扬华管理科学丛书

Real Option's Application in Risk Management of PPP/PFI Projects 实物期权与PPP/PFI项目风险管理

Liu Jicai



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内 容 简 介

随着我国经济的快速发展,大型基础建设项目采用 PPP/PFI 等模式越来越多。基于传统的现金流折现的决策理论与方法存在很大的局限,而实物期权理论充分考虑项目管理中的灵活性,给项目带来资产价值增值,为正确决策提供更好的依据。本书引入实物期权理论,对 PPP/PFI 风险进行分析,并采用三个典型的案例进行实证研究。在此基础上,本书总结了 PPP/PFI 项目中存在的期权形式,并提出基于实物期权理论的 PPP/PFI 项目风险管理模式。

本书可供管理类研究生、教师、科研人员和政府相关机构决策者使用。

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欣闻西南交通大学经济管理学院在学校学科发展工程基金的资助下,出版一套管理科学丛书,我备感高兴并接受邀请为这套丛书作序。国内不乏关于管理科学的著作,但此次一次性集结同一研究机构不同研究人员近年来的研究成果以系列从书形式出版,在国内可以算是一次有益的尝试。

众所周知,管理既是一门科学也是一门艺术。管理科学重点关注于管理中科学性的一面,强调综合运用经济学、运筹学、心理学、人类学等多学科知识基础以及研究方法,探索管理中的一般性规律,发掘经过实证检验的知识,为科学管理和科学决策提供借鉴与指引。

西南交通大学经济管理学院拥有西南地区最早的管理科学与工程一级学科博士学位授权点以及管理科学与工程博士后流动站,取得了众多高水平的研究成果,在国内管理科学与工程领域产生了较大的影响。此次出版的这套系列著作,撷取了学院教师近年来的研究成果,为国内对管理科学感兴趣的研究者提供了一次饕餮大餐。

我国管理科学的研究近年来取得了较大的进步,一些研究成果开始获得国际学术界的认可并发表在国际主流学术期刊上,但我们也应看到,我们在管理科学领域和国际一流研究水平相比还有一定差距。希望以此次系列著作丛书的出版为良好的开端,涌现出更多的学术机构定期将研究人员最新的研究成果集

结成册,与同行交流分享,共同推进我国管理科学领域的研究迈向国际一流水平,并更好地满足我国经济社会持续稳定健康发展过程中对管理方法和技能的需求!

过龙的

2010年6月

Preface

Public-Private Partnership (PPP)/ Private Finance Initiative (PFI) has been a widely used scheme by government to deliver large-scale infrastructure projects, which provide public service and become an essential pillar for global economic growth (Benoit, 1995) and Private sector participation in infrastructure development has been a priority area in many developing countries' policy agenda in the 1990s (World Bank, 2003).

The application of PPP/PFI scheme gives birth to alternative project delivery methods and models such as build-operate-transfer (BOT), design-build-operate (DBO), design-build-finance-operate (DBFO), build-own-operate (BOO) and so on (Miller, 2000). BOT is perhaps the most popular model applied. Technical nuances aside, both private and public sectors adopting these models are ultimately interested in a single, most fundamental question; can the project generate sufficient return (or social benefits from the viewpoint of the public sector) commensurate with the risk implications. Financial analysis of infrastructure projects, assessed from each party's standing, would shed light on this central issue.

The current process of risk management in infrastructure projects includes risk identification, measurement, and mitigation strategies. The mitigation strategies are designed based on the evaluation of the risks of a project through conventional evaluation models. The traditional method of project evaluation in conventional capital budgeting theory adopts the discounted cash flow (DCF) technique, which results in the most commonly used net present value (NPV) and internal rate of return (IRR) approaches. Under certainty, NPV is the correct approach for project analysis. Nonetheless, there are uncertainties in a project from planning, design, construction, and up to the operating and maintenance stage. In NPV analysis, the impact of uncertainties is not sufficiently captured and appraised. The private sector participants, both lenders

and investors, would want to assess the stability of returns generated from the projects through some kind of uncertainty analysis.

Conventional evaluation methods assumed that risks bring losses to a project and lead to passive management strategies. In such models, scenarios in which the project would proceed well and generate additional revenue are overlooked. These turn-up scenarios would bring flexibility to managers of a project. Namely, traditional evaluation methods cannot capture managerial flexibilities to adapt and revise later decisions in response to uncertainties and therefore understate the value of projects by ignoring such managerial flexibility.

Real option theory has proved to be extremely useful for the analysis of many aspects of corporate finance and investment practices (April 1999). Although real options have been adopted for more than two decades in other industries such as oil and gas, real estate and many general manufacturing industries, its application in the context of construction and infrastructure systems is still in its infancy. This book aims to develop a new framework of risk management that incorporates the real option theory and that is suited to the context of infrastructure projects.

Liu Jicai March 2010

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Chapter 1 Theories of PPP/PFI and Real Option

Previous studies on Public-Private Partnership / Private Finance Initiative (PPP/PFI) and real option theory are reviewed. This chapter includes an introduction to the general features of PPP/PFI and the risk management aspects under the PPP/PFI framework. The review of real option will draw comparisons against conventional evaluation methods.

1.1 Introduction to PPP/PFI

1.1.1 Concept of PPP/PFI

The commitment to Public-Private Partnership (PPP) in large scale infrastructure projects is a common policy in countries such as China, India, Indonesia, Australia, UK, Colombia, and Chile (Ranjit and Mathrani, 1990). Nowadays, the PPP procurement is adopted popularly by government to resolve financial constraints in the provision of public facilities and services.

PPP is a key element in a government's strategy for delivering modern, high quality public services and a more competitive economy. Generally, PPPs are developed by the following three broad objectives to the government: ①to deliver significantly improved public services either in terms of the quality of services or the quantity of investments; ②to release the full potential of public sector assets to provide value for tax payers and furnish wider benefits for the economy; ③to allow stakeholders such as the users of the service, tax payers and employees in

both public and the private sectors to receive a share of benefits arising out of the PPP scheme.

There are eight types of PPPs that are identified by the UK government. These include: asset sales, wider market, sales of business, partnership companies, private finance initiative, joint venture, partnership investment, and policy partnership. Among these eight types, Private Finance Initiative (PFI) is the most popular model of PPP (Li et al., 2005).

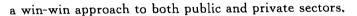
PFI is a means of using private finance and skills to deliver capital investment projects that are traditionally provided by the public sector. Instead of the public sector body directly procuring capital assets and subsequently owning, operating and regulating them, PFI generally involves the private sector owning and operating the facilities, with the public sector playing a larger role in regulating the sector (The Scottish Parliament, 1999). PFI allows the public sector to contract with the private sector to provide quality services on a long-term basis, typically 25-30 years, so as to take advantage of the private sector's management skills incentivised by having private finance or capital at risk.

In most PPP/PFI schemes, the private sector carries the responsibility and risks for designing, financing, enhancing or constructing, maintaining and operating the required assets or infrastructures to deliver product/service in accordance with the public sector's output specification. In some projects, the public sector may also pay for the project through a series of performance or throughout related payments, which cover service delivery and return on investment. Depending on the specific arrangement, the Central Government may provide payment support to public agencies (that are directly dealing with the private sector) through grants and other financial mechanisms.

Generally, projects that are clearly open to adopt PPP/PFI scheme would include infrastructure projects such as toll roads, power plants, water treatment plants and metropolitan transport systems (Mountain, 1998).

1.1.2 Advantages of Adopting the PPP/PFI Schemes

The involvement of private sector in the development and financing of public facilities and services has increased substantially over the past decade. Figure 1.1 illustrates the increasing tendency of private sector's participation in International Development Association (IDA) countries. In principle, PPP/PFI procurement is



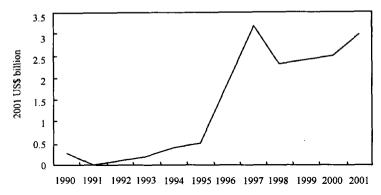


Figure 1.1 Investment in Infrastructure Projects with Private
Participation in IDA Countries, 1990—2001
Source: World Bank PPI Project Database (2003)

First, PPP/PFI relieves the government of a substantial proportion of public debt. Generally, financing of PPP/PFI projects is arranged partly or sometimes completely by the private sector and the government does not play a main and direct role in such financing matter. Through the PPP/PFI scheme, the government does not need to provide funds for these projects, while it has still found an avenue to provide public services to its people.

Second, PPP/PFI procurement is acceptable to both public and private sector participants because the financing can be recovered from the cash flows of the project itself. In some arrangements, the public funding or the debt cannot be secured in a form of a non-recourse arrangement. Non-recourse project finance is an arrangement under which investors and creditors financing the project do not have any direct recourse to the sponsors, as might traditionally be expected (for example, through loan guarantees) (Dejan et al., 2006). Generally, at the end of the concession period, the ownership of the project would be transferred back to the government without payment.

Third, some researchers suggest that PPP/PFI schemes encourage private sector commercial efficiency to replace public sector bureaucratic inefficiency (Hambros, 1999). It is therefore reasonable to expect that the total life-cycle cost of the project can be reduced.

Fourth, both the public client and the private contractor would have more freedom to select innovative methods in the provision of assets and services in the PPP/PFI procurement method (Li et al., 2005). This should lead to time saving by accelerating project development and by avoiding delays in project delivery (Downer and Porter, 1992; Hall, 1998; Utt, 1999).

Last but not least, at the international level and particularly in developing countries, PPP/PFI is seen as attractive in terms of its capacity to achieve the transfer of technological knowledge to local enterprises.

In summary, to the government, PPP/PFI procurement can enhance its capacity, bring innovation in delivering public services, reduce cost and time of project implementation, and proper transfer of major risks to the private sector in order to secure value for money for the taxpayers. From the private sector's viewpoint, they perceive the PPP/PFI market as providing a broader base of business opportunities in which they could possibly make some profits by utilizing their management skills and technology.

1.1.3 Structure of PPP/PFI

As formerly mentioned, some degree of privatization has become a common trend in the development of large-scale infrastructure projects. This has come in different forms of private sector participation models such as build-operatetransfer (BOT), build-own-operate (BOO) and build-own-operate-transfer (BOOT) type of concessions (Thomas et al., 2003). Firstly, although only public sectors and private sectors are mentioned in PPP/PFI in the previous section, there are indeed many parties involved in these infrastructure projects and each party will try to protect their own benefits in the project. Secondly, an infrastructure project generally involves a huge amount of investments and a lengthy contractual period, which will make it more difficult to predict the uncertainties and take action to deal with uncertainties. Finally, many infrastructure projects are designed and initiated to serve public interest and promote social benefits. As such, it is often subject to public's scrutiny; hence the political sensitivity of the project. As a result, PPP/PFI projects are more risky than most projects that are delivered using the "conventional" modes (such as Design-Bid-Build and Design-and-Build).

Some parties who are typically involved in a privately financed infrastructure project are shown in Figure 1. 2. Although the actual contractual arrangement varies from project to project, one common key issue for all parties concerned-

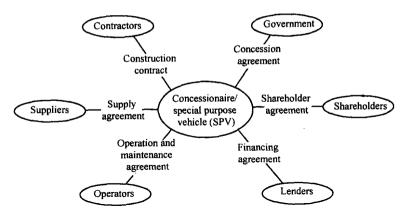


Figure 1.2 Typical Participants in A Privately
Financed Infrastructure Project

government, shareholders, lenders, contractors, suppliers, and operators, is to assess the risks and uncertainties inherent in the project from their respective standpoint.

1.2 Risk Management Aspects of PPP/PFI

1.2.1 Process of Risk Management

Risks and uncertainties are embedded in all PPP/PFI projects. Risk management is a process which enables the analysis and management of risks associated with a project. If risks are managed realistically, the process will increase the likelihood of success of a project. Risk management is not a "once and for all" activity; it should be applied continuously throughout the lifecycle of a project (Thompson and Perry, 1992). A systematic approach to risk management is based on three sub-processes: identification, analysis and risk management strategy (Raftery, 1994). Tiong and Ye (2000) developed an integrated risk management framework of private financed infrastructure projects (as shown in Figure 1.3). The core of this framework is risk control, and the key of risk control is risk allocation. The framework presents four risk control strategies followed by concession design through which all would-be risk-bearers would achieve their trade-offs between risk and return.

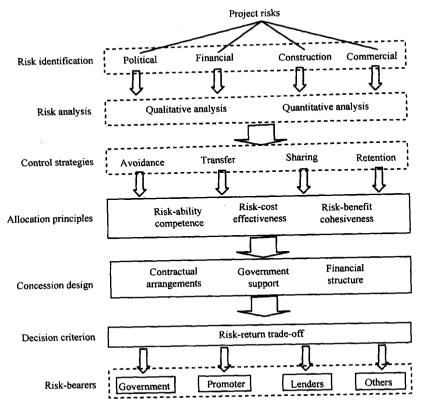


Figure 1. 3 Conceptual Integrated Risk Management Framework
Source: Tiong and Ye (2000)

1.2.2 Risk Identification and Categorization

One method of risk identification is the development of a risk checklist (or catalogue). Generally, the checklist includes a set of Critical Success Factors (CSFs), which are simply defined as key areas of activity for a manager to reach goals (Rockart, 1982). This method has been applied to analyze risks in construction management (Yeo, 1991; Sanvido et al., 1992). Tiong (1996) also analyzed the CSFs for private contractors in competitive tendering and negotiation in BOT projects.

While the growing number of literature on identifying and analyzing construction project risks provide a useful background, it is also important to focus on risk classifications that are specific to PPP or BOT scenarios. For risk categorization, the works of Li et al. (2005), Wang and Tiong (2000) are

regarded as insightful. Their works are reviewed in turn.

Li et al. (2005) proposed a metaclassification approach on the basis of three levels of risk factors for PPP/PFI projects. These three levels comprise: macro level risks, meso level risks and micro level risks (Table 1.1).

Table 1.1 Categorized Catalogue of PPP/PFI Project Risk Factors

Risk meta-level	Risk factor category	Risk factor
Macro level risks	Political and	Unstable government
level risks	government poncy	• Expropriation or nationalisation of assets
		Poor public decision-making process
	Ì	Strong political opposition/hostility
	Macroeconomic	Poor financial market
	(Inflation rate volatility
		Interest rate volatility
		Influential economic events
	Legal	Legislation change
		Change in tax regulation
		Industrial regulatory change
	Social	Lack of tradition of private provision of public services
		Level of public opposition to project
	Natural	Force majeure
		Geotechnical conditions
		• Weather
		• Environment
Meso	Project selection	Land acquisition (site availability)
level risks		Level of demand for project
	Project finance	Availability of finance
		Financial attraction of project to investors
		High finance costs
	Residual risk	• Residual risks
	Design	Delay in project approvals and permits
		Design deficiency
		Unproven engineering techniques

(Continued)

Risk meta-level	Risk factor category	Risk factor
	Construction	Construction cost overrun
		Construction time delay
		Material/labour availability
		Late design changes
		Poor quality workmanship
		Excessive contract variation
		• Insolvency/default of sub-contractors or suppliers
	Operation	Operation cost over-tun
		Operational revenues below expectation
		Low operating productivity
		Maintenance costs higher than expected
		Maintenance more frequent than expected
Micro	Relationship	Organization and co-ordination risk
level risks		Inadequate experience in PPP/PFI
		 Inadequate distribution of responsibilities and risks
		Inadequate distribution of authority in partnership
		• Differences in working method and know-how between partners
		Lack of commitment from either partner
	Third party	Third party tort liability
		Staff crises

Source: Li et al. (2005)

The macro level of PPP/PFI risks comprises risks which are external to the project. This level is generally related to the nation's or industry's environmental or "natural" risks, such as the political and legal conditions, economic conditions, social conditions and weather. The effect of these risks is that, although they occur beyond the system boundary of a project, the consequences will influence the outcomes of the project.

The meso level of PPP/PFI risk includes risks such as risk events (and their consequences) that occur within the system boundaries of the project. These include problems of implementing the PPP/PFI framework, involving issues such as project demand/usage, location, design, construction and technology.

The micro level of PPP/PFI risks represents risks that are formed during the procurement process due to inherent differences between the public and private