrastructure service faces downward-sloping demand for its outputs. The price/effort/output relationship is assumed to be linear and can be written as:

$$x = a - \delta p + e + \varepsilon,\ \ \varepsilon \sim N(0, \Omega),\ \Omega = (\sigma_{ij}) \tag{4-1}$$

where x, p, and e are vectors of outputs, prices, and efforts, a (δ) is a vector (matrix) of parameters, and ε is a vector of random variables that have a bivariate-nomial distribution. δ is assumed to be symmetric and positive definite. The off-diagonal term, δ_{ij}, is a measure of systematic complementarity in demand.

The Government and the Board (both are principals) observe output, x, but not effort, e. The variance σ_{ij} of the random variable ε_i, is a measure of both the difficulty that the CEO has in controlling output x, and the difficulty that the principal has in observing effort e. Finally, the covariance between ε_i, ε_j, and σ_{ij}, is a measure of random complementarity.

The CEO's convex cost-of-effort function, which is quadratic in effort, takes the form

$\frac{1}{2}(e'Ce)$, where $C = (c_{ij})$ is a symmetric cost-of-effort matrix. I assume that $c_{12} \geq 0$, which implies that an increase in the effort devoted to one task does not lower the marginal cost of performing the second task. The parameter c_{12} is a measure of the degree of effort substitutability.

Attention is limited to linear contracts. The CEO receives a performance-payment, β_i, from the capacity/volume sold of each unit of x_i. In addition, she receives a fixed wage, α. α can be either positive or negative. When $\beta = 0$ and $\alpha > 0$, the CEO is fully insured, and as β increases incentives become higher powered. CEO income, y, is

$$y = \alpha + \beta' x - \tfrac{1}{2} e' C e, \tag{4-2}$$

and the CEO has a negative-exponential utility function

$$u(y) = -\exp(-ry). \tag{4-3}$$

In (4-3), r is the CEO's coefficient of absolute-risk aversion. With exponential utility normally distributed shocks and linear contracts, certainty-equivalent income, CE, is

$$CE = E(y) - (r/2)\ var(y) = \beta'(a - \delta p + e) + \alpha - \tfrac{1}{2}(e'Ce) - \tfrac{1}{2} r \beta' \Omega \beta \tag{4-4}$$

In other words, CE is the CEO's expected payment minus her cost of effort minus her risk premium. Finally, the risk-neutral principal's net benefit, π, is

$$\pi = [p - \beta - mc]' x - \alpha, \tag{4-5}$$

where mc is a vector of marginal-production costs (such as bid-preparation cost to the Government, recruiting cost to the Board, etc.). Without loss of generality, mc is assumed to be zero.

The timing of events is as follows. In period one, the principal chooses the term of the contract (α, β) and offers it to the CEO. The CEO can then either accept or reject. In period two, if the CEO accepts the contract, she chooses effort e.

I assume that contracts are efficient but make no assumption about the division of the surplus. In other words, the principals chooses β, p, and e to maximize the expected surplus (expected revenue - expected cost - risk premium) and then uses α, which is a pure transfer, to distribute the surplus in an unspecified fashion. The principals' problem is therefore to

$$\max \quad p'(a - \delta p + e) - \tfrac{1}{2}(e'Ce) - \tfrac{1}{2} r \beta' \Omega \beta. \tag{4-6}$$

subject to the CEO-incentive constraint

$$e \, \varepsilon \; \arg\max \, [\beta'(a - \delta p + e) - \tfrac{1}{2}(e'Ce)] \tag{4-7}$$

The CEO's first-order condition is

$$\beta - Ce = 0 \tag{4-8}$$

$$\text{or} \quad e^* = C^{-1}\beta. \tag{4-9}$$

(4-6) can therefore be written as

$$\max \; p'(a - \delta p + C^{-1}\beta) - \tfrac{1}{2}(\beta' C^{-1}\beta) - \tfrac{1}{2} r \beta' \Omega \beta, \tag{4-10}$$

where (4-10) is an unconstrained maximization, Assuming that $e^* > 0$, first-order conditions for this maximization are

$$C^{-1}p - C^{-1}\beta - r\Omega\beta = 0 \tag{4-11}$$

$$\text{or} \quad p = [I + rC\Omega]\beta \tag{4-12}$$

and $a - 2\delta p + C^{-1}\beta = 0.$ (4-13)

Substituting (4-12) into (4-13) and solving for β yields

$$\beta^* = [2C\delta(I + rC\Omega) - I]^{-1}Ca, \tag{4-14}$$

where β^* is the optimal contract. It is useful to examine special cases in order to understand this contract.

Case 1. No uncertainty or risk neutrality ($\Omega = 0$ *or* $r = 0$). In the certainty case, (4-12) reduces to

$$\beta^* = p. \tag{4-15}$$

(4-15) implies that the principals give property right of infrastructure project to the CEO at marginal cost (= 0 here), and the CEO produce output x at the market price p. The CEO earns rent, due to downward-sloping demand and increasing-marginal cost of effort. This rent, however, can be extracted through the use of α. Case one is thus a standard transfer-pricing problem.

Case 2. Unrelated efforts ($\sigma_{12} = \delta_{12} = c_{12} = 0$). With unrelated efforts, it is straight-forward to show that

$$\beta_i^* = a_i c_{ii} / [2c_{ii}\delta_{ii}(1 + rc_{ii}\sigma_{ii}) - 1]. \tag{4-16}$$

(4-16) indicates that, when activities are unrelated, the optimal contract for the i-th task is independent of the characteristics of j-th activity. Moreover, the CEO is given lower-powered incentives when she is more risk averse (r is large), when the environment is more uncertain (σ_{ii} is large), when the market/project scale is small (a_i

is small), and when demand is more elastic (δ_{ii} is large), holding price and all model parameters except δ_{ii} constant. The final prediction is due to the fact that the increased effort that accompanies a high β_i, shifts out the demand for x_i. The resulting increase in revenue, which is lower when demand is elastic, must be balanced against the increase in risk, which is independent of demand.

Case 3. Task two is an outside activity $(\beta_2 = P_2)$. The final special case is, tailored to fit the transport service market. When government decide to deliver infrastructure under contract, they at times allow the franchise to engage in secondary activities (such as estate development) but do not participate in these activities themselves. In other words, the CEO and the Board are residual claimants with respect to the outside activity. Moreover, they own the skills and stocks of estates/real-properties associated with this activity. The government in most cases, however, owns the land or its property right. Given this situation, we can ask how the characteristics of the outside activity affect the optimal choice of transport service-output contract, (β_1^*, α^*).

With case three, I assume that the price of the secondary activity is exogenous to the franchise. This means that, for example, franchise sell estate at market prices. The price of transport service, however, shifts the demand for estate because it affects the number of potential customers. This could be proved as below.

> Under the assumptions of case three, an optimal contract for project-service-consumption involves lower-powered incentives for task one (a fixed wage α is substituted for an incentive β_1) when
>
> i) δ_{12} is large, and
>
> ii) σ_{12} is large.
>
> Moreover, the values of a_2, δ_{22}, and σ_{22} are irrelevant. Finally, if $c_{11} = c_{22}$, β_1 is more apt to be higher in the two-task situation than in the one-task situation if δ_{12} and σ_{12} are small.

Under the assumptions of case three, the principal's problem is to choose β_1 and p_1 to

$$\max \quad p'[\ a - \delta p + C^{-1}\beta] - ½(\beta' C^{-1}\beta) - ½(r\beta'\Omega\beta) \qquad (4\text{-}17)$$

with $\beta_2 = P_2$. Let $C^{-1} = \tilde{c}_{ij}$. In other words, $\tilde{c}_{ij} = c_{ij}/D > 0$, and $\tilde{c}_{ij} = -c_{ij}/D < 0$, where $D = c_{12}\, c_{22} - c_{12}^2$.

When the objective function (4-17) is expanded, it becomes

$$\begin{aligned} &\{a_1 - \delta_{11}p_1 - \delta_{12}p_2 + \tilde{c}_{11}\beta_1 + \tilde{c}_{12}\beta_2\}p_1 \\ &\quad + \{a_2 - \delta_{12}p_1 - \delta_{22}p_2 + \tilde{c}_{12}\beta_1 + \tilde{c}_{22}\beta_2\}p_2 \\ &\quad - ½\{\tilde{c}_{11}\beta_1^2 + 2\,\tilde{c}_{12}\,\beta_1\beta_2 + \tilde{c}_{22}\beta_2^2\} \\ &\quad - ½ r\{\sigma_{11}\beta_1^2 + 2\sigma_{12}\,\beta_1\beta_2 + \sigma_{22}\beta_2^2\} \end{aligned} \qquad (4\text{-}18)$$

First-order conditions for the maximization of (4-18) with respect to p, are

$$\{a_1 - 2\,\delta_{11}p_1 - 2\,\delta_{12}p_2 + \tilde{c}_{11}\beta_1 + \tilde{c}_{12}\beta_2\} = 0 \qquad (4\text{-}19)$$

$$\text{or} \quad p_1 = (a_1 + \tilde{c}_{11}\beta_1 + \tilde{c}_{12}\beta_2 - 2\,\delta_{12}p_2)/(2\,\delta_{11}) \qquad (4\text{-}20)$$

First-order conditions for the maximization of (4-18) with respect to β, are

$$\begin{aligned} &\tilde{c}_{11}p_1 + \tilde{c}_{12}p_2 - \tilde{c}_{11}\beta_1 - \tilde{c}_{12}\beta_2 - r\sigma_{11}\beta_1 - r\sigma_{12}\beta_2 \\ &\quad = \tilde{c}_{11}p_1 - \tilde{c}_{11}\beta_1 - r\sigma_{11}\beta_1 - r\sigma_{12}\beta_2 \end{aligned} \qquad (4\text{-}21)$$

Substituting (4-20) into (4-21) one obtains,

$$(\tilde{c}_{11}/2\delta_{11})[\ a_1 - (2\delta_{12} - \tilde{c}_{12})\beta_2 + \tilde{c}_{11}\beta_1] - r(\sigma_{11}\beta_1 + \sigma_{12}\beta_2) = 0 \qquad (4\text{-}22)$$

Finally, solving (4-22) for β_1, we have

$$\beta_1^* = \{ \tilde{c}_{11}[a_1 - (2\delta_{12} - \tilde{c}_{12})\beta_2] - 2\delta_{11} r\sigma_{12}\beta_2\} / 2\delta_{11}(\tilde{c}_{11} + r\sigma_{11} - \tilde{c}_{11}^2)$$

$$= \{ \tilde{c}_{11}[a_1 - (2\delta_{12} - \tilde{c}_{12})\beta_2] - 2\delta_{11} r\sigma_{12}\beta_2\} / \eta \qquad (4\text{-}23)$$

where $\eta > 0$ by the second-order conditions. Comparative statics, which make use of (4-23), show that

$$[d\beta_1 / d\delta_{12}] = -(2\tilde{c}_{11}\beta_2)/\eta \quad < 0,\ [d\beta_1 / d\sigma_{12}] = -(2r\delta_{11}\beta_2)/\eta \quad < 0, \qquad (4\text{-}24)$$
$$[d\beta_1 / da_2] = 0,\ [d\beta_1 / d\delta_{22}] = 0,\ [d\beta_1 / d\sigma_{22}] = 0.$$

when $c_{11} = c_{22}$, $\tilde{c}_{11} = c_{11} / D$ and $\tilde{c}_{12} = c_{12} / D$. Using these relationships, one obtains

$$\beta_1^* = \{c_{11} a_1 - c_{11}[(2\delta_{12} - c_{12}/D)\beta_2] - 2\delta_{11} r D\sigma_{12}\} \qquad (4\text{-}25)$$
$$/ \{2\delta_{11} c_{11}[1 + rD\sigma_{11}/c_{11}] - c_{11}^2 / D\}$$

The denominator of (4-26) is positive by the second-order conditions for the maximization of (4-18) with respect to β_1. One can compare (4-26) to the optimal β_1 for the single-task situation,

$$\beta_1^* = (a_1 c_{11})/[2 c_{11}\delta_{11} (1 + rc_{11}\sigma_{11}) - 1]. \qquad (4\text{-}26)$$

This comparison shows that the change in β_1^* as we move from the single to the double-task situation is ambiguous. However, since β_1^* in (4-26) is negatively related to δ_{12} and σ_{12}, β_1 is more likely to increase when these parameters are small. Therefore, the optimal incentive for CEO under the assumptions of case three would be

$$\beta_1^* = \{\tilde{c}_{11}[a_1 - (2\delta_{12} - \tilde{c}_{12})\beta_2] - 2\delta_{11} r \sigma_{12}\beta_2\}/[2\delta_{11}(\tilde{c}_{11} + r\sigma_{11}) - \tilde{c}^2_{11}]$$

$$\tilde{C} = (\tilde{c}_{ij}) = C^{-1}$$

In addition, comparative statics are investigated. The principal results are as follows.

First, a high degree of demand and risk complementarity is associated with lower-powered incentives. In other words, complementarity leads to higher remuneration and lower output-based compensation. The intuition that underlies these conclusions is as follows.

When the cross-price-demand effect is large, greater effort in the infrastructure-service activity reduces revenues in the secondary activity by a larger amount. The increase in risk that accompanies a higher β_1, however, is independent of the cross-price elasticity of demand.

When the random shocks are highly correlated, the CEO is given low-powered incentives because positive correlation is an additional source of risk and leads to a greater need for insurance. Negative correlation, in contrast allows the CEO to diversify her risk. The effect of cost complementarity, in contrast, is ambiguous. If β_1 is low and efforts are highly substitutable, the CEO will spend all her time in the estate development and neglect transport service consumption. At the opposite extreme, if β_1 is high and efforts are highly substitutable, the CEO spends all her time selling transport service. The direction of the effect of an increase in effort substitutability on β_1^*, therefore, depends on β_1^*.

Finally, as one and two-task situations were compared in the proof above, it is shown that when a second-activity is introduced β_1 can either rise or fall. It is more likely to rise, however, when demand and random complementarity are low.

Turning to the application, recall that the maintained hypotheses are that covariation in shocks across tasks and cross-price effects are higher, whereas case of substitution of effort is lower, when the second activity is a commercial estate activity. These hypotheses can be used to predict the terms of the contract for transport service consumption. In particular, service consumption should be more entrepreneurial when the outside activity is a residential rather than a commercial. In addition, when one and two-task franchise are compared, it is likely that service consumption will be more entrepreneurial at two-task franchises with residential estate development. This is unlikely to be enhanced, however, when the second task is a commercial estate development. From the viewpoint of incentive regulation on quality, the lower cross-price effect and covariation in shocks across task are preferred and less entrepreneurial in residential estate development shall be encouraged. These are the predictions that are assessed in section 4-3.

4.2 Contract Forms Designation

Incentive contracts are related to their transport service styles through one of four classified contracts. These contracts, which range from fully insurance to arms-length transactions in a market, are described in turn.

Fully Insured Incentive (Type 1). Under this arrangement, the CEO, who owns no assets (even no stock option), is worked as a fixed-salary employee. Moreover, remuneration is independent of effort and output. Type one contracts correspond to a remuneration scheme $\beta_1^1 = \beta_2^1 = 0$ *and* $\alpha^1 > 0$, where a superscript denotes the contract type. All other contractual arrangements involve some degree of incentive-based pay and CEO-asset ownership.

Mixed (Fixed-and-Variable) Incentives (Type 2). CEOs receive a fixed payment, which is independent of effort, and a performance-based-style payment per unit of infrastructure service consumption. Service consumption is known as the prime. The secondary activities, in contrast, consist of all other operations--- mostly an estate development. This contractual arrangement, which is the most common in the franchised cases, corresponds to a remuneration scheme with $0 = \beta_1^1 < \beta_1^2,\ \beta_2^2 \approx p_2$ *and* $\alpha^2 > 0$.

Performance-Based Incentives (Type 3). The remuneration for these CEOs is fully dependent on their performance. As with type-two incentives, CEOs are entrepreneurs in the franchise operation and own the associated stock-option contracts. Whereas the franchise fee is, in principle, common to all franchise; fees are project specific and reflect locational advantages (especially in transport infrastructures), demand, and other service characteristics. Contract-type three corresponds to a remuneration scheme with $0 < \beta_1^2 < \beta_1^3,\ \beta_2^3 \approx p_2$ *and* $\alpha^3 > 0$.

Self-Insured Incentive (Type 4). Finally, a few franchises might privately owned by the CEO (or she owns majority of stocks). Whereas this arrangement is, very common in some locals it is much rarer in regional infrastructure services. Self-employed CEOs, who are residual claimants with respect to all aspects of their business, own all/most-of the infrastructure assets. Nevertheless, they often pay a franchise fee or receive a small subsidy. When the government provides the franchise with some financing, the operator might amortize her loan by means of installments of franchise fee. The fourth contract corresponds to a remuneration scheme with $\beta_1^3 \approx \beta_1^4,\ \beta_2^4 \approx p_2$ *and* $\alpha^4 = 0$.

To summarization, all contracts are linear. Moreover, $\beta_1^1 < \beta_1^2 < \beta_1^3 \approx \beta_2^4$ and $\alpha_2^1 > \alpha_2^2 > \alpha_2^3$. Even though $\alpha_2^3 < \alpha_2^4 = 0$, with incentive type three it is possible for the principals to partially insure the CEO against down side risk by charging a franchise fee that is somewhat less than market value. This means that, as we move to higher numbered contracts, higher-powered incentives are substituted for lower. Finally, the degree of CEO-asset ownership also increases with contract type.

A possible difficulty arises with respect to contract type four. When the fixed payment is zero, the principals' objective function is no longer given by (4-6), and double marginalization can occur. For this reason, the contract-choice model can be estimated both with and without these type-four contracts.

4.3 Empirical Exploration

Comparative statics from the theoretical model form the basis of the empirical test. As linear contracts are mostly used in our project sample, attention is limited to such arrangements. In this section, I assess how variations in the parameters for one task affect the choice of contract for another. Important parameters are the covariation in uncertainty across tasks, the cross-price elasticity of demand, and the substitution between tasks.

1. Data and Estimation

A. Data and Preliminary Data Analysis

The contract data pertain to information obtained from projects of major transport infrastructure concessions awarded from late 1980s to 1990s. The concession awards are group by countries. Each country heading contains three pieces of information (please refer to Appendix A). The first is a country group classification according to the World Development Indicators (see. e.g., World Bank 2001: Appendix; expect for two cases from Taiwan). The second is number of concession in each country. The third is project cost. All cost figures are converted into U. S. dollars. The data presented in Appendix A suffer from variations in different sources. When variation occurs, a news source is chosen instead of using a secondary source, a local source is chosen instead of using an international source and a larger figure is chosen instead of using a smaller figure. The value of dummy variables is mainly adopted from questionnaires and interviews.

The project characteristics are service density for the project or DENST, hours of operation per day or HOURS, and expected annual service consumption volume or VOL. In addition there are several dummy variables, RREAL for residential real-estate activity, CREAL for commercial real-estate activity, IREAL for industrial real-estate activity, REGU for government regulation on rate/price, and RESUB for government sets up regulation and provides subsidization. The dummy variables equal one if the project has the corresponding characteristic and zero otherwise.

Table 4-1 shows summary statistics for the explanatory variables. The first row, which is for the entire sample, is followed by statistics for each country group. This table shows that an average project is serving about five thousand population per square mile, stays operating for twenty one hours a day, and expects to produce just under thirty million passenger-trips a year. Twenty-one percent have residential real-estate development activities, forty percent of the projects have commercial real-estate development ones, and ten percent have industrial real-estate development ones. Moreover, sixty percent are government regulated, fourteen percent have both government regulation and subsidization, and the remainder of seventeen percent are government subsidized only.

Table 4-1 Summary Statistics – Project Characteristics

	Number of Projects	DENST (Thou. Pop. Per Mile^2)	Average HOURS (per day)	Average VOL (10^6 per year)	RREAL (% of projects)	CREAL (% of projects)	IREAL (% of projects)	REGU (% of projects)	RESUB (% of projects)
Sample	58	5.1	20.8	27.4	21	40	10	66	17
Country 1	23	5.5	21.3	29.3	20	39	4	65	22
Country 2	20	5.1	20.4	28.2	13	30	16	60	10
Country 3	15	4.7	21.2	21.5	33	53	13	73	20

Note: DENST: service density; RREAL, residential real estate developments; CREAL, commercial real estate development; IREAL, industrial real estate development; REGU, government-regulated; RESUB, with both government regulation and subsidization; country group 1 are countries with high-income; country group 2 with upper-middle-income and middle-income; and country group 3 with lower-middle income and low-income.

Tables 4-2 and 4-3 show percentages of projects operating under each type of contract, both for the 58-project sample and for each country group. As noted earlier, type two (mixed incentive) is the most popular contract, followed by type three (performance-based incentive). In private sector, fully-insured and self-insured projects account for only nine and five percent of the sample, respectively. Moreover, country group one has no type-one and type-four contracts. In incentive regulation, there are no type-one and type-four in all cases.

Table 4-2 Summary Statistics – Type of Contracts (Board's View)

	Type 1: Fully Insured (%)	Type 2: Mixed (%)	Type 3: Performance Based (%)	Type 4: Self Insured (%)
Sample	9	55	31	5
Country 1	0	70	30	0
Country 2	5	55	30	10
Country 3	27	33	33	7

Table 4-3 Summary Statistics – Type of Contracts (Government's View)

	Type 1: Fixed (%)	Type 2: Mixed (%)	Type 3: Performance Based (%)	Type 4: Self Insured (%)
Sample	0	55	45	0
Country 1	0	26	74	0
Country 2	0	65	35	0
Country 3	0	87	13	0

Tables 4-4 and 4-5 list correlation coefficients between contract type and project characteristics from the franchise's view. The variable TYPE, equals j if project i is operated under contract type j. TYPE is therefore an ordered-qualitative variable, increasing with the power of the incentives offered. The project-characteristic variables, with the exception of DENST, HOURS, and VOL, are dichotomous. Spearman-rank-correlation coefficients, which are appropriate for qualitative data, are therefore shown.

Table 4-4 indicates that high-volume government-regulated projects that stay open for long hours and have no residential real estate development are associated with lower-powered incentives. The correlation coefficients, however, are unconditional and could therefore be spurious. The problem is that a characteristic might appear to be correlated with TYPE due to a common-causal factor. The econometric model of contract choice, however, does not suffer from this problem.

Table 4-4 Correlation of Characteristics with Contract Type (Board's View) (Spearman-Rank Correlation Coefficients)

DENST (Thou. Pop. Per Mile^2)	HOURS (per day)	VOL (10^6 Units per year)	RREAL (dummy variable)	CREAL (dummy variable)	IREAL (dummy variable)	REGU (dummy variable)	RESUB (dummy variable)
0.30**	-0.51**	-0.45**	0.69**	-0.06	0.12	-0.48**	0.13

Note: ** denotes significance at the 97% level of confidence; see Table 4-1 for key to abbreviations.

Table 4-5 Correlation of Characteristics with Contract Type (Government's View) (Spearman-Rank Correlation Coefficients)

DENST (Thou. Pop. Per Mile^2)	HOURS (per day)	VOL (10^6 Units per year)	RREAL (dummy variable)	CREAL (dummy variable)	IREAL (dummy variable)	REGU (dummy variable)	RESUB (dummy variable)
0.24**	-0.29**	-0.33**	-0.27**	0.15	0.11	0.31**	0.12

Note: ** denotes significance at the 97% level of confidence; see Table 4-1 for key to abbreviations.

Table 4-5 indicates that high-volume without government-regulated projects that operate for long hours and have residential real estate development are associated with lower-powered incentives. Again, the correlation coefficients, however, are unconditional and could therefore be spurious due to same reasons as in Table 4-4

If one computes averages of TYPE across groups of projects with different characteristics, this variable can be used to compare single and multiple-task projects. The first column in Table 4-6 indicates that there are seventeen projects offering prime transport infrastructure service only. The average of TYPE for these projects is 2.06. Columns two, three, and four pertain to group of multitask operations. Twelve have residential real estate development, twenty three projects have commercial real estate developments, and six offer industrial real estate development. The first and third of these groups are mutually exclusive, whereas there is some overlap between the second group and each of the other two.

Table 4-6 Single and Multitask Projects Compared – Average of Contract-Type (Board's View)

	Infrastructure Services Only	RREAL	CREAL	IREAL
Average Type	2.06	2.92**	1.80	2.10
Number of Projects	17	12	23	6

Note: ** denotes difference from 2.06 at the 99% level of confidence; see Table 4-1 for key to abbreviations.

Finally, TYPE averages 2.92 for the projects that have residential real estate development, 1.80 for those that have commercial real estate development, and 2.10 for those with industrial real estate development. These numbers indicate that when a second activity is added, on average, transport-service-based incentives increase significantly when this activity is a residential real estate development, fall when it is a commercial real estate development, and remain almost the same when it is an industrial real estate development. The empirical regularities therefore support one of the theoretical predictions.

Table 4-7 indicates that from incentive regulation's viewpoint, average TYPE for transport service is 2.57. It is 2.28 for the projects that have residential real estate development, 2.71 for those that have commercial real estate development, and 2.54 for those with industrial real estate development. These numbers indicate that when a second activity is added, on average, transport-service-based incentives increase significantly when this activity is a commercial real estate development, fall when it is a residential real estate development, and remain much the same when it is an industrial real estate development. The empirical regularities therefore support one of the theoretical predictions to incentive regulation.

Table 4-7 Single and Multitask Projects Compared – Average of Contract-Type (Government's View)

	Infrastructure Services Only	RREAL	CREAL	IREAL
Average Type	2.57	2.28**	2.71	2.54
Number of Projects	17	13	25	7

Note: ** denotes difference from 2.57 at the 99% level of confidence; see Table 4-1 for key to abbreviations.

The econometric model assesses contract choice for projects that Government and the Board are not unified in CEOs' behavior monitoring. Indeed, the predictions of the theoretical model are based on the assumption that the CEOs are partially residual claimant with respect to the secondary activity. Nevertheless, the unified/separated monitoring decision is of independent interest.

These two modes of monitoring are compared in Table 4-8, which shows that no unified monitoring project has residential real estate developments or both government regulation and subsidization. Moreover, project concessions, which are having shorter concession period, are more likely to have commercial real estate development and being put on government regulation. Finally, all these differences are statistically significant.

Table 4-8 Averages of Characteristics of Monitoring and Contract Projects (Mann-Whitney-Wilcoxin Test for Difference in Mean)

Type	Projects	DENST	HOURS (per day)	VOL (10^6 Units per year)	RREAL (%)	CREAL (%)	IREAL (%)	REGU (%)	RESUB (%)	DUR (years)
Unified	5	5.1	22.4	24.4	0.0**	80.0**	20.0	71.0*	0.0**	21.2**
Separated	53	5.3	20.9	30.1	40.2	24.1	8.2	68.4	21.0	28.4

Note: * denotes significance difference at the 95% level of confidence; ** denotes significance difference at the 99% level of confidence; see Table 4-1 for key to abbreviations.

Note: As many of the characteristics are dichotomous, the Mann-Whitney-Wilcoxin test is used. For a description of this nonparemateric test, see Gibbons (1976). The validity of this test, which is appropriate for qualitative data, does not depend on underlying distributional assumptions. In particular, no appeal is made to large-sample theory.

B. Econometric Model

For the econometric model, the project characteristics are assumed to be exogenous. Clearly, there is an earlier stage in which the characteristics are chosen. For most transport infrastructure projects, however, this choice was made before concession bidding and is costly to change. Contracts, in contrast, are easier to change, and most shall be rolled over several times since the characteristics were chosen. After the contracting decision has been made the type and terms of the contract must be chosen. This contract is then offered to the CEO. If the CEO accepts, she chooses effort.

Figure 4-1 shows the sequence of decisions in this market, In the first stage, the characteristics are chosen; in the second, the separated/unified monitoring decision is made; for contract projects, there is a third stage in which the type of contract is selected. Finally, effort is chosen. At each stage, earlier decisions are assumed to be observable and not renegotiable.

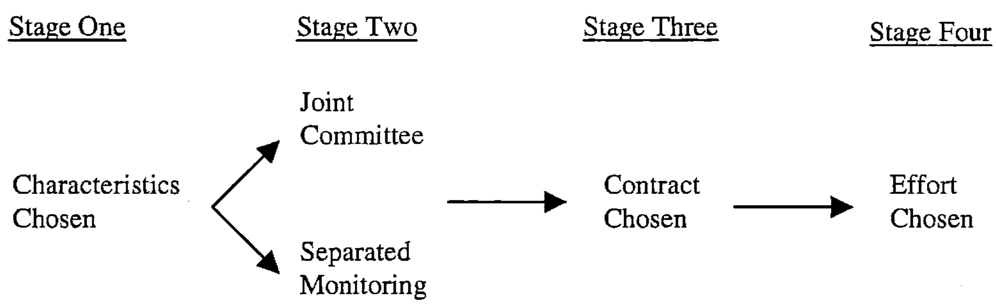


Figure 4.1 Sequence of Decisions

One could model stages two and three as simultaneous decisions. In this case, it would be natural to postulate a multiple-choice model of organizational form for monitoring. This approach was not taken for two reasons. First, the nested-decision process has a certain theoretical appeal. Second, and more important, there is a practical problem. In the data, there is much less variation in characteristics across unified monitoring projects than across separated monitoring projects. For example, no unified projects have both government regulation and subsidization, or residential real estate developments. A simultaneous choice model would therefore suffer from perfect multicollinearity.

The econometric model of contract choice is a Probit equation. The dependent variable, I_{id}, is a dichotomous indicator that equals one if the incentive is performance-based (contract type three) and zero if incentive is mixed (contract type two). Given that an ordered-Probit cannot be estimated with only three observations in one class, it is not clear how to treat the three self insured projects. On the one hand, they could be included with the performance-based incentive, since $\beta_1 = p_1$, in both contracts. However, as there are significant differences between performance-based and self-insured incentives, it might be preferable to exclude these projects. The model is therefore estimated with and without the type-four projects.

The explanatory variables are those listed in Table 4-4. In addition, I created dummy variables for each of the projects, which are fixed effects in the Probit equation. Most of the explanatory variables are specified in the contracts and are thus exogenous. Transport service consumption volume, however, is potentially endogenous. For example, from Board's view, a contract with high-powered incentives can induce the CEO to exert more effort, which can in turn result in higher service consumption volume.

The method that I use to assess exogeneity of regressors in Probit models is due to Rivers and Vuong (1988). It consists of adding an auxiliary equation that relates the potentially endogenous variable, w, to relevant exogenous variables, Z. The system of equations is then

$$y^* = \alpha w + \delta' X + u, \tag{4-27}$$

$$w = \eta' Z + v \tag{4-28}$$

where y* is an unobserved latent variable, X is a matrix of exogenous variables, and α, δ, and η are parameters to be estimated.

To test the exogeneity of w, the Probit MLE is applied to (4-27) with the OLS residuals, $\hat{v}$, from (4-28) as an additional regressor. The '*t-statistic*' that tests if the coefficient of $\hat{v}$ is zero involves the correlation between the OLS residual, $\hat{v}$, and the generalized residuals, $\tilde{u}$, from the Probit.

2. Contract-Choice Equations and Empirical Results

Tables 4-9 and 4-11 show estimated coefficients from the Probit model of contract choice; *t-statistics* can be found under their respective coefficients. Equation one includes the four self-insured projects whereas equation two excludes them. Given that estimated coefficients are virtually identical in the two equations, this choice seems unimportant. Indeed, to avoid the problem of double marginalization discussed in section 4-2, all subsequent equations two, three, four and five exclude the type-four projects. Equation three does not contain the fixed effects, which are insignificant in equations one and two. Again, we find that coefficient estimates are insensitive to this exclusion. The implication is that there is no systematic differences, in the rules that determine, contract choice across projects.

The auxiliary equation for volume from Board's view can be found in Table 4-10. Identifying instruments in this regression are the project fixed effects. These effects, as well as many of the other explanatory variables, are significant. Indeed, volume is higher at projects in the highly-density service area that stay open for long hours, have neither residential nor commercial real estate development and have both government regulation and subsidization.

Equation four in Table 4-9 includes the OLS residuals $\hat{v}$ from the auxiliary-volume equation. The associated '*t-statistic*' indicates that simultaneity is not a problem. A comparison of Tables 4-4 and 4-9 shows that, whereas the unconditional correlation coefficient between TYPE and VOL is significantly negative, when one conditions on the other's characteristics this significance disappears. This finding is reassuring. Indeed, all else equal, we expect higher-powered incentives to be associated with higher, not lower, service consumption volume.

In Table 4-9, the normalized-success ratio indicates the proportion of successful predictions. The first four ratios show that predicted and observed choices coincide for approximately seventy-two percent of the projects. The likelihood-ratio statistic tests the overall significance of each equation; it compares the estimated equation to one with a constant term only. All equations perform well on both counts.

The estimated equations show that performance-based incentive contracts are more apt to have residential estate development than mixed incentives. In addition, they are less apt to government regulation and to have commercial estate development. To interpret these regularities, recall that the multitask model predicts that higher-powered transport-service-consumption incentives will be offered at projects that provide residential estate development compared with those that have commercial estate development. Given that the incentive for infrastructure service consumption (β_1) is higher in type-three contracts, the findings concerning non-transport-service offerings at separated-monitoring projects are compatible with the theory. The estimated coefficients of service density and operation hours are not significant. The theory offers no predictions with respect to these variables. Nevertheless, if it were difficult to determine whether terms of the contracts had been fulfilled, we would expect to observe that CEOs of projects located in lower service density area were given higher-powered incentives.

The final equation in Table 4-9 contains a concession duration variable. Duration is included as in explanatory variable to test the hypothesis that all results can be explained by correlation with an omitted variable. Indeed, longer projects seemly tend to have government regulation, have residential real estate developments, consume lower service volumes, and stay open for shorter hours. They also tend to be awarded under type-three or -four contracts. Table 4-9, however, shows that concession duration is not a significant determinant of contract choice.

Table 4-9 Probit Equations for Contract Choice (Board's View)
(Performance Based Incentive =1)

Equ.	DENST	HOURS	VOL	RREAL	CREAL	IREAL	REGU	RESUB	Country $_1$	Country $_2$	VHAT	DUR	CONS	No. of Obs.	Normal. Success Index	LF (d.f.)
1	0.02	-0.19	0.75	2.64	-2.71	-0.97	-1.61	1.04	-0.41	-0.06			2.76	53	0.74	50**
	(0.9)	(-1.8)	(0.2)	(3.4)**	(-2.6)*	(-1.1)	(-2.5)*	(1.4)	(-0.5)	(-0.1)			(1.3)			(10)
2	0.02	-0.19	0.81	2.62	-2.70	-0.95	-1.61	1.04	-0.42	-0.08			2.66	50	0.72	46**
	(0.8)	(-1.7)	(0.2)	(3.4)**	(-2.5)*	(-1.0)	(-2.5)*	(1.4)	(-0.6)	(-0.1)			(1.2)			(10)
3	0.02	-0.19	0.65	2.63	-2.71	-0.86	-1.61	1.01					2.71	50	0.71	46**
	(0.9)	(-1.7)	(0.2)	(3.6)**	(-2.6)*	(-1.0)	(-2.5)**	(1.4)					(1.3)			(8)
4	0.02	-0.16	3.09	2.41	-2.46	-0.85	-1.73	1.18			0.01		3.08	50	0.71	46**
	(0.9)	(-1.0)	(0.5)	(2.8)**	(-2.2)*	(-1.1)	(-2.6)**	(1.5)			(0.5)		(1.3)			(9)
5	0.04	-0.33	2.03	3.94	-1.85	-0.07	-1.75	0.89				-0.08	3.64	50	0.80	51**
	(0.8)	(-1.7)	(0.5)	(2.5)**	(-2.0)*	(-0.4)	(-1.4)*	(0.9)				(-1.2)	(1.3)			(9)

Note: * denotes significance difference at the 95% level of confidence; ** denotes significance difference at the 99% level of confidence; Equ.: equations; CONS, constant term; d.f., degree of freedom; LF, likelihood function; Normal., normalized; Obs., observation; VHAT, the residuals from the OLS equation for volume; for remaining abbreviations see Table 4-1.

Table 4-10 Auxiliary Equation for Service Consumption Volume (Board's View)

DENST	HOURS	RREAL	CREAL	IREAL	REGU	RESUB	Country $_1$	Country $_2$	CONS	No. of Observation	X^2	LF (d.f.)
1.29	0.13	-0.35	-0.74	0.39	-0.22	0.51	0.93	0.86	0.41	50	0.48	54 **
(2.1)*	(3.2)	(-3.4)**	(-2.8)**	(1.4)	(-0.8)	(2.1)*	(3.9) **	(3.4) **	(0.5)			(9)

Note: * denotes significance difference at the 95% level of confidence; ** denotes significance difference at the 99% level of confidence; CONS, constant term; d.f. degree of freedom; LF, likelihood function; Normal., normalized; Obs., observation; VHAT, the residuals from the OLS equation for volume; for remaining abbreviations see Table 4-1.

Table 4-11 Probit Equations for Contract Choice (Government's View)
(Performance Based Incentive =1)

Equ.	DENST	HOURS	VOL	RREAL	CREAL	IREAL	REGU	RESUB	Country $_1$	Country $_2$	VHAT	DUR	CONS	No. of Obs.	Normal. Success Index	LF (d.f.)
6	0.01	-0.13	0.54	-2.12	2.87	-0.79	1.42	1.01	-0.35	-0.08			2.43	50	0.62	49**
	(0.7)	(-1.5)	(0.2)	(-2.9)**	(2.5)*	(-1.0)	(2.3)*	(2.1)*	(-0.4)	(-0.1)			(1.1)			(10)
7	0.01	-0.13	0.58	-2.22	-2.54	-0.75	-1.52	0.94					2.51	50	0.61	47**
	(0.8)	(-1.4)	(0.1)	(3.1)**	(-2.2)*	(-1.1)	(-2.3)**	(1.2)					(1.2)			(8)
8	0.01	-0.13	2.01	-1.93	2.93	-0.81	1.52	1.11			0.01		2.81	50	0.61	45**
	(0.7)	(-1.0)	(0.3)	(-2.8)**	(2.3)*	(-1.1)	(2.4)**	(2.3)*			(0.3)		(1.2)			(9)
9	0.02	-0.24	1.56	-2.91	1.92	-0.09	1.54	0.93				-0.05	2.93	50	0.65	48**
	(0.7)	(-1.4)	(0.4)	(-2.4)**	(2.1)*	(-0.3)	(1.9)*	(2.0)*				(-0.9)	(1.3)			(9)

Note: * denotes significance difference at the 95% level of confidence; ** denotes significance difference at the 99% level of confidence; Equ.: equations; CONS, constant term; d.f., degree of freedom; LF, likelihood function; Normal., normalized; Obs., observation; VHAT, the residuals from the OLS equation for volume; for remaining abbreviations see Table 4-1.

Equation six in Table 4-11 includes all projects whereas equation seven does not contain the fixed effects from country group. Equations eight and nine test the impacts from the OLS residuals $\hat{v}$ and concession duration, respectively. The associated t-statistic indicates that simultaneity is not a problem, too. A comparison of Tables 4-5 and 4-11 shows that, whereas the unconditional correlation coefficient between TYPE and VOL is significantly negative, when one conditions on the other's characteristics this significance disappears again. This finding is reassuring. Indeed, all else equal, as discussed above we expect higher-powered incentives to be associated with higher, not lower, service consumption volume, even from incentive regulation's perspective.

In Table 4-11, the first two normalized-success ratios show that predicted and observed choices approximately approaches sixty-four percent of the projects. Again, the likelihood-ratio statistic tests show all equation six, seven, and eight perform well on statistical significance and prediction success.

The estimated equations show that performance-based incentive regulation contracts are more apt to have commercial real estate developments than mixed incentives. In addition, they are less apt to have residential real estate development. To interpret these incentive regularities, recall that from incentive regulation's perspective the multitask model predicts that higher-powered transport-service-quality incentives will be offered at projects that provide commercial real estate development compared with those that have residential real estate development. Given that the incentive for infrastructure service consumption (β_1) is higher in type-three contracts, the findings concerning non-transport-service offerings again are compatible with the theory even from incentive regulation's view.

3. Summary and Conclusions

The multitask-agency model of organizational form explains how interrelations among tasks determine optimal-contractual arrangements. Specifically, tasks can be related through demand effects, covariation in uncertainty, or through the cost-of-effort function.

The most important predictions of the theoretical model are as follows. First, when transport service consumers view the output of tasks as complementary, CEOs should be given lower-powered incentives from the Board and higher-powered incentives from the Government. Indeed, the increased effort that accompanies a high incentive shifts out demand and results in a higher infrastructure rate/fare. When activities are complementary, implying that cross-price effects are large, the higher transport service rate/fare dampens secondary revenues. For government, to encourage efforts allocated to primary transport service, less complementary second activity should be discouraged.

Second, when uncertainty across tasks is highly correlated, CEOs should also be given lower powered incentives. Indeed, a positive relationship increases the CEO's risk and therefore her need for insurance. A negative relationship, in contrast, is a source of risk diversification. From incentive regulation perspective, higher-powered incentive should be given when the relationship is positive and lower when it is negative.

These are the general predictions. With respect to the empirical application, they translate into the following. For projects that are operated under separated monitoring, from Board's perspective, incentives should be higher powered if the second activity is a residential real estate development and not a commercial. This is true because transport-service and commercial real estate development are more complementary. Moreover, when one contrasts single and multiple-task projects, it is likely that incentive for transport service will be higher if the second activity is a residential real estate development but not if it is a commercial real estate development. However, incentive regulation should be lower powered if the second activity is a residential real estate development and not a commercial. This is true because transport-service and residential real estate development are less complementary. And, when one contrasts single and multiple-task projects, it is likely that incentive regulation for transport service will be lower if the second activity is a residential real estate development but not if it is a commercial real estate development. All of these predictions are confirmed by the data.

The transport infrastructure market is an ideal laboratory for testing the model. Transport infrastructure marketing is a relatively homogeneous activity and, within the high-service-density area, monitoring difficulties are reduced. Moreover, most government's regulatory incentives are for transport service consumption only; CEOs are partially residual claimants with respect to secondary activities. In spite of this uniformity in the primary task, the variation in transport-service consumption contracts is large. I find that a substantial fraction of this variation can be explained by the characteristics of the outside activity. Furthermore, in no case is a theoretical prediction contradicted by the evidence.

The formal tests are based on a particular modification of the Holmstrom and Milgrom (1991) model. Nevertheless, they lend informal support to other agency model predictions. For example, the empirical analysis confirms the prediction of Holmstrom and Milgrom (1994) that piece-rate incentives, agent ownership, and freedom to engage in outside activities go hand in hand. Indeed, compensation for type-three-incentive CEO is output based, the CEO directly control the concession and own the information, and she decides how to divide her effort between tasks.

The agency model above is very stylized and neglects a number of aspects of contract choice. For example, due to data limitation the model is static, whereas the real agency relationship is repeated and contracts is renegotiable. There is therefore no room in the model for reputation formation which could be important for government's decision on subsidization and regulation and board-of-directors' decision on financial contracting. Also, couple driving forces from CEOs' implicit incentive are not included. These are especially important for some CEOs in private franchise who does not view profit as the only operation goal. In addition, the transport service market is assumed to be monopolistic and strategic behavior is excluded. In spite of its simplicity, however, the agency model performs well in explaining many of the empirical regularities found in private investment of transport infrastructure.

Chapter 5 Summary of Work and Ideas for Future Research

The objective of section 5.1 is to summarize chapters one to four with special attention on what we believe are contributions to financial-agency research on private provision of transport infrastructure. As this study was conducted, several areas needing further research (to make this analysis more robust) became apparent. In section 5.2, ideas for future research are discussed.

5.1 Summary of Work and Contribution

In chapter one the research objective presented was to uniquely combine the topics of infrastructure delivery, financial-agency theory, and executive compensation to analyze the financial-contracting process between the CEOs and principals, who are taking control and intervention of a transport infrastructure as it is privately provided. In earlier research by others looking at public- versus private-delivered infrastructure, a dichotomy emerged between whether private investment leads to improved efficiency. One group argues that shifting new infrastructure control to the private sector (through private investment) is the catalyst needed to transform an infrastructure into an efficient operation.

Others argue that promoting competition, both from domestic and international concerns, and exposing the franchise to market forces will encourage greater efficiency. The bridge that links both schools is incentivization, which means to create incentives within an organization to operate more efficiently. In our analysis of the financial-contracting process involving the CEO and principals of a private-delivered infrastructure, issues on negotiating an efficient contract were critically examined.

A premise used in this study is that one of the most important tasks at the time of infrastructure delivery is likely to be the development of a viable relationship among CEOs, the Board of Directors, and the Government. In our study, agencies with multiple-tasks and multiple-principals in transport infrastructure provision will have lower-powered incentives and are subjected to constraints on their behavior. The power incentives can be restored if a constitutional rule in infrastructure delivery can restrict each principal to base principal's incentives only on the dimension of the agency's tasks that is of direct concern to him. Therefore, the CEO has to devote himself to the bonding activities associated with the solidification of this relationship.

The core contribution made in this study is contained in chapters three and four. Recognizing the lack of homogeneity between cases of private delivery (even within the same country), we identified and codified the important facets to the financial-contracting process between the executives (specifically, the CEO) and principals in private investment of transport projects. The private investment of a transport infrastructure creates a unique set of circumstances that affect (among others) the CEO and call for dynamic adjustment of the incentive scheme offered, to achieve his cooperation.

The CEO Problem was dissected into two problems--one of adverse selection and one of moral hazard. The problem of adverse selection is: "Who should the CDO be, given that a candidate for CEO holds private information about himself that (if the Board and the Government had this information) could have an effect on their selection?" The problem of adverse selection exists because the above principals do not have complete information on the candidates for CEO. This information asymmetry could, for example, lead principals to overestimate the CEO candidates' value to the project, resulting in their selection of one over (perhaps) more-qualified managers. Other facets of the adverse-selection problem that exist under the private delivery scenario were discussed in this study.

The second problem, which is one of moral hazard, is: "What financial contract should be offered to the CEO to provide the incentives necessary for him to perform most efficiently and effectively?" In moral-hazard models a manager's effort or action is explicitly specified as a determinant of output. Unlike individuals who are assigned specific tasks, a manager's "output" might not correlate at all closely to his effort. How the CEO allocates his effort during a private delivery might (arguably) be more important than the amount of time he devotes (overall). How should the CEO allocate his effort with a private delivery? While our analysis did not specifically answer this question, it did illuminate the relevancy of this question-particularly at the time of an infrastructure's delivery when the development of a relationship between the franchise and the principals begins.

This research views the development of the above relationship through a financial-agency paradigm. The incentives that are incorporated into the financial contract should (implicitly) motivate the CEO to give these areas of agency the needed attention. How effort is allocated between the primary and secondary activities is an important facet of the CEO Problem. The CEO's priorities over these tasks do not coincide with those of the Board and the Government, perhaps because they require different qualities of effort, or because different tasks have different values to her in terms of its original mission. In any case, the principals must devise an incentive scheme to alter the effort allocation of the agent. The choice will depend on the degree of observability of different inputs and outputs, as well as on the differences in values between the two parties.

The model specified for the CEO's utility assumes that he will make his decision as to how hard to work based on expected wealth and expected variance in wealth. The use of expected variance in the utility specification for a CEO involved in a private investment in transport project is a contribution to the infrastructure delivery literature. The important implication is that a CEO's utility will be reduced (the reduction will depend on how the CEO adjusts his expectations for variance in wealth) during private delivery, if the CEO is exposed to greater uncertainty.

In the mathematical form, we uniquely integrated multitask agency and common agency into our modeling. The outcome could be simplifies as: the equilibrium with n principals is exactly as if there is just one hypothetical principal with an objective function that is the sum of all the separate principals' objectives, but the agent's risk aversion is multiplied n-fold. Remember that the more risk averse the agent, the lower the power of the incentive scheme. Thus, the Nash equilibrium incentive scheme with n principals has, roughly speaking, only *(1/n)*-th the power of the second-best scheme that would be offered by one truly unified principal.

The low power of the incentives in turn makes the second result of Holmstrom and Milgrom (1994) even more important. The agent's efforts may often be influenced better by prohibiting some activities than by rewarding others with conventional marginal incentives.

One must distinguish different levels of efficiency in the outcomes. The hypothetical ideal with observable efforts and Coasean bargaining between all principals and the agent would be the first-best. Respecting the information asymmetry but allowing all principals to get together and offer a combined incentive scheme would give the second-best. If the principals cannot be so united, their Nash equilibrium is in general a third-best (see Bernheim and Winston 1986 for the exact relationships among these). In these formal terms, the result above says that the third-best outcome that is achieved has very low-powered incentives.

To do better than the Nash equilibrium, one would have to allow some explicit cooperation among the multiple principals. This may not be feasible in the context of franchised infrastructure's day-to-day interaction; but we may be able to think of some improvements. One such device would restrict each principal to basing his incentive scheme only on the dimension of the CEO's effort that is of primary concern to that principal, and would prohibit any attempts to penalize the CEO for efforts in other dimensions. In the example above, this means that the Board cannot condition his payment to the CEO on the output of quality-producing nor the Government on that of profit-making. This could be done by preventing each from observing the other's outcome, or forbidding each to act on any such observation. Now each principal, in order to attempt to induce the CEO to put more effort into task that concerns him (principal), offers a higher-powered incentive scheme. In the resulting equilibrium, the overall incentives scheme is actually higher power than the one that would be offered by a single unified principal who aggregates the interest of the Board and the Government.

After chapter three's careful analysis of the facets of financial contracting, in chapter four ideas were presented to illustrate how an empirical analysis of all franchise might be conducted to uncover evidence that conveys information as to what changes were actually made to executive remuneration during private delivery. The most important predictions of the theoretical model are as follows. First, when transport service consumers view the output of tasks as complementary, CEOs should be given lower-powered incentives from the Board and higher-powered incentives from the Government. Indeed, the increased effort that accompanies a high incentive shifts out demand and results in a higher infrastructure rate/fare. When activities are complementary, implying that cross-price effects are large, the higher transport service rate/fare dampens secondary revenues. For government, to encourage efforts allocated to primary transport service, less complementary second activity should be discouraged.

Second, when uncertainty across tasks is highly correlated, CEOs should also be given lower powered incentives. Indeed, a positive relationship increases the CEO's risk and therefore her need for insurance. A negative relationship, in contrast, is a source of risk diversification. From incentive regulation perspective, higher-powered incentive should be given when the relationship is positive and lower when it is negative.

These are the general predictions. With respect to the empirical application, they translate into the following. For projects that are operated under separated monitoring, from Board's perspective, incentives should be higher powered if the second activity is a residential real estate development and not a commercial. This is true because transport-service and commercial real estate development are more complementary. Moreover, when one contrasts single and multiple-task projects, it is likely that incentive for transport service will be higher if the second activity is a residential real estate development but not if it is a commercial real estate development. However, incentive regulation should be lower powered if the second activity is a residential real estate development and not a commercial. This is also true because transport-service and residential real estate development are less complementary. And, when one contrasts single and multiple-task projects, it is likely that incentive regulation for transport service will be lower if the second activity is a residential real estate development but not if it is a commercial real estate development. All of these predictions are confirmed by the data.

The financial-agency hypotheses have not been econometrically tested for acceptance/rejection. The proxies used have not been statistically linked to the areas of conflict; e.g., the proxies used for perquisite consumption have not been shown to have a statistical link with actual perquisite consumption. Therefore, the proxies have only been analyzed qualitatively to see if they appear to be consistent with a particular conclusion.

5.2 Ideas for Future Research

Because most of the theories and empirical evidence described in chapters three and four are of a tentative nature, more research is needed for a better understanding the agency issues of private provision of transport infrastructure. The need for more theoretical development notwithstanding, this thesis has identified six empirical areas for further investigation.

I. How Changes in Risk-Preference Assumptions Change the Results?

It is not certain that shareholders and the Government of newly private-delivered transport infrastructure are less risk-averse than the executives managing those franchises. A logical extension of the analysis presented in this research would be to consider and contrast how the financial-contracting process would be affected by changing the risk-preference assumptions applied to the principals and CEOs.

II. The Effect of Regulation on Financial Contracting

Often infrastructures are regulated even it is being delivered by the private sector. There are at least two regulation schemes that could be enacted. One would limit how much profit and promote how great the quality the franchise can generate from its operations. A second scheme would be for the regulating body to set prices and then permit the franchise to generate as much quality and profit as it can (under the price constraint). The assumption used herein is that regulation does not affect the financial-contracting process between the franchise's executives and principals. The premise behind our assumption is that regulation can affect the franchise's objective function, without altering the shareholders' underlying objective of wealth maximization and (implicit to that objective) their desire to have the executives perform as effectively as possible. Therefore, we are assuming (indirectly) the later form of regulation just described.

Very likely, though, regulation will affect financial contracting due to the constraints that the government imposes. Changes in the infrastructure franchise's objective (vis-a-vis government regulation) might, correspondingly, necessitate changes in the measures of CEO performance. A CEO compensation plan is then proposed in Appendix B for discussion.

To the extent that a CEO's remuneration is based on a set of performance standards that are consistent with imposed regulations, the CEO's incentives will partly align with the regulatory authority's objective for the franchise. This is one reason why prospective investors try to anticipate what role the government will take after an infrastructure is delivered. In the event of regulation, the delivery of an infrastructure will not yield a complete shift in control to the private sector. Further research could investigate the ramifications of regulation with respect to the financial-contracting process.

III. Consideration of Implicit Incentives

This thesis considered a profit-based private franchise in provision of transport infrastructure. However, not all CEOs in private business view profit or the other performance-related-pay as the only goal on effort allocation. Implicit incentives such as self-actualization, reputation, career concern, etc., are much more important driving forces in their daily business. This consideration should be involved in theoretical modeling and empirical study in further study.

IV. Consideration of Different Country Groups and Transport Infrastructures

Due to its data limitation, this thesis homogeneously view sample points such as countries are with the same culture and law enforcement situation and service characteristics are viewed similar in different transport infrastructures. These are not true in its reality. To identify these differences, observation based on homogenous countries and on different transport services need to be conducted.

V. Dynamic Consideration in Empirical Study

The empirical exploration of our agency model is very stylized and neglects a number of aspects of contract choice. For example, due to data limitation the empirical exploration model is static, whereas the real agency relationship is repeated and contracts is renegotiable. There is therefore no room in the model for reputation formation which could be important for government's decision on subsidization and regulation and board-of-directors' decision on financial contracting. In addition, the transport service market is assumed to be monopolistic and strategic behavior is excluded. To be empirically applied this study a dynamic framework of analysis (at its time frame and strategic interaction with the market) should be modeled.

VI. Application of this Research to Actual Private Delivery

From the practitioner's perspective, the complementary phase of this research is to explore ways to integrate the insights from this work into the day-to-day, real-life private delivery activity occurring right now all over the globe. The research herein has implied that, through this financial-agency paradigm (that has been used to analyze the issues relevant to financial contracting), an incentive contract can be struck between the CEO and principals (the Board and the Government) that will entice the CEO to behave "optimally." The implied optimal behavior for the CEO is for him (l) to consume an "optimal" amount of perquisites and to put in an "optimal" amount of effort; (2) to pursue an "optimal" level of risk in the infrastructure franchise's investments; (3) to pursue an "optimal" amount of investments. Attempting to assess what these "optimal" levels are will be a continuing objective for research using (among other theories) agency theory.

Because of the elusiveness of the set of optima suggested from the financial-agency theory, translating the insights into incentives and performance objectives is nebulous. For example, the principals cannot reward the CEO for achieving an optimal profit-quality structure if they themselves do not know what the optimal structure is. Similarly, how is the CEO to know what the optimal amount of information to release is--i.e., that amount of information that will balance the gains in the values of the transport franchise's securities with the losses that will result because of actions taken by rivals (as a response to the released information)?

Therefore, to increase the value of this research (to the practitioner), a tangible methodology for guiding the financial-contracting process in a direction that explicitly integrates the insights gleaned from viewing private delivery from a financial-agency paradigm needs to be developed.

Appendix A: Empirical Exploration Database

This appendix presents general information on BOT concession awards during 1985-2000. The data presented in Table A-1 are taken from major journals that cover BOT news or events as well as secondary sources from BOT case studies. The news sources include various issues of *Bangkok Post Economic Review, Bangkok Post Weekly Review, Construction Weekly* (now merged with *Contract Journal, U. K.), Engineering News Record, Far Eastern Economic Review, Indonesia Business Weekly, International Railway Journal, Passenger Train Journal, Public Works Financing International, Tunnel and Tunneling,* and *World Highways, etc.*

The secondary sources include (Augenblick and Custer, 1993), (Cohen, 1991), (Gomez-Ibanez and Meyer, 1991), (Tiong, 1990) and annual reports from selected projects. The descriptive format was adopted from Hwang (1995). The concession awards are group by countries. These counties are the ones having sufficient data and information good for econometric modeling. Country group 1 is those countries listed with high-income. Country group 2 is the ones marked with either upper-middle-income or middle-income. Country group 3 with either lower-middle-income or low income. Each country heading contains three pieces of information. The first is a country group classification according to the World Development Indicators (see. e.g., World Bank 2001: Appendix; Taiwan is classified by her income per capita as upper-middle-income group). The second is number of concession in each country. The third is project cost. All cost figures are converted into U. S. dollars. The figures reported here suffer from variations in different sources. When variation occurs, a news source is chosen instead of using a secondary source, a local source is chosen instead of using an international source and a larger figure is chosen in stead of using a smaller figure. Data and information from questionnaire and interview are also used in econometric modeling. There are 62 effective sample points from private franchises and 58 from the government agencies. To make the comparison on the same basis, it gives us 58 projects good for econometric modelling and parameter estimation. Table A-2 shows the database for econometric modelling.

Table A-1 Sample of Concessions Awarded in Transport Infrastructure

Project-Name	*Description*	*Lead Concessionaire (Headquarters)*	*Financial Advisor, Lead Bank*	*Project Cost*	*Year of Concession Award*
AUSTRALIA: high-income, 3 Projects, $1,060 mil (Country Group 1)					
Sydney Harbor Tunnel	1.7-mile. 35-year BOT twin-tube concrete tunnel	Kumagai Gumi (Tokyo) and Transfield Group (Sydney)	Westpac Banking Corp Ltd	$664 mil	1986
Sydney F4 Freeway	10-km. 35-year BOT toll road	Statewide Roads Pty Ltd (Sydney)	Commonwealth Bank of Australia	$180 mil	1969
Sydney F5 Freeway	14-km. 35-year BOT toll road	Interlink Roads Pn. Ltd (Sydney)	Commonwealth Bank of Australia	$216 mil	1989
CANADA: high-income, 2 Projects, $1,370 mil (Country Group 1)					
Northumberland Strait Crossing	8-mile. 35-year BOT vehicle bridge	Morrison Knudsen Corp (US). GTM Enterprise (France), and SCI Engineers & Contractors (Canada)	Gordon Capital Corp and Wood Gundy Inc	$800 mill	1993
Pearson International Airport Terminal Renmation	57-year BOT airport terminal	Lockheed Air Terminals Canada (Toronto) and Ellis-Don Inc (London)	Canadian Imperial Bank of Commerce	$570 mil	1993
FRANCE: high-income, 4 Projects (Channel Tunnel not included). $6,031 mil (Country Group 1)					
Orlyval Airport-Regional Express Rail Link Project	7-km. 30-year BOT automated light rail	Matra Transports SA. AIR INTER and the RATP (France)	Credit Lyonnais and Banque Indosuez	$225 mil	1988
Toulouse Metro Project	10-km. BOT light rail	Caisse des Depots et Consignations	Credit Local de France and Transcet	$575 mil	1988
Marseilles Prado/Carenage Road Tunnel	2.4-km 2-lane. 30-year BOT toll road	Societe Marseilles du Tunnel Prado Carenge and Societe Auxiliare	Banque Indosuez	$221 mil	1989

U. K.: high-income, 7 Projects (including Channel Tunnel), $11,062 mil (Country Group 1)

Channel Tunnel	31-mile. 55 year BOT twin-bored rail link	CTG (London) and French Manche (Paris)	National Westminster Bank, Midland Bank, Banque National de Paris, Credit Lyonnais, Robert Fleming. and Morgan Grenfell	$9,200 mil	1986
Dattford Crossing	2.87-km. 4-lane. 20-year (maxi.) BOT cable-stayed toll bridge	Trafalgar House (UK)	Bank of America, Midland Bank, Toronto Dominion Bank, Prudential Insurance Co	$310 mil	1986
Dublin Bridges	BOT toll bridge	National Toll Roads Plc	N. A.	$62 mil	1988
Second Severn Crossing	3-mile. 30-year (maxi.) BOT cable-stayed toll bridge	John Laing Plc (London) and GTM Entrepose Nanterre (France)	Bank of America and Barclavs de Zoete Wedd	$825 mil	1990
Skye Bridge	BOT toll bridge	Miller Construction (UK) and Diwydag (Germany)	Bank of America	$37 mil	1991
Birmingham Northern Relief Road	43-mile. 3-lane. 53-year BOT dual carrageway	Trafalgar House (London) and Italatat (Italy)	N. A.	$850 mil	[991
Midland Metro Line 1	20-mile. 23-year BOT light rail	Ansaldo Transporti (Italy) and Taylor Woodrow (London)	N. A.	$153 mil	1992

U. S.A.: high-income, 8 Projects, $9,619 mil (Country Group 1)

Toll Bridge Fargo	2-lane BOT toll bridge	The Bridge Corp and Municipal Develop Corp (US)	Piper. Jaffray Hopwood	$2 mil	1986

Orlando.Maglev Project	13.3 mile. BOT maglev rail	C. Itoh (Japan) and Transrapid International (Germany)	N. A.	$622 mil	1989
Virginia Dulles Greenway	14-mile. 30-year BOT toll road	Bryant and Lochnau. Brown & Root Civil (Houston) and Autostrada International (Italy)	Prudential Power Funding, CIGNA investments, John Hancock Mutual Life Insurance Inc., Barclays Bank, and Deutsche Bank	$340 mil	1990
California Mid-state Toll Road	95-mile. 5-lane. 35-year toll road	Parsons Municipal (US)	N. A.	$1,475 mil	1990
CaLifornia SR 57 Toll Road (Santa Ana Viaduct Express)	11.2-mile. 4-lane limited access (cars-only) 35-year BTO toll road	Perot Group and Greiner Engineering Inc (Texas)	N. A-	$688 mil	1990
California SR 91 Toll Road	10-mile. 4-lane. 35-ycar BTO AVI HOV/toll road	Peter Kiewit Sons' (US) and Cofiroute (France)	Citicorp, Banque Nationale de Paris and Socicte Generale	$125 mil	1990
California SR 125 Toll Road	10-mile. 4-lane. limited access 35-year BTO toll road	Parsons Brinckerhoff Quade & Douglas Inc, Fluor Daniel (US) and Transroute International (Spain)	N. A.	$367 mil	1990
Texas High Speed Rail	BOT high speed intercity rail	Morrison Knudsen Co (US), GEC Alsthom and Bombardier Inc (France)	N. A.	$6.000 mil	1991

CHILE: middle-income, 2 projects, $46 mil (Country Group 3)

Camino de la Madera	BOT toll road	N. A.	N. A.	$21 mil	1993

GREECE: upper-middle-income, 2 Projects, $2,728 mil (Country Group 2)

Rion-Andirrion Crossing	BOT toil bridge	N. A.	N. A.	$428 nul	1992
Athens' Spata International Airport	50-Year BOT airport	Hochtief AG. Flughafen Frankfurt Main AG and Schaltanlagen GmbH (Germany)	N. A.	$2,300 mil	1993

HONGKONG: upper-middle-income, 3 Projects, $1,612 mil (Country Group 2)

Eastern Harbor Crossing	8.6-km/5-km. 30-/22-year BOT road/rail tunnel	Kumagai Gumi (Japan). Paul Y Construction Co Ltd and Lilley Construcuon Co Lid (UK)	Shearson Lehman Brothers	$436 mil	1985
Tate's Cairn Tunnel	4-km. 2-lane. 30-Year BOT road tunnel	Nishimatsu (Japan). Gammon. Trafalgar House and Jardine Matheson (UK)	Bank of Tukyo, Bank of China and Fuji Bank	$276 mil	1988
Western Harbor Crossing	1.2-mile. 6-lane. 30-year BOT tunnel	Nishimatsu and Kumagai Gumi (Japan)	International Trust & Investment Corp	$900 mil	1992

MALAYSLA: middle-income, 5 Projects, $2,677 mil (Country Group 3)

North Kelang Straits Bypass	BOT highway bypass	N. A.	N. A.	$20 mil	1986
Kepong Interchange	BOT highway interchange	N. A.	N. A.	$86 mil	1986
Kuala Lumpur interchanges	BOT highway interchanges	N. A.	N. A.	$300 mil	1987
Malaysia's North-South Expressway	504-km. 30-year BOT toll road	United Engineers and Renong Group (Malaysia)	N. A.	$1,800 mil	1988
Kuala Lumpur Light Rail Project	7-mile BOT light rail	Taylor Woodrow International Ltd (UK) and AEG Wesunghouse GmbH (Germany)	N. A.	$471 mil	1992

PUERTO RICO: upper-middle-income. 2 Projects. $470.00 mil (Country Group 2)

San Jose Lagoon Toll Bridge	2.1-mile. 35-year BOT concrete toll bridge	Dragados y Construcclones (Spain) and Rexach Construction (Puerto Rico)	Paine Webber Inc	$120mil	1992
San-Juan-Rio Grande Highway	14-mile. 30-year BOT toll road	Dragados v Consuucciones (Spain) and Rexach Construction (Puerto Rico)	Buckley, Lebron Associates and Corplan Inc	$350 mil	1992

TAIWAN: upper-middle-income, 2 projects, $15,794 mil (Country Group 2)

Airport Link MRP	27-mile. 30-year BOT mass rapid transit	Archilife Int. Group (Taiwan)	Chiao-Tung Commercial Bank	$1,050 mil	1999
West Corridor HSR	260-mile. 30-year BOT high speed rail	Taiwan HSR Consortium (Taiwan)	ICBC & domestic banking group	$9,824 mil	1998
Kao-Hsiung Metro MRP	35-year mass rapid transit system	China Steel Co. (Taiwan)	ICBC & domestic banking group	$4,920 mil	2000

THAILAND: middle-income, 3 Proiects, $6,020 mil (Country Group 3)

Second Stage Expressway	20-mile. 30-year BTO toll road	Kumagai Gumi Co Ltd (Japan)	N. A.	$1,000 mil	1988
Bangkok's Blue Line (Sky Train)	23-mile. 30-year BOT elevated light rail	SNC-Lavaline International (Montreal)	N. A.	$1,820 mil	1988
Bangkok Red Line Light Rail/Toll Road Project	38-mile. 30-year BOT elevated light rail (2-lanes)/ toll road (6-lancs)	Hopewell Holdings Ltd (Hong Kong)	N. A.	$3,200 mil	1990
Bangkok's Green Line	9-mile. 2-lane. 30-year BOT light rail	Tanayong Co (Hong Kong) Parsons Brinckerhoff Ltd (US) and Acer	M. A.	$880 mil	1992

CHINA: low-income, 2 Projects, $1,763 mil (Country Group 3)

Guangzhou-Shenzhen-Zhuhai Superhighway	75-mile. 4-lane. 30-year BOT toll road	Hopewell Holding Ltd (Hong Kong)	Bank of Hong Kong and Bank of China	$1,500 mil	1987
Guangzhou Ring Road	14-mile. 33-year BOT bellway	New World Development (Hong Kong)	Bank of China	$363 mil	1992

INDONESIA: lower-income, 1 Project, $360.00 mil (Country Group 3)

Cikampek-Padalarang Expressway	29-mile. 4-lane. 25-year BOT toll road	Trafalgar House (UK) and PT Citia Lamtoro Gung Persada (Indonesia)	N. A	$360 mil	1988

MEXICO: low-income, 12 Projects, $4,732 mil (Country Group 2)

Guadalajara-Colima Highway	148-mile BOT toll road	BANOBRAS (Mexico)	BANOBRAS and Jalisco State	$125 mil	1989
Cuernavaca-Acapulco Toll Road	262-km. 14-year 8-month BOT toll road	Grupo ICA. Grupo Mexicano Desarrollo and Tribasa (Mexico)	Serfin, CAPUFE, and Guerrero State	$900 mil	1990
Monterrey-Nuevo Lareda Toll Road	171-km. 8-year BOT toll road	Viaductos de Peaje	Banco Serfin	$127 mil	1991
Zapotlanejo-Lagos Toll Road	152-km. 13.5-year BOT toll road	Constructoray Promotora Affa-Omega (Mr-xico)	Jalisco State and Banamex	$250 mil	1991
Cordoba-Veracruz Toll Road	98-km. 7-year 10-month BOT toll road	Grupo Mexicano Desarrollo (Mexico)	Comermex	$180 mil	1991
Merida-Cancun Toll Road	150-km. 17-year 8-month BOT toll road	Consorcio de Mayab (Mexico)	Bancomer	$180 mil	1991
Mazatlan-Culiacan Toll Road	292-mile. 175-year BOT toll road	ICA Group (Maxico)	Grupo Bursatil Mexicano	$377 mil	1992
Leon-Lagos-Aguascalientes Toll Road	112-km. 18.5-year BOT toll road	IASA (Mexico)	Comermex	$231 mil	1992

Tecatc-Mexicali Toll Road	151 -km. 19 6-year BOT toll road	M. H. Constructores (Mexico)	Somex	$277 mil	1992
La Tinaja-Cosoleacaque Toll Road	235-km. I5-year 11-month BOT toll road	Grupo Mexicano Desarrollo (Mexico)	Bancomer	$615 mil	1992
Cadereyta-Reynosa Toll Road	175-km. 12-year BOT toll road	Coutacminos	CBI Casa de Bolsa	$270 mil	1993
Mexico City-Guadalajara Toll Road	200-mile. 18-year 3 month BOT toll road	ICA Grupo. Grupo Mexicano Desarollo and Tribasa Freeman Fox (UK)	Lehman Brothers and Interacciones	$1,200 mil	1993

Table A-2 Database for Empirical Exploration

Project	Country Group	DENST (Thou. Pop. Per Mile^2)	HOURS Average (per day)	Average VOL (10^6 per year)	RREAL (0 = No, 1 = Yes)	CREAL (0 = No, 1 = Yes)	IREAL (0 = No, 1 = Yes)	REGU (0 = No, 1 = Yes)	RESUB (0 = No, 1 = Yes)	Contract TYPE Board's View	Contract TYPE GOV's View
Sydney Harbor Tunnel	1	4.9	24	24.3	0	0	0	0	0	2	2
Sydney F4 Freeway	1	4.5	24	26.7	0	0	0	1	0	2	3
Sydney F5 Freeway	1	4.3	24	25.4	0	0	0	1	0	2	3
Northumberland Strait Crossing	1	3.8	24	20.1	0	0	0	1	1	3	2
Pearson International Airport Terminal	1	4.2	18	32.3	0	1	1	0	0	2	3
Orlyval Airport-Regional Express Rail Link	1	5.9	18	30.1	0	1	0	1	1	2	3
Toulouse Metro Project	1	6.1	18	34.2	1	1	0	0	0	3	3
Marseilles Prado/Carenage Road Tunnel	1	5.7	24	24.7	0	0	0	0	0	2	3
Channel Tunnel	1	5.9	24	35.4	0	1	0	0	0	2	3
Dattford Crossing	1	6.3	24	31.2	0	0	0	1	0	3	2
Dublin Bridges	1	6.1	24	24.9	0	0	0	1	0	2	3
Second Severn Crossing	1	6.1	24	27.2	0	0	0	1	0	2	3
Skye Bridge	1	6.4	24	29.8	0	0	0	0	0	3	3
Birmingham Northern Relief Road	1	6.3	24	29.9	1	1	0	0	0	2	3
Midland Metro Line 1	1	5.8	24	33.4	0	1	0	1	1	2	2
Toll Bridge Fargo	1	5.9	24	31.1	0	0	0	0	0	2	3
Orlando Maglev Project	1	5.7	18	31.1	1	1	0	1	1	3	3
Virginia Dulles Greenway	1	5.8	20	27.2	1	1	0	1	0	2	2
California Mid-state Toll Road	1	5.4	24	34.5	0	0	0	1	0	2	3
CaLifornia SR 57 Toll Road	1	5.5	24	29.2	0	0	0	1	0	2	3
California SR 91 Toll Road	1	5.9	24	34.9	0	0	0	1	0	3	3
California SR 125 Toll Road	1	5.8	24	33.2	0	0	0	1	0	3	2
Texas High Speed Rail	1	5.3	18	24.2	1	1	0	1	1	2	3
Camino de la Madera	2	5.2	24	22.1	0	0	0	0	0	2	2
Rion-Andirrion Crossing	2	5.5	24	23.6	0	0	0	1	0	3	2
Athens' Spata International Airport	2	4.8	20	22.2	0	1	1	0	0	3	3
Eastern Harbor Crossing	2	6.1	24	32.4	0	0	0	1	0	3	3
Tate's Cairn Tunnel	2	5.7	24	33.2	0	0	0	1	0	3	3
Western Harbor Crossing	2	5.8	24	34.1	0	0	0	1	0	3	3
North Kelang Straits Bypass	2	4.2	24	27.2	0	0	0	0	0	2	2
Kepong Interchange	2	4.4	24	29.2	0	0	1	1	0	2	2
Kuala Lumpur interchanges	2	5.1	24	29.9	0	0	1	1	0	2	2
Malaysia's North-South Expressway	2	4.1	24	20.2	0	0	0	0	0	2	2
Kuala Lumpur Light Rail Project	2	5.5	19	29.4	1	1	0	1	0	2	2
San Jose Lagoon Toll Bridge	2	4.9	24	32.2	0	0	0	0	0	1	2
San-Juan-Rio Grande Highway	2	4.8	24	25.4	0	0	0	0	0	3	2
Airport Link MRP	2	4.9	20	22.1	1	1	0	0	0	4	3
West Corridor HSR	2	4.7	18	30.7	0	1	0	1	1	4	3
Kao-Hsiung Metro MRP	2	5.7	18	28.2	1	1	0	1	1	2	3
Second Stage Expressway	2	5.1	24	26.8	0	0	0	0	0	2	2
Bangkok's Blue Line (Sky Train)	2	5.6	24	32.9	0	0	0	1	0	2	2
Bangkok Red Line Light Rail/Toll Road	2	5.4	24	30.2	0	1	0	1	0	2	2
Bangkok's Green Line	2	5.4	24	32.2	0	0	0	1	0	2	2
Guangzhou-Shenzhen-Zhuhai Superhwy.	3	4.7	22	19.8	0	1	1	0	0	2	3
Guangzhou Ring Road	3	5.8	22	25.3	1	1	0	0	0	2	3
Cikampek-Padalarang Expressway	3	4.1	22	16.8	0	1	1	0	0	4	2
Guadalajara-Colima Highway	3	3.8	22	22.9	1	0	0	0	0	2	2
Cuernavaca-Acapulco Toll Road	3	4.2	22	20.3	0	0	0	1	0	2	2
Monterrey-Nuevo Lareda Toll Road	3	4.6	24	24.7	0	1	0	1	1	3	2
Zapotlanejo-Lagos Toll Road	3	4.5	24	16.8	0	0	0	1	0	3	2
Cordoba-Veracruz Toll Road	3	4.3	24	18.4	0	0	0	1	0	1	2
Merida-Cancun Toll Road	3	4.1	24	23.6	0	1	0	1	0	3	2
Mazatlan-Culiacan Toll Road	3	5.2	24	20.8	0	1	0	1	0	2	2
Leon-Lagos-Aguascalientes Toll Road	3	4.8	24	22.6	1	0	0	1	0	3	2
Tecatc-Mexicali Toll Road	3	5.2	24	19.4	1	1	0	1	1	1	2
La Tinaja-Cosoleacaque Toll Road	3	4.9	24	20.8	0	0	0	1	0	1	2
Cadereyta-Reynosa Toll Road	3	5.4	24	21.6	0	0	0	1	0	3	2
Mexico City-Guadalajara Toll Road	3	5.5	24	28.4	1	1	0	1	1	1	2

Appendix B: A Proposed Framework for Deciding Compensation Plan for CEOs

In this appendix, a proposed framework for deciding managerial compensation which is designed to overcome the regulation deficiency (as discussed in section 1.2) is described. This CEO compensation plan directly rewards efficient performance, at least as we have defined. The objective of this framework is to induce the most efficient performance possible from CEOs in order to have prices or rates as low as possible. It may not operate in the Board of Directors' interest, a subject to which we will return later, so it is quite possible that the Government may have to impose it upon the regulated transport franchises.

1. Proposed Compensation Scheme

In this subsection I provide a detailed description of a proposed framework for deciding CEO's compensation plan. Since the ultimate objective is the lowest possible rates, it seems reasonable to use the level of rates and/or the change in rates over time as a primary determinant of the level of compensation paid to CEOs.

The proposed CEOs' compensation plan changes the basic structure of remuneration so that some portion of remuneration is contingent upon acceptable performance. Put most simply, better performance (as measured by lower rates) will mean higher remuneration, and poorer performance (higher rates) will result in lower remuneration—with the linkage between performance and remuneration established a concrete, predictable manner.

The linkage between remuneration and rates of performance needs to be carefully considered. Several principles are important. First, we do not want to penalize the CEO of the franchise for factors beyond their control, such as changes in the demographic structure of commuters which cause their costs (and thus their rates) to increase and we do want to encourage efficient long-term behavior.

A performance index will be calculated for each franchise based upon the franchise's level of average prices or rates (average revenue) compared to a group of similar firms and based upon the change in the franchise's average rates over time compared to the change in rates for a group of similar firms. There are literatures that support the use of comparisons of groups of firms in designing incentive compensation plan. Several theoretical papers (Holmstrom 1994 and Lazear and Rosen 1981) have developed the principle that if firms' economic environments are correlated (for example, they have similar input prices), then managers in theses firms should be rewarded in accordance with other managers' performance as well as their own. Hart (1995) has shown in a rigorous manner that competitive, unregulated markets will provide nearly perfect incentive systems for management. He shows that the actions of CEOs in firms that are otherwise independent will still become interdependent through prices in competitive industries.

We will discuss the selection of the comparable firms later in this appendix; we turn now to the development of the performance index. To begin with we need to calculate the average rate or average price for each compared firm to which the CEO compensation plan is applied. To simply illustrate the proposed framework, most of the firms that are price or profit regulated can adequately be characterized for our purposes as single output firms. For example, while high-speed rail franchises do sell their output to different classes of customers (economic and business), there is a single measurable unit of output—a passenger-mile. The average price or average fare would simply be calculated by dividing the firm's total revenues by the total number of passenger-miles consumed during the year.

The performance index would then be calculated as follows:

$$P_I = \begin{cases} F_l * 1/3 + F_c * 2/3 & if\, R \geq R_g\, mean \\ F_l * 2/3 + F_c * 1/3 & if\, R \leq R_g\, mean \end{cases} \qquad \text{(B-1)}$$

The choice of the fractions *1/3* and *2/3* in above equation is a matter of judgement. The objective is to place greater weight on the change factor for those firms which have very little opportunity to earn performance based compensation due to their high rate levels, and vice versa. *1/4* and *3/4* could have worked as well; the choice of these particular fractions is an example of wholesomely arbitrary decision.

If the franchise's rates are above average ($R > R_g$ *mean*), the performance index will place a greater weight (*2/3*) on the change factor, which is described below, and a lesser weight on the level factor. Thus, franchises which begin the program with relatively high rates have a greater opportunity to earn a good performance rating (and thus high remuneration) if they improve substantially relative to their group, since the change factor in that case will be a large number. On the other hand, we do not want to penalize a franchise that has extremely low rates to begin with by placing a great deal of importance on the change in their rates relative to some comparable group, since they are already doing as well as possible. For franchises that have rates below the average level of rates for the comparable group, a greater weight is placed upon the level of their rates, and a lesser weight is based upon the change in the level of their rates.

The factors F_l and F_c are determined according to a comparison of the franchise's rate level and rate changes with those of its group. If the franchise compares relatively well, its factor will be positive and large; if the franchise's performance is average, its factor will be one. A poor performance on either rate level or rate change can result in a factor that is close to zero.

To calculate F_c, the change factor, we must first calculate the average level of rates, R_t for the franchise for the first couple years (assumed five years in this proposed plan) prior to year *t*. We must also claculate the five-year average rate level for the group of comparable firms (average over the firms and the five years prior to year t), R_t^g. With these in place, and utilizing the average rates in year *t* for the franchise, R_t, we can calculate the change in rates for the firm in year *t* relative to its five-year average as follow:

$$\Delta R_t = [(R_t - R_t^5)/R_t^5] * 100 \tag{B-2}$$

This gives the percentage change in rates in year t relative to the five-year average for the firm. This same calculation is made for all members for the franchise's group, ΔR_t^g, excluding the firm itself. The change factor F_c is then determined from figure B.1. If the franchise's change in rates has been at an average level, that is, if the quantity ΔR_t - ΔR_t^g is zero, the change factor (F_c) will be 1.0.

The formula for F_c is as follows:

$$F_c = \begin{cases} 0 & \text{if } \Delta R_t - \Delta R_t^g \geq 5, \\ 2 - (\Delta R_t - \Delta R_t^g + 1)^{.3867} & \text{if } 5 > \Delta R_t - \Delta R_t^g \geq 0, \\ \left| \Delta R_t - \Delta R_t^g - 1 \right|^{.3867} & \text{if } 0 > \Delta R_t - \Delta R_t^g \geq -5, \\ 2 & \text{if } \Delta R_t - \Delta R_t^g \leq -5. \end{cases} \tag{B-3}$$

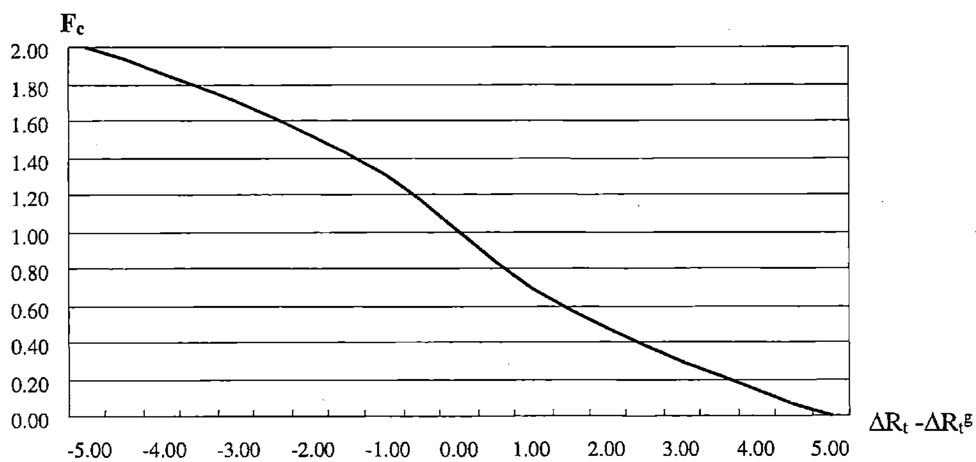


Figure B.1 Change Factor and Relative Rate Change Performance

Since the change in rates for most firms will be near the average, most firms will cluster near the ΔR_t - ΔR_t^g = 0 point. We want infrastructure franchise to see a large benefit for improved performance. Therefore, the payoff to improved performance when a franchise is near the group average is substantial. The franchise which is far from the mean still see a benefit from improved performance, though the amount of this benefit is reduced. Franchise whose percentage change in rates exceeds the average by more than five points will have change factor of zero: they will receive no compensation increment reflecting change in rates. Franchise whose rate changes by five points less than the average (or less) will receive the maximum amount. Of course, the choice of five percentage points as the reward cutoffs is a matter of judgement and could easily be modified. Also, this relationship of change factor to performance could be linear if the government/regulatory agency wishes to reward improvements proportionately.

In designing the rate level factor F_l, we want to reward good long-term performance and avoid possible adverse incentives that would have the franchise CEOs postpone needed maintenance or investment in order to achieve a higher bonus in any one year. As a result we base the rate level factor on the five-year performance of the franchise relative to its peer group. First, we calculate the franchise's average rates over the most recent five-year period, including the current year t, as R_{τ}. The same operation is performed for the comparison group, and the result is R_{τ}^{g}.

We then from the percentage difference in rate levels (ρ_t) as follows:

$$\rho_t = (R_{\tau} / R_{\tau}^{g} - 1) * 100$$

ρ_t is the percentage amount by which the franchise's rates exceed (positive ρ_t) or are less (negative ρ_t) than the group team. The franchise's level factor is then determined from figure B.2. As can be seen, if the franchise's rates are below the average rate for its group, the rate level factor (F_l) will be greater than one. The formula for the determination of F_l is:

$$\begin{aligned} F_l &= 0 && \text{if } \rho_t \geq 5, && \text{(B-4)} \\ &= 2 - (\rho_t + 1)^{.3867} && \text{if } 5 > \rho_t \geq 0, \\ &= \left|\rho_t - 1\right|^{.3867} && \text{if } 0 > \rho_t \geq -5, \end{aligned}$$

$= 2 \qquad\qquad \text{if } \rho_t \geq -5.$

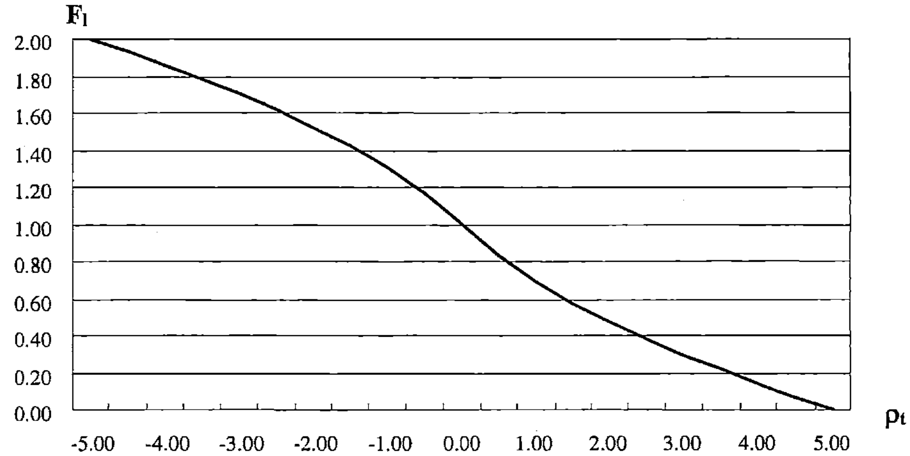


Figure B.2 Level Factor and Relative Rate Level Performance

The performance index is then calculated in accordance with formula (B-1). Since each factor (F_c and F_l) has a maximum value of two, the performance index also has a maximum value of two. The minimum performance index is zero, and the management of an average should receive a performance rating of one.

It is entirely feasible to have the entire remuneration of the CEOs determined by this performance factor. Such a plan would, however, place a great deal of risk upon the CEOs of the franchise, and it would probably by rather difficult to attract individuals to bear such risks. Indeed, Shavell (1979) has shown rigorously that if managers in a firm are risk averse, a Pareto optimal fee schedule will pay an amount which will depend upon their performance to a certain degree, but that they will not bear the entire risk of poor performance of the firm.

In addition to a performance-related portion of the compensation, there should be therefore a portion of the base salary that is not directly performance related. This latter fixed amount should be adjusted so that the expected compensation (for the average CEOs) should be somewhat higher with proposed management compensation plan than in the present fixed cases. This upward adjustment in expected compensation is reasonable since the CEOs is being required to bear somewhat more risk in his or her primary income under the performance-related remuneration system that under the free market system. In order to leave the CEOs at least as well off as in free market, a risk averse individual will require an increase in expected compensation.

2. Selection of the Control Group

The selection of an adequate control group is probably the most difficult and controversial aspect of this proposal. These groups should be selected so as to minimize an undesirable aspect of any performance compensation: one should attempt to eliminate factors over which CEOs has no control, but which materially affect costs and, thus, rates.

Starting this criterion slightly differently, we want to group firms together which have a high correlation of economic environments with each other. The more highly correlated are the economic environments, the more confident we can be that management practice is responsible for better performance within the leading firms. Indeed, if two firms are subject to identical exogenous influences, including input prices, customer/location density, et cetera, then rate levels will differ only because of different management abilities.

If we were to design a program to deal with transport infrastructures, we would need want to include factors such as:

- Average load factor;
- Tax levels;
- Local environment requirements;
- Proportion of services to commuting, business, freight, recreation customers;
- Density of location/commuters;
- Total capacity;
- Historical demand growth; etc.

A statistical technique, such as factor analysis or principle components analysis, could be used to group these factors (and any others which the Government/Regulator Agency might wish to adopt) into a manageable set of explanatory variables. These explanatory variables could then be used, with a technique such as cluster analysis, to place firms into group subject to similar economic environments. Cluster analysis is a widely used analytical technique for grouping objects by observed attributes. Following this statistical procedure, the Government/Regulatory Agency would certainly want to use some seasoned judgement on whether the outcome appears to be reasonable with respect to its objectives.

Whether or not this grouping can be accomplished to everyone's satisfaction is highly doubtful. Indeed, we would forecast that this procedure would become the focal point for those who do not wish to see CEO compensation program of this sort adopted. However, we caution policy makers to avoid what Demsetz (1969) calls the "nirvana approach to public policy", that is, asking whether a particular arrangement is perfect (in this case a clustering technique). The question is not whether a perfect technique can be developed, but whether a set of incentives (including the clustering technique) can be developed which dominates the traditional set of incentives.

3. A Comparison with an Alternative

There are a number of possible ways to reward franchise's increased efficiency. One of the most frequently made proposals is allow a higher return on equity capital if the franchise has lower operating costs (or average rates) and a slightly lower return on equity if the firm performs poorly. There are two reasons why we favor a management compensation plan as an incentive for economic efficiency. Rather than a plan which rewards and penalizes stockholders, especially when the equity stock of the franchise is held by a widely dispersed group of owners as it is in the United States.

The first advantage of CEO compensation plans over increased return on equity stockholders is their immediacy. We are asking CEOs (or executive management team), not stockholders, to undertake drastic changes in the way franchises are managed. Furthermore, we would like to attract better management to the task of running the franchise (and managers of regulated franchises are relatively poorly paid). Both of these goals are best served by having variable (and, on average, higher) compensation paid to CEOs. Of course, if stockholders were able to agree amongst themselves and react to possible higher returns with no frictions or lags, the possibility of higher returns on equity from more efficient performance would bring forth a similar response. The problem is that while stockholders do, of course, favor higher returns, the linkage between a bonus return on equity and hiring more efficient CEOs is tenuous.

The second, and more important, reason why CEO compensation programs are preferred is the cost involved with the respective rewards, costs which are necessarily provided by the customers of the infrastructure franchise. Because most of the regulated transport franchises are very capital intensive, it is much less costly to provide a high percent increase in numeration of the CEOs than it is to provide an increase after tax return on equity of a low percent as a reward to superior performance. Due to limitation on empirical data in transport industry, we cite an example from the New York State Electric and Gas Company (NYSE&G) providing electricity and natural gas service to Ithaca, New York. The book value of common equity capital for NYSE&G in 1997 was $443 million. If the company were to be rewarded for superior efficiency with a 1 percent increase in the return on the book value of their equity capital, assuming a marginal corporate income tax rate for NYSE&G of 46 percent, the regulatory commission would need to allow, at most, increased earnings of $8,204,000 to reward greater efficiency.

An alternative to awarding greater efficiency with higher returns on equity is to reward the better performance with higher remuneration for the CEOs. If the regulatory commission were to put a compensation plan in place for the remuneration of CEOs of NYSE&G, and if the commission were to allow a maximum performance related remuneration of 35 percent of the total base remuneration of this upper management level, the size of the funds available to be distributed would be, at most, $194,763. It is, of course, not possible to determine if this performance related remuneration of 35 percent is equivalent in its incentive creating effects to a possible increase in return on equity of 1 percent to the stockholders. However, even if they are not exactly equivalent, it is quite clear that the CEO compensation plan is much less costly. Indeed, the maximum cost of the CEO compensation plan is only 2.4 percent of the maximum cost of the stockholder compensation plan.

4. Principal-Agent Conflicts

As described in section 1.2, in private provision of transport service, governments have currently structured regulations so that the CEOs serve the stockholder principals (the board of director for their representative), while not necessarily serving the interests of the customer principals (the government and its regulatory agency as representative), at least with regard to the level of rates/fares and economic efficiency. In proposing the incentive contract it is likely that we have created a possibility for a schizophrenic group of CEOs: serving two principals with two different objectives. Is it possible that we can solve this dilemma?

One approach would be simply wait and see if a conflict arises. Another would be to have the board of directors (who are clearly representatives of the stockholder principals) present the portion of the rate cases that deal with the rate of return on equity, and have the CEOs represent all other portions of the rate cases. The board of directors would then hire counsel and rate-or-return witnesses who would argue for as high a rate of return as possible before the regulatory commission.

A third approach would be reasonable if and only if the regulatory commission believes that the CEO remuneration program resolves all incentive problems for efficient management. If that is the case, there is no reason to continue with the present structure of rate cases every twelve to twenty-four months and no reason to retain the regulatory lag incentive for efficient performance. If all incentive problems are resolved, we should then just allow the franchise to recover all of its costs through what is essentially cost plus regulation.

A plan that would accomplish this form of regulation would be to have the franchise provide evidence, such as audited accounting reports of its cost over a recent past period (for example, the last twelve months), periodically to the government, perhaps every three months. The government could then set rates so that if costs continued at their past level, the franchise would earn a predetermined allowed rate of return. This allowed rate of return would be set through some straightforward formula at an estimate of the franchise's cost of capital.

A procedure such as this was adopted in New Mexico. The Public Service Company of New Mexico (PNM) provided quarterly audited financial statements showing the rate of return earned over the previous twelve months. In calculating this rate of return, PNM used the actual costs. For revenues PNM calculated what the total revenues would have been over the last twelve months under the assumption that the most recent rates were in effect for the entire period. This calculation assumes a zero elasticity of demand for the quarterly rate change. If the rate of return was less than 13.5 percent, rates are adjusted upward so that, were the new rates in effect for the previous year, the rate of return earned would have been 13.5 percent. If the rate of return on equity were greater than 14.5 percent, then rates were adjusted downward so that the rate of return earned would have been 14.5 percent. If the rate of return was between 13.5 percent and 14.5 percent, no adjustment was made.

The Public Service Commission adopted this mechanism for several reasons. By adjusting rates every quarter, and by adjusting them up to a minimum rate of return at 13.5 percent, the Commission felt it was reducing the risk borne by PNM stockholders and, thus, the cost of capital incurred for the construction of new infrastructure. The rate of return band (13.5 – 14.5 percent) was adopted to give CEOs an incentive for efficient operation. As long as the rate of return did not rise above 14.5 percent, CEOs could keep the proceeds of productivity savings. Finally, the Commission felt that transaction cost or "the tyranny of the rate cycle" would be reduced under this proposal, and its staff would then have much more time to investigate other more important manners.

We can learn several things from New Mexico's experience and put them into our incentive design in transport services provision. First, in a period of continuous inflation, an adjustment that always looks at past experience to estimate current costs will always underestimate those costs. As a result the firm will never quite earn the minimum allowed rate of return (13.5 percent) chosen by the commission as reasonable, always being one or two percentage points behind. This experience could be easily corrected by adding an incremental amount to the allowed rate return that is larger in periods of more rapid inflation.

A second lesson to be learned is that the transaction costs saving may be illusory. If the staff of the Commission fells that it must check and recheck all of the franchise's calculations, then there will not be any reduction in workload. The staff must adopt a policy of spot-checking and relying upon the franchise' auditors, or else the "tyranny of the rate cycle" will just be increased.

The third lesson learned from New Mexico is that an automatic adjustment clause program such as this will be perceived by consumers to shift risk from stockholders of the franchise to the customers of the franchise. Changes in input prices, changes in managerial efficiency, and all other parameter changes will affect rates paid by consumers, but will not affect the return on equity to any great extent. While this is certainly true, I would argue that the customers of regulated infrastructure monopolies eventually bear all or nearly all these risks in any case. What this proposal does is to explicitly recognize that these risks are borne by customers, and it formalizes this fact. The traditional form of regulation can result in a lower rate of return on equity earned by shareholders for a short period of time if its costs rise unexpectedly (between rate cases), but, in the long run, the shareholders of regulated infrastructure franchises must be paid a rate of return on equity consistent with the risks they bear, or else the franchise will eventually go bankrupt. So the current regulatory practice will result in some short-term risk being borne by shareholders, but in the long run, all risks and nearly all costs must be eventually paid by consumers.

If the CEO incentive program proposed here achieves its objectives, rates will be lower because franchises are more efficient. In addition, the lower risk resulting from the automatic price adjustment mechanism faced by investor-owned firms should result in lower costs of equity capital. For both reasons, rates or prices should be lower.

5. Concluding Remarks

Productivity and efficiency seem to be topics that are currently receiving greater and greater attention from business leaders, government policy makers, the legislative, and the press. In some competitive markets we can reply upon Adam Smith's invisible hand to encourage firms to be productive and efficient. However, in transport service markets which are monopolies and have prices regulated by government agencies, this invisible hand does not provide incentives for efficiency and penalties for inefficiency. In an attempt to remedy this problem, we have proposed a CEO incentive plan that offers explicit predictable benefits to successful CEOs and penalizes nonproductive or inefficient CEOs. Existing incentive plans that relate performance to rewards are generally designed to assure that CEOs, as agent of stockholders (principals), take actions to maximize the stockholders' interest. What is proposed in this appendix is the establishment of a framework in providing an incentive plan that will have transport franchise CEOs take actions to serve different principal's objectives; that different principal is the government (the representative of customer of the franchise), and the objective of this principal is lower prices or rates.

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