Revenue Risk Management for P3 Highway Projects: Implementation of Revenue Guarantees in the U.S. Market

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Abstract

The Public-Private Partnership (P3 or PPP) model has been proposed as an alternative delivery system to address funding shortage problems associated with large-scale projects. Appropriately allocating and managing risks among project participants is critically important for a P3 project's success. This thesis focuses on one of the tools to manage revenue risk, the revenue guarantee, where a guarantor compensates a concessionaire with a predetermined amount of revenue in the event of a revenue shortfall. It is a form of real option—specifically a put option if a premium is paid for the downside protection or a collar option if potential upside revenue is traded for the protection.

Previous research has explored the purpose and valuation of revenue guarantee options. This study focuses on the feasibility of utilizing a guarantee in US P3 highway projects through preparatory study and field investigation. In the preparatory phase, the work examines existing revenue risk management methods and how revenue guarantee options supplement them while also proposing an implementation framework. Additionally, it discusses a new option type, a collar option, including its concept, benefits, applicability, and valuation. In the field investigation phase, the preparatory work is synthesized into interview protocols that are used to seek market perspectives on revenue risks and revenue guarantee feasibility. Twenty people representing government officials, concessionaires, financial advisors and lending institutions were interviewed.

The interview results indicated that a revenue guarantee shows promise as a viable tool, and the government should be willing to provide one. The decision to utilize a revenue guarantee depends on funding method selection, a public agency's institutional capacity, and the effectiveness of alternative risk mitigation approaches. Suggestions for implementation, such as applicable projects and a guarantee triggering criterion, are also provided.

Dedication

To my father Yi Shan (单奕) and my mother Shuxia Qiao （乔淑霞）.

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Glossary[1]

Availability payment is a periodic payment made by a public agency to a concessionaire contingent on specific contracted services being available.

Brownfield project is a facility that has been built and was in public-sector ownership; it usually has an established revenue stream therefore contains lower revenue risk compared to a greenfield project.

Call option gives the option buyer the right, but not the obligation, to buy the underlying instrument from the option seller at a specified price during a specified period of time.

Collar option is a combination of a put option and a call option and it limits the range of possible positive and negative returns on an underlying asset to a specific range.

Concessionaire is the private developer in a Public-Private Partnership.

Greenfield project is a completely new facility built with a Public-Private Partnership.

Credit enhancement instruments reduce credit risks by requiring collateral, insurance, or other agreements to provide lenders with reassurance that they will be compensated if the borrower defaults.

Ramp up phase is the period immediately following construction during which a facility's revenue stream is established.

Real option is the right, but not the obligation, to undertake a business decision, typically of making a capital investment based on an underlying real asset.

Real toll is collected by a concessionaire and used to repay the concessionaire's investment.

Revenue guarantee grants a concessionaire the right to claim a subsidy from a revenue guarantor if the collected revenue is below a specified amount.

Revenue risk is the uncertainty that future revenue is not sufficient to fulfill a concessionaire and/or a public agency's financial goals.

Revenue sharing requires a concessionaire to transfer a portion of revenue to a public agency in the event that the revenue exceeds a specified amount**.**

Public-Private Partnership (PPP or P3) is a long-term contractual relationship between the public and private sector where mutual benefits are sought and where the private sector provides operating services and/or puts private finance at risk.

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[1] Definitions are drawn from Hull (2008), Yescombe (2007), Amram and Kulatilaka (1999), and Buxbaum and Ortiz (2009)

Put option gives the option buyer the right, but not the obligation, to sell the underlying instrument to the option seller at a specified price during a specified period of time.

Shadow toll is a fixed schedule of payments by a public agency to a concessionaire per driver/mile.

Underlying asset is the asset on which the value of options depends.

1. Introduction

1.1 P3 market and revenue risk management

The demand to develop new infrastructure facilities and to rehabilitate existing ones has prompted the global infrastructure community to rethink previous paradigms. Traditional financing mechanisms have not kept pace with the growing need for infrastructure expansion, modernization, and restoration requirements; and due to minimal support for tax increases to finance such investments, federal funding has leveled or diminished (Garvin, 2007a). These circumstances have forced public owners to look toward other sources of capital such as user fees or tolls to finance facility development and improvement. The public-private partnership (P3 or PPP) movement is a significant worldwide trend to address the public-sector funding shortage. Within the US, P3 activity has begun to increase, with over 20 states having passed legislation to permit some form of public-private initiatives on state transportation projects. In addition, the recent leases of the Chicago Skyway and the Indiana Toll Road have further attracted the attention of the government and investors. The United Kingdom's Private Finance Initiative, which began in earnest in 1992, has facilitated the delivery of nearly 800 projects valued at over £54 billion. Outside of developed countries, the use of private capital for infrastructure projects within emerging economies has become quite common, with financially challenged public administrations seeking private-sector support to develop basic infrastructure (Garvin, 2007b).

While the government may view P3s as an innovative way to address chronic funding shortfalls, recent controversial concession lease deals in the US, such as the Chicago Skyway and the Indiana Toll Road have sparked debate over the long-term benefits of these deals (Iseki et al., 2009). Those deals did not incorporate a revenue sharing mechanism, which is usually used to protect the public's interest by requiring a concessionaire to share some level of revenue with the government. Another revenue-related issue that the public sector has been criticized for is not achieving sufficient transfer of risk, and thus not receiving adequate value for taxpayers' money (Li et al., 2005). One example is the Malaysia-Singapore Second Crossing project, in which the government agreed to fill the revenue gap between the collected tolls and the developer's operation and maintenance expenses. This revenue guarantee package grew to be worth RM54 million, a significant portion of the project's total NPV of RM326.6 million (Cheah and Liu

2006). Admittedly, it is not surprising for a concessionaire to request some sort of risk coverage to protect its profits, so by absorbing more risk, a public agency can attract more consortiums to participate in P3 procurements, thus intensifying the competiveness of the bidding process, which in turn will elicit better offers. However, it is questionable how long governments will be able to continue to offer such generous subsidies with the shrinking availability of public funding.

Revenue risk allocation is central to P3 agreement design. A concession relies on an adequate revenue stream to earn its target investment return; the government intends to appropriately allocate the risk to successfully procure a project while fulfilling its social and economic objectives in transportation development. Allocating revenue risks between a cash-strapped government and a concessionaire who is generally reluctant to make any unjustified additional investment, unfortunately, is not an easy task. Lessons have to be drawn to promote the P3 market's development and avoid setting unsuccessful precedents to hinder consideration of carefully designed P3 schemes in the future.

1.2   Option and real option

An option is a financial instrument that conveys the right, but not the obligation, to engage in a future transaction based on an underlying security (Hull, 2008). For example, buying a call option provides the right to buy a specified quantity of a security at a set strike price at some time on or before the expiration date, while buying a put option confers the right to sell.

A real option is the right, but not the obligation, to undertake a business decision, typically of making a capital investment based on an underlying real asset (Amram and Kulatilaka, 1999). For instance, consider Table 1-1. In case 1, the public agency guarantees a minimum amount of user fee revenue to a concessionaire in order to improve the creditworthiness of a project financing arrangement; in effect, it has written a put option. In case 2, it has granted the concessionaire the right, but not the obligation, to expand a tolled facility; in other words, the concessionaire has been granted a call option (Garvin, 2005).

Table 1-1: Payoff structures for infrastructure project options

Payoff Structure to Private Concessionaire	
Case 1	Case 2
Payoff=0, if $A \geq G$	Payoff=1-X, if $I \geq X$
Payoff=G-A, if $A<G$	Payoff=0, if $I<X$
Where: A=actual revenue collected by a concessionaire G=guaranteed revenue by a guarantor	Where: I=incremental revenue after expansion X=cost of expansion

(Adopted from Garvin, 2005)

1.3   Research background

1.3.1   Revenue guarantee option

A revenue guarantee option is a real option in which a concessionaire has the right, but not the obligation, to claim a revenue shortfall subsidy from a guarantor. The concessionaire and the revenue guarantor choose an underlying asset, such as traffic volume or toll revenue, and calculate the guaranteed value of the underlying asset—G. Once the actual value of the underlying asset, A, falls below G, the concessionaire can choose to exercise the option and the guarantor has to compensate the concessionaire's loss (G-A). If A is greater than G, then the option is out-of-the-money and expires without being exercised. Clearly this option has value, but no attempt is usually made to gauge the exact amount it is worth. If the value is substantial, a public agency may have unknowingly provided a concessionaire a tremendous subsidy. Alternatively, the concessionaire may disregard or attach a conservative value to the option in light of its vagueness. In order to maintain the fairness of the free market, the concessionaire should be expected to pay for the benefits it receives. Option fees can serve as a risk premium to the revenue subsidy provider. Recent research has been conducted to develop computational modeling tools to evaluate the value of a revenue guarantee (Chiara et al., 2007).

1.3.2   Literature review in real options for construction projects and revenue guarantees

While real options were initially applied to natural resources, the methodology and concepts have been extended to the construction industry in the past decade. Boukendour and Bah (2001) assessed a maximum price guarantee contract and the contractor's remuneration. Ho and Liu

(2001) developed an option pricing model which considers the uncertainties of both the construction cost and the project net cash flows to evaluate the financial viability of Build-Operate-Transfer (BOT) projects. Ford et al. (2002) investigated a real option approach to valuing strategic flexibility in project planning. Sing (2002) analyzed the time-to-build option in real estate development projects. Zhao and Tseng (2003) identified an expansion option to design the capacity of an infrastructure project under uncertain demand conditions. Ng et al. (2003) designed a model to value an option for deferring a material purchase. Ng and Björnsson (2004) compared real option analysis and decision analysis to evaluate alternatives in investment uncertainties in AEC (architecture, engineering and construction) and showed that those two methods lead to the same valuation results in a complete market. Garvin and Cheah (2004) identified and evaluated a deferral option for the Dulles Greenway. Yiu and Tam (2006) explored under-pricing bidding strategies using a real option model. Matter and Cheah (2006) studied different pricing models to calculate private risks in large engineering projects. Zhao et al. (2004) analyzed the managerial decisions impacted by three uncertainties—traffic demand, land price and highway deterioration. de Neufville et al. (2006) illustrated a spreadsheet approach to valuing real options in a parking garage design example. Mayer et al. (2007) introduced a practical way of using real options to evaluate flexible alternatives that can affect mine production and profitability. Menassa and Peña Mora (2009) investigated real option theories and incorporated them with life-cycle costs to perform economic analysis studies of constructing and operating renewable energy facilities. Menassa et al. (2009) applied an option pricing model to estimate the ADR (alternative dispute resolution) investment cash flow during the project planning phase. Huang and Pi (2009) used a sequential compound option model to valuate uncertain BOT project values in future expansion and the possibility of expansion or abandonment. Hui and Fung (2009) examined the prior work of treating vacant lots of land as options to wait to develop and generated a valuation framework.

Several prior studies have focused on revenue guarantee options. Cheah and Liu (2006) valued government support in infrastructure projects using Monte Carlo simulations. Huang and Chou (2006) calculated the minimum revenue guarantee and the value of an option to abandon for BOT infrastructure projects. Chiara et al. (2007) developed a computational modeling tool to evaluate the value of a multiple-exercise revenue guarantee. Cui et al. (2008) valued the

warranty ceiling clause for New Mexico Highway 44. Brandao and Saraiva (2008) explored revenue guarantees and caps. They considered the guarantees and caps separately and studied how different levels of each of them impact a project's NPV. Similarly, Liu and Cheah (2009) explored a wastewater project with a guarantee on treatment volume by a public agency and a cap on the tariff (not on the volume) imposed by the public agency as well.

1.3.3   Current state of real option practice

Given that real option research has drawn significant attention from academia, one might expect a commensurate interest in industry. Real options have indeed been applied by many companies to evaluate investment opportunities and associated risks, and many managers give credit for decision-making improvements to the application of real options. Even so, the extent of acceptance and application of real options today probably has not lived up to the expectations created in the mid- to late-1990s, when real options first began to take hold in a broad cross-section of companies. Real options are still limited to serving primarily as a conceptual tool for strategic planning and framing of decision problems. Only a small fraction of companies have adopted the valuation techniques. For example, in 2000, Bain & Co. conducted a survey of 451 senior executives across more than 30 industries regarding their use of 25 management tools (Triantis 2005), and the results showed that only 9 percent used real options. Another survey of 205 Fortune 1000 CFOs by Ryan and Ryan (2002) also found real options trailing a field of 13 other capital-budgeting tools.

Busby and Pitts (1997) identified two impediments to real option application. First, computational models are not generally well known or understood by corporate managers, and many of the required modeling assumptions are often violated in real cases. In addition, behavioral and organizational constraints limit the extent to which options can be exercised. For example, Das and Elango (1995) listed three disadvantages of flexibility; in addition to the obvious financial reason that flexible processes usually cost more than non-flexible ones, there is also increased stress in the workforce due to the fact that employees may feel threatened because they have to be more versatile than when working in a regular and routine environment. Additionally, lack of organizational focus in a state of flux also undermines productivity.

In addition to these limitations, another has not been discussed—the market trade mechanism. This issue considers how a real option transaction between two entities can be realized. In fact, to the author's knowledge, the potential of commercializing real option deals has not drawn any academic attention yet.

1.3.4   Research gap identification

While working on solutions for the previous two limitations, academia also needs to explore the feasibility and effectiveness of trade mode candidates. Otherwise, the commercialization (or practical implementation) of real options will never be realized, even though it is a promising approach to addressing risk allocation problems. This research focuses on the revenue guarantee transaction in highway P3 projects in the US. Figure 1-1 summarizes the logic flow of how the research gap has been identified.
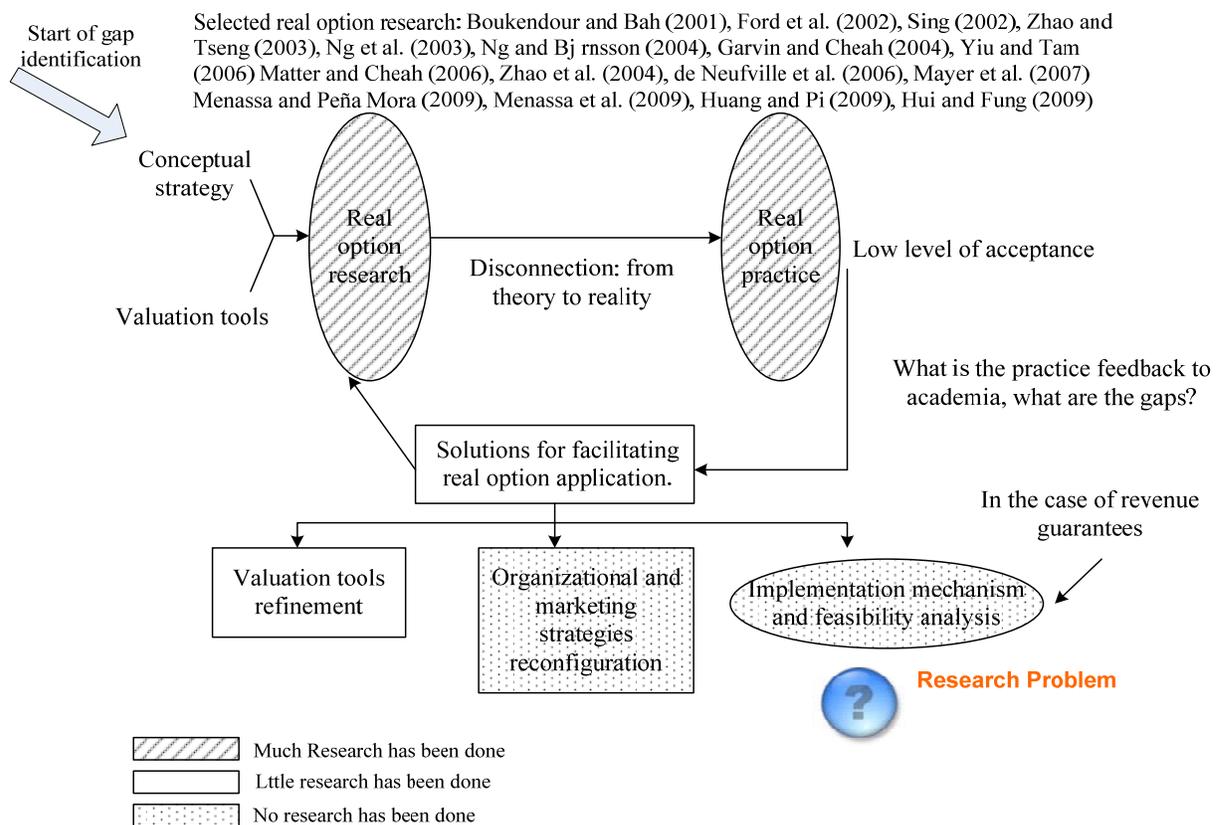
Figure 1-1: Research gap identification

1.4   Research objective, methodology, and process

This research attempted to fill the option utilization gap identified. Specifically, it focused on

the possibility that revenue guarantees can be an alternative tool for public agencies and concessionaires' consideration in the risk management toolbox for P3 projects. The research proposed a revenue guarantee option framework and evaluated its implementation feasibility.

The research methodology and process are demonstrated in Figure 1-2. As the figure illustrates, the research consisted of a preparatory phase and a field investigation phase to ascertain market perspectives. The preparatory study generally focused on characterizing revenue risk management practices and revenue guarantee implementation issues while the field investigation queried the US P3 market participants for their views.
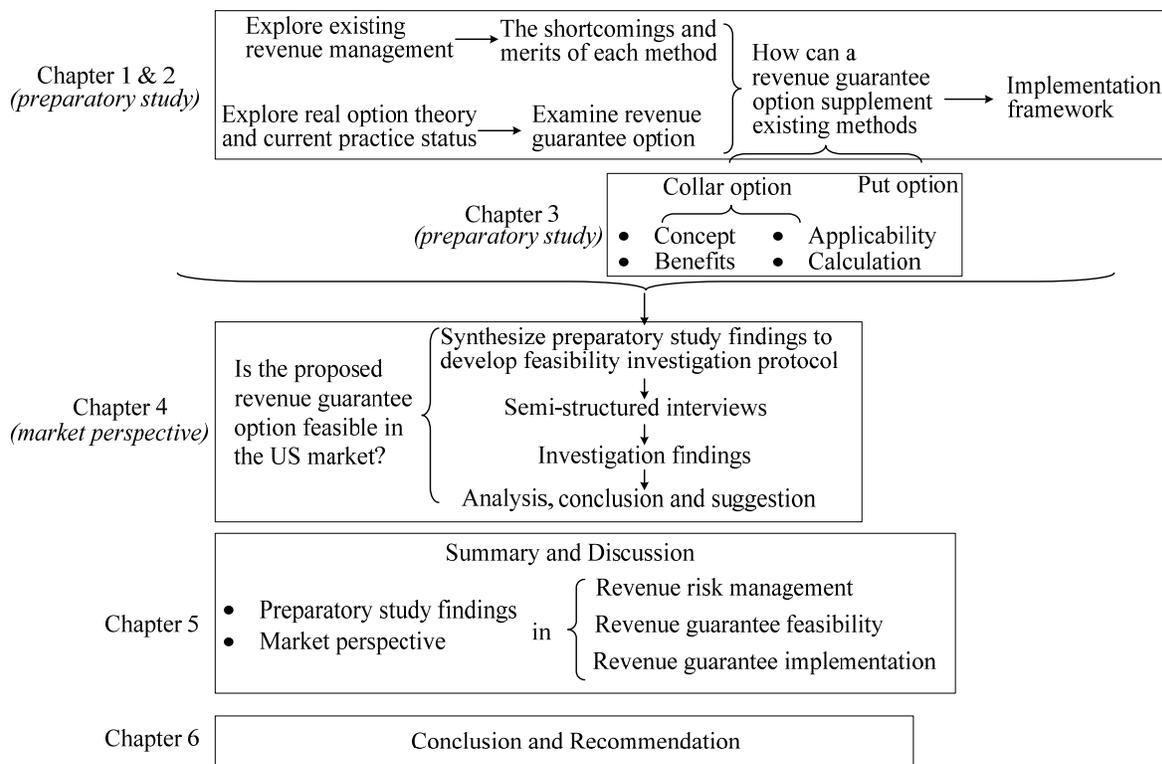
Figure 1-2: Research methodology and process

Chapter 2 explores funding methods and existing revenue management methods, identifying their shortcomings and merits, and analyzing how a revenue guarantee method can be added into the toolbox to supplement existing methods. Also, an implementation framework was proposed to address the issues of option transaction and option agreement terms. Previous research has focused on the put option form of revenue guarantees, as subsequent chapters make clear. A collar option, which can couple a revenue guarantee with revenue sharing, has not been

addressed but offers several unique advantages that deserve exploration. Thus, Chapter 3 closely studies this type of option, including its concept, benefits, and applicability. A primary task of building a collar option's structure is to determine lower and upper revenue thresholds. A numerical case study was built to illustrate how to establish and calculate the thresholds. Table 1-2 summarizes the issues studied in Chapters 2 and 3 as well as how they are connected with the research objective.

Table 1-2: Preparatory study topics

Issues to be studied	Rationale
Funding methods	Revenue risk management is less of a concern in projects with particular funding methods.
Agreement terms	Are they effective? Does the market need an alternative approach?
Existing credit enhancement tools	Are they effective? Does the market need an alternative approach?
Windfall profits and revenue sharing	The revenue sharing requirement may impact revenue guarantee practice.
Implementation framework	Specify revenue guarantees' conditions and terms
Collar option	Collar option combines a revenue guarantee with a revenue sharing requirement.

A field investigation based on the preparatory work was conducted and is described in Chapter 4 where three topics were examined: 1) general revenue risk management, 2) revenue guarantees' feasibility in the US P3 market, and 3) revenue guarantees' implementation framework. It was anticipated that the field investigation would indicate the market's preferences for alternatives developed for each implementation issue or suggest other alternatives that were not considered in the preparatory study. The field investigation reached out to industry stakeholders to seek their opinions. The investigations findings were analyzed and used to draw conclusions. Chapter 5 compared the preparatory study findings and market perspectives. The final chapter provided concluding thoughts and recommendations for revenue guarantee development.

1.5 Research contribution

The contributions of the research are threefold. First, this work thoroughly investigated the

revenue guarantee concept in conjunction with revenue risk management in a P3 highway projects. The revenue guarantee implementation framework and feasibility study were conducted with consideration of a project's objectives and financial conditions, as well as market competition. Second, it proposed a new type of revenue guarantee option—a collar option, and examined its advantages and established a numerical case to illustrate how to price the guarantee. Third, it collected market perspectives to assess the feasibility of the revenue guarantee. Accordingly, the conclusions drawn about the feasibility of revenue guarantees is based on both academic and practitioners' points of view, which should make them more accurate and reliable.

2. Commercialization of revenue guarantee options in highway PPP projects: Prospects and Challenges

2.1 Abstract

Interest in Public-Private Partnership (PPP) for highway projects continues despite the recent economic troubles. In the current environment, however, their success is even more dependent upon understanding and managing the risks inherent in these projects, with revenue risk being a crucial one. Although current practices reduce a concessionaire's vulnerability during revenue shortfalls to a certain degree, they introduce other issues which may compromise a PPP project. Previous research has explored revenue guarantee options as a means to assess and mitigate revenue risk. This paper advances this concept, and studies the potential of commercializing such an option. Specifically, the paper explores option types and a practical implementation framework. In addition, it investigates the challenges for commercialization and suggests how to evaluate implementation feasibility in future work.

2.2 Introduction

Prior to the economic troubles that began in 2008, the interest in Public-Private Partnerships (PPP) for infrastructure, and particularly highways, was substantial (Garvin and Bosso, 2008). Certainly, a driver of this interest was the potential of additional private financing to address public-sector budgetary shortfalls (Yescombe, 2007). Despite the current economic troubles, several indicators suggest that PPPs in the highway sector will continue to be considered as an option to address the nation's transportation challenges. In the fall of 2008, the Federal Highway Administration established the Office of Innovative Program Delivery (IPD) to provide resources to the transportation community when considering innovative program delivery strategies; one of its six program areas is PPPs. Early in 2009, Secretary of Transportation LaHood commented that addressing the nation's transportation issues would require out-of-the-box thinking like increased tolling and private capital investment (Reinhardt, 2009). And the $200 million allotted to TIFIA in the Transportation Investment Generating Economic Recovery (TIGER) program is tangible evidence of the administration's desire to leverage federal funds to support high impact transportation projects that are likely to have a mix of conventional and non-conventional sources of finance.

The success of PPP projects largely depends on effectively mitigating a variety of involved risks (Ng and Loosemore, 2007; Li et al., 2005; Tiong, 1996). A common principle is that risks should be allocated to the party who is best able to manage them (Loosemore et al., 2006). For example, the government uses its authority and jurisdiction to acquire right-of-way, while the concessionaire takes the responsibility of completing the project on time and within budget. As for revenue risks, however, little consensus exists on the mitigation approaches due to unique project needs and market conditions. In fact, a variety of approaches have been implemented in PPP projects. In the current economic environment, assessing such risks becomes even more significant since all parties cannot afford to speculate. The paper discusses existing revenue risk management practices and investigates a revenue guarantee option in the hope that this new tool can add to the risk management tool box. The revenue guarantee option has been proposed by previous research. While the conceptual and computational issues associated with it have been studied, the question about whether it can be commercialized and how to commercialize it has not been addressed. This paper attempts to develop an implementation framework and assess the revenue guarantee option's feasibility of being implemented.

2.3 Existing revenue risk management practices

Every PPP project presents different characteristics, and each involved concessionaire and its equity investors have various risk profiles and portfolios as well (Kessler, 2007). As a result, there would be no revenue risk management panacea for each project; one solution might be more suited for one project and the stakeholders' needs than others. The proposed revenue guarantee option is mainly another risk management tool in the toolbox. Although it only applies to real toll projects, there is a need to explore the existing risk management practices in other types of projects so that stakeholders would have a better understanding of how the new tool supplements the existing methods and in which situation it should be deployed.

Overall, current revenue risk management practice tends to focus on how to allocate the risk between concessionaires and government agencies by applying different funding methods (such as real toll, shadow toll, and availability payment), or outsource it to a third party with financial guarantee products. Real toll projects, as its name suggests, charge user fees to fund a project that concessionaires collect; their concession length can be set or changed based on the project

economic characteristics. Shadow toll projects allow free usage, while concessionaires are compensated by the government with a fixed fee per vehicle. In availability payment projects, the government reimburses the concessionaire with periodic transfers which are typically subject to payment increase or deduction due to satisfactory or unsatisfactory service. These funding methods use different mechanisms to address the revenue risk. Although financial guarantee products exist for various funding methods in initial financing and refinancing stage (FSA, 2009; Ambac, 2009), this study will discuss its usage in real toll projects which contain more revenue risk for concessionaires.

2.3.1 Real toll project

Real toll projects with a fixed concession duration

One common approach to dealing with the revenue risk in real-toll fixed-duration projects is that the concessionaire assumes the entire risk, and the government does not provide any subsidy when the collected revenue is not sufficient to cover upfront construction cost and subsequent operating and maintenance expenses. Since the concessionaire takes full responsibility for reimbursing its expenses from project revenues and carries credit risks, lenders may require substitution clauses that grant them step-in rights in case of default on payments (Yescombe, 2007). Further, lenders may also ask for insurance and security packages which serve as credit enhancements to protect themselves against the concessionaire's default (Yescombe, 2007). In the case that credit enhancement products are utilized, the associated cost will be added to the total project financing price, and ultimately transferred to end users. In addition, because toll rates and demand are the major determinants of operating revenue, the concessionaire may demand a non-compete clause to safeguard its project revenues. These clauses, however, pose legal impediments to future meet the current and future mobility needs of the traveling public. A well-known example is California's SR91 Express Lane where the public was strongly concerned with the high tolls and the government's inability to address the congestion issue. The government ended up purchasing back the facility rather than challenging the agreement's non-compete clause in order to add capacity in adjacent areas (FHWA, 2003).

Another approach is that the government grants subsidies when the project is not able to generate the predicted level of revenue. Since the government would bear the vast majority of the revenue

risk (Hemming, 2006), no revenue protection clauses are required, nor are implicit premium toll rates imposed on the general public. Free subsidy is essential for certain projects to boost their financial viability. However, this strategy should be used with caution in order to wisely deploy government's budget and achieve optimal risk allocation (Ward and Sussman, 2006). Some countries such as Chile, Colombia, Korea and Spain, grant minimum revenue guarantee in exchange for sharing upside revenue (Mandri-Perrott, 2006). On the other hand, some developed counties embrace a different procurement principle. For example, Australia, U.S., and U.K. have yet chosen to use direct subsidies (Mandri-Perrott, 2006; Li et al.; 2005). Academia has made attempts to apply real option pricing techniques to value revenue guarantee; in practice, valuation is not the norm or conducted in an unsophisticated manner (Mandri-Perrott). The implementation framework discussed below explores issues associated with guarantee valuation and various option forms.

As discussed above, utilizing credit enhancement products outsources the risk to a third-party. Monoline insurance was once a common method. However, influenced by the general credit turmoil (Moody's Investor Service, 2009), the insurers currently tend to bear lower risk tolerance and generally prefer to avoid greenfield projects with higher revenue uncertainties (Garnier, 2008). Assured/FSA expressed it would not underwrite structured finance deal in the near future (Seymour, 2009). There is no doubt that the retreat of those insurers negatively impacts PPP financing, but it would be premature to conclude that the entire financial guarantee supply evaporates. In fact, the I-595 project obtained a commitment of bond insurance from a bank when the concessionaire contemplated to issue PAB bond (Project Finance, 2009). It is reported that a new monoline company has been established recently and will start to underwrite deals in 2010 (Bond Buyer, 2009). Other credit enhancement products are the loan guarantee and standby lines of credit provided by the TIFIA program. But according to a report from U.S.DOT, those two products are not widely used (U.S. Department of Transportation 2008).

Real toll projects with a variable concession duration
In a variable-duration concession, the contract ends only when certain financial targets are met. The least present value of revenue (LPVR), a typical model championed by Engel et al. (Engel et al., 2001) grants the concessionaire the right to collect the tolls until the present value of the total

revenue reaches an agreed level. Evidently this mechanism allows adaptation to changing circumstances such as toll schedule and adding a competing facility without lengthy and costly renegotiation, which are hard to accomplish in the standard fixed-duration contracts. The least present value of net revenue (LPVNR) takes the duration-dependent operation and maintenance costs into account and uses the net revenue as the threshold parameter instead (Nombela and de Rus, 2004). The uncertain concession duration, however, complicates the financial planning and discount rate selection (Nombela and de Rus, 2004). In 2003, Spain modified its governing laws to allow modifications to concession durations, among other things, when ex-ante upper and lower revenue or traffic thresholds differ substantially from actual revenue or traffic values (Vassallo and Gallego, 2005).

2.3.2 Shadow toll projects

Shadow tolls are used to eliminate the public resistance against real tolls or enhance a project's financial viability as the facility's revenue may not be sufficient to compensate the concessionaire. It also grants governments more flexibility in future development (non-compete or proximate work clauses are usually not required). However, with a banding scheme, the government's liability to the concessionaire is capped in the event of higher-than-expected traffic; as a result, the concessionaire's revenue is limited (FHWA, 2008). Also, the PPP community in the U.K. has realized that the concessionaire contributed less to improve traffic flow and was less inclined to optimize the road space and availability (Aziz, 2007). The U.K. National Audit Office (NAO) criticized the use of shadow tolls for the reduction of net savings that could otherwise be generated by allocating traffic volume risks to the concessionaire (Aziz, 2007). Moreover, the shadow toll method leaves the funding shortage issue unaddressed: the government is still in need of funding to pay remuneration to the concessionaire in due course (Bousquet and Fayard, 2001). In fact, Portugal which once made a bold attempt to use shadow tolling, has been shifting to real tolls as an effort to revive PPP projects' financial viability (Project Finance, 2004; Poole, 2009)

2.3.3 Availability payment projects

The availability payment method motivates the concessionaire to provide quality service and eliminates many of the problems of estimating traffic and structuring toll rates in real-toll

projects. It also reduces the uncertainties of toll schedule and total revenue that undermine the project's financial viability. This is seen in the second M5 refinancing in Hungary where the concessionaire changed from real tolls to availability payments, and consequently the financial closure was quickly achieved and the financing cost did not increase much despite the fact that the debt-equity ratio raised from 75:25 to 90:10 (Project Finance, 2004). However since the periodic payment to the concessionaire does not depend on the actual revenue, essentially it is still the government who assumes this risk. The expenses associated with monitoring and measuring the facility serviceability is an extra burden. In addition, the economic downturn during which the government's tax revenue diminishes increases the chance of the government breaching its responsibility of issuing timely payments.

2.4 Revenue guarantee option

Similar concepts to revenue guarantee option have already existed. However, the accuracy and transparency of pricing the guarantee with simplified methods might undermine the efficiency of allocating budgetary resources. The paper integrates real option techniques which are well recognized in academic with the revenue guarantee to improve the pricing efficiency. Specifically, it will examine the selection of underlying assets. In addition, it develops an implementation framework which covers a wide range of issues and solutions associated with commercializing the guarantee option. In this section, the paper will first introduces the basics of the guarantee option, including 1) fundamentals of the guarantee option, 2) the efforts needed to commercialize the product, 3) potential option underwriters, and 4) the differences between the option and other credit enhancement products.

2.4.1 Overview

Real option is a right, but not the obligation to undertake a business decision, typically of making a capital investment based on an underlying real asset, for example option to defer an investment, option to expand/acquire asset and option to abandon an investment (Brach, 2002). A revenue guarantee option is a type of real option in which a concessionaire has the right, but not the obligation, to claim a revenue shortfall subsidy from a guarantor. The concessionaire and the revenue guarantor choose an underlying asset, such as traffic volume or toll revenue, and calculate the guaranteed value of the underlying asset. In the event that the actual value of the

underlying asset falls below the guaranteed value, the concessionaire has the right to exercise the option and the guarantor must compensate the concessionaire's loss. If the actual value is greater than the guaranteed value, the option is out-of-the-money and expires without being exercised. By securing the concessionaire's minimum income, revenue guarantee options improve the project's financial viability.

2.4.2 Commercialize revenue guarantee option

Since Myers coined the term real option, conceptual and computational research has been conducted in a multitude of areas, including construction. Some examples of the most recent work are Menassa et al. (2009), Cui et al. (2008), Matter and Cheah (2006), Garvin (2005), Zhao and Tseng (2003), and Ng et al. (2003). Some research has focused on the revenue guarantee option: Ho and Liu (2002) use private equity as the underlying asset and calculate the value of the government debt guarantee; Huang and Chou (2006) and Brandao and Saravia (2008) study the value of the minimum revenue guarantee; Cheah and Liu (2006) calculate the value of government's revenue support; Dailami et al. (1999) and Irwin (2003) value a simple revenue guarantee with a European style; Chiara et al. (2007) develop a multi-least-squares Monte Carlo model to determine the value of a more general revenue guarantee option with an Australian style.

In practice, unfortunately, the real option notion has not been broadly recognized (Triantis, 2007; Ryan and Ryan, 2002). Lack of knowledge of senior managers, unrealistic modeling assumptions (Busby and Pitts, 1997), and behavior and organizational constraints collectively result in the low acceptance of real options (Das and Elango, 1995). Besides these factors, the absence of research on market trade mechanisms also limits the real option's implementation. A revenue guarantee option is a product innovation and also a process innovation. Commercializing such a product or service requires defining its specific terms, identifying and creating supply and demand, and establishing a market distribution channel. To the authors' knowledge, none of these issues has drawn academic attention yet. This study attempts to advance the conceptual idea to real transactions. The rest of the paper discusses the potential revenue guarantee option types and establishes an implementation framework.

2.4.3 Revenue guarantee option type

The revenue guarantee option can be categorized according to who acts as the underwriter and how the upside revenues are shared.

Direct deal and third-party deal

In a direct deal, the government underwrites the option, and the concessionaire negotiates directly with the government; in a third-party deal, a financial institution underwrites the option, and the concessionaire chooses the offer with the most favorable terms through a competitive bidding process.

Put option and zero-cost collar

With a put option, the option buyer has the right to claim a revenue shortfall from the underwriter and secures its minimum revenue at level 2-2' as illustrated in Figure 2-1.

A collar, on the other hand, is a combination of a call option and a put option. The concessionaire buys a floor (a put option) to receive protection against the revenue below the floor and sells a cap (a call option) to defray the cost of the floor. As shown in Figure 2-2, the concessionaire secures its minimum revenue at level 2-2', but gives up the revenue beyond level 3-3'. When the collar is structured in a way that the premium received from the sale of the put option completely offsets the purchase price of the call option, no upfront cost is involved and this type of collar is called a zero-cost collar. The shade areas represent the concessionaire's effective revenue.
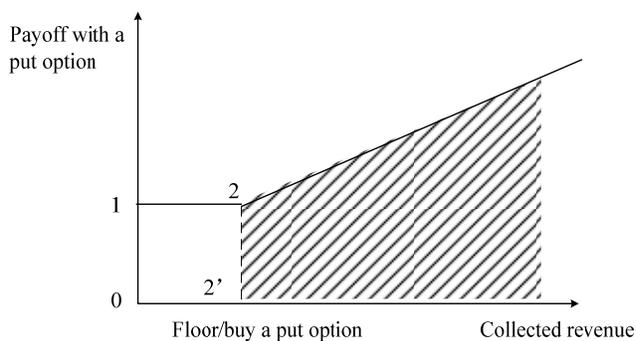
Figure 2-1: Payoff diagram with a put option
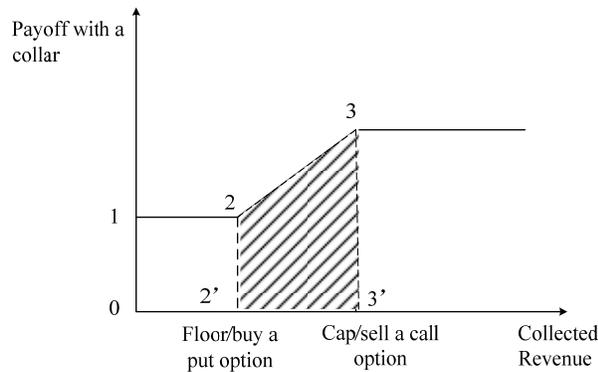
Figure 2-2: Payoff diagram with a collar

2.4.4 Compare revenue guarantee option with alternative products

Bond insurance and letters of credit are common products to enhance a project's financial credibility for lenders. Revenue guarantee option fulfills the same objective, however, with a great deal of flexibility. The two alternative products provides irrevocable guarantee of timely payment of scheduled principal and interest for either bond or bank loans. They fully cover the potential default loss for insured lenders only, no more and no less. The revenue guarantee option (the collar type), on the other hand, is able to reduce or extend the guarantee coverage. First, it can stretch the protection line to equity investors. Setting a higher left threshold (level 2-2' in Figure 2-2) allows not only timely debt repayment but also a minimum rate of return for equity. Oppositely, setting a lower left threshold (level 2-2' in Figure 2-2) can realize a partial debt guarantee that promises timely debt service to a predetermined amount. International Financial Corporation's partial credit guarantee product shares the same feature. This structure is applicable to a scenario that lenders are more confident in the project operation performance and have a more risk tolerance. The partial guarantee allows the concessionaire to achieve a lower all-in cost of funds and accordingly increase its return. It also allows more projects to get access to underwriters' limited credit exposure. The left side of Figure 2-3 demonstrates the coverage provided by alternative products, while the right side demonstrates the coverage provided by the revenue guarantee option.

Financing Structure
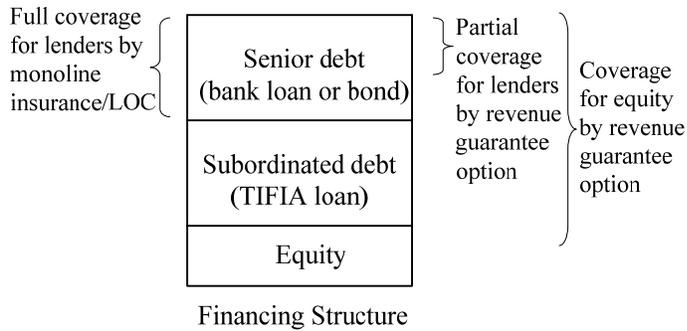
Figure 2-3: Financial guarantee products comparison

2.5 The implementation framework of the revenue guarantee option

Two categories of issues need to be considered to commercialize revenue guarantee options. One relates to how the option transaction is incorporated into the project procurement process. The other one relates to the option agreement terms. Seven issues in total under these two categories will be discussed in detail. For each issue there are two or three alternatives for the corresponding parties to consider. The discussion will focus upon the third-party deal which is more complex but similar issues would apply to the direct deal.
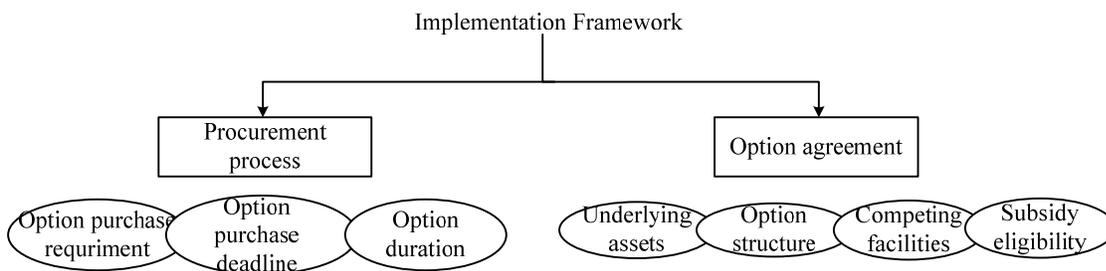
Figure 2-4: Implementation framework

2.5.1 Procurement issues

Option Purchase Requirement

The government specifies in the Request for Proposal whether the concessionaire:

1) Is required to purchase a revenue guarantee option;

2) Has the right to purchase a revenue guarantee option.

The third-party deal shares some characteristics of a performance bond in a construction project.

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In order to enhance bidders' credibility, the owner may require them to contract a performance bond with a surety company as a prerequisite for bidding the project. Similarly, the government requests the concessionaire negotiate with the underwriter for a revenue guarantee option. The concessionaire exercises its due diligence to obtain the guarantee with the lowest fee. The revenue risk is then transferred to the underwriter, and the government is released from any subsidy obligation. However, a word of caution is that mandating the purchase might turn bidders away and thus undermine the competiveness of the procurement process.

Option purchase deadline

The purchase of the option:

1) Must be closed prior to the bid opening;
2) Can be executed after the winning bid is selected.

From the government's perspective, the former is preferable since it excludes the uncertainties of the financial arrangement. However, infrastructure projects require huge financial resources, and raising the needed funds is a time-consuming process. In addition, given the complexity and the scope of PPP projects, it is common that the government negotiates with short-listed bidders and revises the contract documents afterwards. The revenue guarantee option purchase can be a subject that bidders would like to discuss with the government. Moreover, preparation of the bidding documents for PPP projects usually costs millions of dollars. Arranging a guarantee option for a bid that might fail increases bidders' total procurement expenses which discourages bidders to participate.

Option duration

The option's duration may be:

1) Through the ramp-up phase in greenfield projects;
2) Until all the debts are paid off in greenfield or brownfield projects.

The uncertainty of demand level is substantially higher in greenfield projects compared to brownfield projects, where the demand most likely has materialized and traffic prediction is relatively more accurate based on data collected through years of operation. The different risk

levels and risk evolvement patterns in the two project types should be taken into consideration; the government and the concessionaire can consult each other and decide when to start the revenue guarantee and how long the guarantee lasts. The principle is that a higher level of uncertainty calls for stronger hedging strategies. Considering the significant traffic volume volatility involved in the ramp-up phase of a transportation project, at least the early stage of a greenfield project should be required to be covered with a revenue guarantee option. The length of the ramp-up phase varies; the government and the underwriter can refer to studies by traffic consultants for the traffic growth pattern and ramp-up phase length. A more conservative way is to keep the option in hand until the end of debt service period.

2.5.2 Option agreement issues

Underlying assets

The sole objective of the revenue guarantee option is to hedge the loss brought by the underlying assets' value fluctuation. The influencing forces of the fluctuation are classified into market and non-market forces. Market forces are free of the direct control or impact of option purchasers, option underwriters, and the government. The factors are considered non-market forces if any one of these parties has discretional power to directly change them. These forces are listed in Table 2-1. Note the government discussed here refers to a transportation agency, and the judgment criteria focuses on whether it has direct legislative authority to influence the factors. For the land use factor, although interaction with other government entities involved, departments of city planning (other than transportation agencies) often make final decisions in zoning and land use. In this case, the land use factor is a market force. However, when transportation and land use planning are integrated, then the land use factor is a non-market force.

The revenue guarantee option should only hedge the risks associated with market forces; otherwise the option value is indeterminable. Take the toll rate as an example. If the toll rate is set completely at the government's will (a non-market force) and is included as the guarantee option's hedging element, the government's unilateral decision would impact the revenue stream behavior. In the case of revenue decline as a result of escalated tolls, it is impossible to isolate the impact of the government's policy and determine to what extent it should be responsible for the loss. Therefore, the option price is indeterminable and the option deal cannot be constructed.

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Table 2-1: Influencing forces in tolled highways

Influencing Factors		Influence Description	Influence Category
Population		More travel demand in populated areas.	Market force
Land Use	Residential density	More commuting trips	Market/Non-market force
	Employment density	More commuting trips	Market/Non-market force
Macroeconomic	Gross Domestic Product (GDP)	Economic growth creates more economic activities.	Market force
	Individual disposable income	Great disposable income creates more travel trips, such as tourisms, entertainment and shopping.	Market force
	Fuel price	High fuel price discourages travelling.	Market force
Seasonality		Traffic volumes fluctuate across the seasons.	Market force
Toll Rate		High price, low demand.	Non-market force
Road Network	Competing facilities	Alternative routes attract traffic.	Non-market force
	Road route	Connections among places of interests, such as airports and business center generate traffic demand.	Non-market force
Serviceability	Safety	Safety issues negatively impact traffic volume.	Non-market force
	Improvement and maintenance	Service is closed during the period of improvement and maintenance.	Non-market force

Underlying assets can be the following:

1) Toll revenue

2) Traffic volume

3) EBIT (Earnings Before Interest and Tax)

4) FCFE (Free Cash Flow to Equity)

The revenue stream is mainly determined by two variables: toll rate schedule and traffic volume. In a typical contract arrangement, the government reserves the rights to change the level of toll

rate. If the toll rate, and consequently the revenue, is influenced at the government's discretion, then using toll revenue as the underlying asset does not comply with the condition that the underlying asset should not be influenced by a non-market force. However, if the government finalizes the toll schedule before the concessionaire quotes the option price and guarantees not to subsequently revise it and also not to exert any influence on future toll rates, then the toll rate is solely in the hands of market forces and the revenue is qualified to be an underlying asset. Alternatively, the toll rate should be adjusted only in line with economic factors, for example Consumer Price Index (CPI), a popular way in many projects.

Using traffic volume also cannot isolate the impact of toll rate completely. The fluctuation of toll rates impact drivers' decision on whether to use the facility given other choices of alternative parallel routes. In addition, it might not be a good indicator of the concessionaire's financial performance: a high traffic volume will not necessarily lead to high revenue (Vassallo and Gallego, 2005).

Gross revenue does not necessarily result in adequate EBIT, which excludes operating expenses. In a typical balance sheet, a company must pay O&M costs and other expenses prior to fulfilling its debt obligations (CFA, 2009). Lenders expect the project to be updated and maintained in a timely manner so that the facility serves the demand satisfactorily. Use of EBIT grants the strongest protection for the concessionaire. However, its inefficient O&M or management decision mistakes and resulting expense overruns are not market forces, so the escalated cost should not be recovered by the guarantee option. Moreover, the information regarding the operation costs is usually asymmetrical, and hard to be verified by the underwriter. As such, many researchers endorse the use of revenue for risk management purposes (U.S. Department of Transportation, 2008; Vassallo and Gallego, 2005).

FCFE is a post-debt free cash flow and measures what a company can afford to pay out in dividends (CFA, 2009). Debt has claim on the cash of the company that must be satisfied before any money can be paid to sponsors. Therefore, while lenders are more concerned about the project's EBIT, while sponsors (shareholders) are more concerned about FCFE. Using FCFE as an underlying asset can realize a minimum rate of return for sponsors which is absent in other

credit products targeted for lenders such as letters of credit. However, since this coverage is greatest among the four underlying assets, the premium cost of this type of option would be higher.

Option structure

The following acronyms are used to explain the factors involved in the option structure design.

GV: Guaranteed value of an underlying asset.

AV: Actual value of an underlying asset.

V: Option value at settlement dates. If AV$\geq$GV, V=0 and the option is out of the money; If GV>AV, V=GV-AV and the option is in the money.

L_{gs}: Length of the guarantee service (in years).

N: Number of exercise dates in a guarantee contract. If the option is exercised at the end of each year, then N=L_{gs}; If it is exercised semi-annually or a quarterly, then N=2*L_{gs} or 4*L_{gs}.

M: Number of exercise rights.

L_o: Length of one single option. L_{gs} regulates the entire contract signed by the concessionaire and the underwriter, which can be a package of multiple options. In other words, if one option is valid for a quarter (L_o=three months) and it expires after three months, the contract is still valid and another subsequent option will become effective. L_o cannot be greater than L_{gs}.

Two possible option structures are:
1) Multiple European Options (M=N)
2) Multiple-exercise Australian Option (M<N)

Figure 2-5 illustrates an example of a multiple annual European option (L_o=1 year). The concessionaire has the right to exercise the option and receives guarantee coverage at the end of each year. One option will expire annually, and the option fee will be reset annually for the remaining guarantee service period. The floating-rate-like structure is able to mark the option price to market fluctuations, better reflect the intrinsic value by renewing the option fee annually, and thus reduce the risks borne by the underwriter.
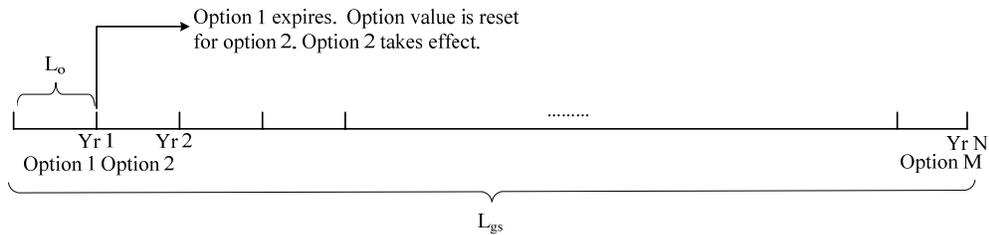
Figure 2-5: Multiple European option

With a multiple-exercise Australian option as illustrated in Figure 2-6, the concessionaire can exercise M options. However, the concessionaire is not covered for revenue shortage each year since M is less than N. The value of the entire option package is determined at the outset of the guarantee service and will not be reset. The number of exercise rights is pre-determined, while the timing of exercise (L_o) is uncertain and solely depends on the concessionaire's discretion. In the example, L_{o1}=2 years and L_{o2}=3 years. A multiple-exercise Australian option costs less than a multiple European option since it has fewer exercise rights.
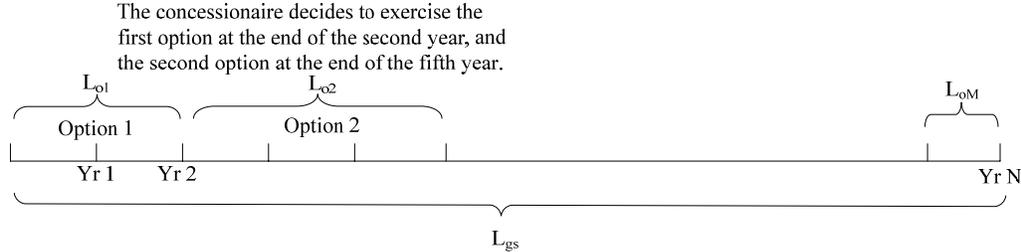
Figure 2-6: Multiple-exercise Australian option

Competing facilities

The government agrees not to add additional free lanes or other directly competing enhancements until the project debt is repaid;

Competing facilities are allowed; the underwriter provides guarantee service assuming a non-compete clause exists, but receives reimbursement from the government for the difference between actual payment to the concessionaire and the payment calculated in a non-compete scenario.

Although the option fee will be much higher when competing facilities are allowed, general speaking, the government is sensitive to the non-compete clause or any other protection clauses that disfavor the public's interest. The House Committee on Transportation and Infrastructure suggests states not include non-compete clause in PPP concession agreements (Oberstar and DeFazio, 2009). Some states, such as Alabama, Florida, Mississippi, North Carolina, and Texas, prohibit such clause (FHWA, 2009).

Subsidy eligibility

An underwriter can set a subsidy eligibility criterion to incentivize concessionaires to exercise its due diligence to produce a traffic projection within a reasonable range of accuracy. For example, the concessionaire only claims the subsidy under the condition that actual revenue is above a certain percentage of forecasted revenue. In this way, the underwriter's losses are capped. However, the two parties might need to negotiate about extraordinary events, such as natural disaster and severe economic recession, to exempt the concessionaire from this constraint.

2.6   Assessment of the feasibility of the revenue guarantee option

In order to investigate whether the proposed revenue guarantee option is merely a pure academic endeavor, or can be endorsed by practitioners as a feasible tool, interviews will be conduct to obtain the opinions of the stakeholders in the PPP deals, including the government, concessionaire, financial institution (the guarantor in a third-party deal), financial advisor, and modeling service provider. Specifically, semi-structured interview form will be used to allow flexible processes and discussions on complex questions and at the same time ensure to focus on the interview agenda (Robson, 2008).   In addition, interviewees will have opportunities to comment on other issues that are not prepared in interview protocols.

The interview protocol will be designed to accommodate each stakeholder's concerns based on its own perspectives. In a direct deal, the government's in-house finance expertise and experience to underwrite a guarantee option will be assessed. Another critical issue is that in a third-party deal the government needs to ensure the public interest not to be compromised by the presence of potential underwriter's negotiation power. From a concessionaire's perspective, the

benefit and cost associated with the guarantee option is the primary concern, such as its risk profile (risk and return expectation), guarantee option premium preference (put option or collar), and expectation on revenue sharing. In a third-party deal, an underwriter might need to consider the timing to expand its infrastructure investment portfolio, competition with alternative products, a minimum market demand to generate liquidity, and the government's commitment to honor the agreement. Last but not the least, modeling specialists' opinions on valuation techniques, availability of financial information and project data, and accuracy of traffic project are also of great importance.

2.7 Discussion and future research

Many issues exist for consideration beyond conceptual or computational matters if the revenue guarantee option is going to evolve from an academic area of inquiry into a financial product, as the previous section demonstrated. For example, the choice between mandatory or voluntary option purchases could impact the competiveness of the procurement process. The timing and length of the guarantee, as well as the option structure (multiple European options or multiple-exercise Australian option), influence the value for money the option provides. Several underlying assets are available, but toll revenue seems the most suitable. Allowing competing facilities complicates the option deal but may be preferred for the public's interest.

The involved stakeholders' opinions are critically important to option commercialization. Future work will explore the concerns and willingness of the government, concessionaires, and financial institutions to participate in revenue guarantee option transactions. These perspectives must complement investigations of the adequacy of current valuation techniques to derive a computational result with desired accuracy. All these efforts in aggregate should lead to the deduction of whether commercializing revenue guarantee options in highway projects is feasible and/or desirable.

3. Collar options to manage revenue risks in real toll public-private partnership transportation projects

3.1 Abstract

The revenue risk is of great importance to ensure the success of a real toll Public-Private-Partnership (PPP) transportation project. Past research has proposed a revenue guarantee put option as an alternative way to quantify and potentially manage this risk. A practical, or commercial, limitation of this type of option is its requirement for an upfront premium payment, and a concessionaire is likely to shy away from additional monetary requirements. A collar option, which is a combination of a put and call option, not only overcomes this barrier but it also provides other benefits. Modifications to the basic collar's structure can redistribute downside losses and upside profits to fulfill stakeholders' needs and thus improve the effectiveness of risk management. The terms, applicability and limitations of a collar option are discussed, and a numerical example is developed to illustrate how to determine the strike prices of a collar option.

3.2 Introduction

Prior to the economic troubles that began in 2008, the interest in Public-Private Partnerships (PPP) for infrastructure in the U.S., and particularly highways, was substantial (Garvin and Bosso, 2008). Certainly, a driver of this interest was the potential of additional private financing to address public-sector budgetary shortfalls (Yescombe, 2007). Despite the current economic troubles, several indicators suggest that PPPs in the U.S. highway sector will continue to be considered as an option to address the nation's transportation challenges. In the fall of 2008, the U.S. Federal Highway Administration established the Office of Innovative Program Delivery (IPD) to provide resources to the transportation community when considering innovative program delivery strategies; one of its six program areas is PPPs. Early in 2009, U.S. Secretary of Transportation LaHood commented that addressing the nation's transportation issues would require out-of-the-box thinking like increased tolling and private capital investment (Reinhardt, 2009). And the $200 million allotted to the TIFIA program in the Transportation Investment Generating Economic Recovery (TIGER) program is tangible evidence of the administration's

desire to leverage federal funds to support high impact transportation projects that are likely to have a mix of conventional and non-conventional sources of finance.

The success of PPP projects largely depends on effectively mitigating a variety of involved risks (Ng and Loosemore, 2007; Li et al., 2005; Tiong, 1996). A common principle is that risks should be allocated to the party who is best able to manage them (Loosemore et al., 2006). For example, the government uses its authority and jurisdiction to acquire rights-of-way, while the concessionaire takes the responsibility of completing the project on time and within budget. In the context of revenue risks, however, little consensus exists on the mitigation approaches due to unique project needs and market conditions. In fact, a variety of approaches have been implemented in PPP projects. Funding methods govern the risks at a macro level;they determine how the risks are allocated between the government and a concessionaire. Real toll projects, as its name suggests, charge user fees to fund a project that concessionaires collect. Shadow toll projects allow travelers to use the facility free at the point of use, while a concessionaire is compensated by the government with a fixed fee per vehicle. In availability payment projects, the government reimburses a concessionaire with periodic payments subject to service quality. In all three types of projects, concessionaires bear some form of revenue risk, i.e. the probability of not receiving payment. In availability payment projects, this risk is essentially budgetary appropriations risk – whether or not the government will allocate the funds necessary for payment over the contract period. In shadow toll projects, the concessionaire assumes appropriations risk and does bear demand/traffic risk since its fees are tied to traffic volume. In real toll projects, concessionaires typically bear the full brunt of revenue risks. In the current economic environment, assessing revenue risks becomes even more significant since all parties cannot afford to speculate. Since revenue guarantees and the collar option proposed subsequently only apply in cases where demand/traffic risks are present, the focus here is on real toll projects; shadow toll arrangements are not considered because trends indicate that these arrangements are becoming less prevalent. Within a real toll funding method, revenue risks are managed by specific concession agreement terms and financial guarantees (explained subsequently).

This work presents a collar option, a class of derivatives from finance, as a technique to manage

revenue risks in real toll projects; its potential features are derived from an exploration of existing risk management practices in real toll projects. The collar's conceptual framework, applicability, advantages, and distinctive characteristics are discussed, while a numerical case is built to illustrate how to determine a collar's two strike prices. A revenue collar option is best suited for a project with moderate or promising cash flows and subject to revenue volatility throughout its lifecycle, especially in the ramp-up phase. Future work will investigate its potential for implementation or commercialization via semi-structured interviews with experts in the field.

3.3 Existing revenue risk management practices in real toll PPP transportation projects

Every PPP real toll project has different characteristics, and each involved concessionaire and its equity investors have various risk profiles and portfolios as well (Kessler, 2007). As a result, no single revenue risk technique will apply universally; one solution might be more suited for one project and the stakeholders' needs than others. A revenue guarantee option is mainly another risk management tool for the toolbox. To enhance understanding of how this new tool supplements other methods and in which situations it should be adopted, other existing tools are examined.

3.3.1 Real toll projects with a fixed concession duration

One common approach to dealing with the revenue risk in a real-toll fixed-duration project is that the concessionaire assumes the entire risk, and the government does not provide any subsidy when collected revenue is not sufficient to cover upfront construction cost as well as operating and maintenance expenses. Since the concessionaire takes full responsibility for reimbursing its expenses from project revenues and carries great credit risks, lenders may require substitution clauses that grant them step-in rights in case of default on payments (Yescombe, 2007). Further, lenders may also ask for insurance and security packages which serve as credit enhancements to protect themselves against the concessionaire's default (Yescombe, 2007). If credit enhancement products are used, the resulting risk premium will be added to the total project financing price, and ultimately transferred to end users. In addition, since toll rates and demand are the major determinants of operating revenue, the concessionaire may require a non-compete clause to safeguard its project revenues. This clause, however, poses legal, and socio-political,

impediments to meet the current and future mobility needs of the traveling public. A well-known example is California's SR91 Express Lanes where the public was concerned about the high tolls and the government's inability to address mobility issues on parallel routes. The government ended up purchasing back the facility rather than challenging the agreement's non-compete clause in order to add capacity in adjacent areas (FHWA, 2003).

Another approach is that the government grants subsidies when the project is not expected to generate the needed level of revenue. In these cases, the government has lessened the concessionaire's revenue risk burden (Hemming, 2006); no revenue protection clauses are typically required nor are implicit premium toll rates imposed on the general public. Such subsidies are essential for certain projects to boost their financial viability. However, this strategy should be used with caution in order to wisely deploy a government's budget and achieve optimal risk allocation (Ward and Sussman, 2006). Some countries such as Chile, Colombia, Korea and Spain, grant minimum revenue guarantees in exchange for sharing upside revenue (Mandri-Perrott, 2006). On the other hand, some developed countries embrace a different principle. For example, Australia, U.S., and U.K. have yet chosen to use such guarantees or direct operating revenue subsidies (Mandri-Perrot, 2006; Li et al., 2005). While academics have made attempts to apply real option pricing techniques to value revenue guarantees, valuation, in practice, is not the norm or it is conducted in an unsophisticated manner (Mandri-Perrot, 2006). The implementation framework discussed subsequently explores issues associated with guarantee valuation and various option forms.

Utilizing credit enhancement products outsources the risks to a third-party. Monoline insurance was once a common method. However, influenced by the general credit turmoil (Moody's Investor Service, 2009), insurers currently are demonstrating lower risk tolerance and generally are avoiding greenfield projects with higher revenue uncertainties (Garnier, 2008). Assured/FSA recently expressed it would not underwrite structured finance deals in the near future (Seymour, 2009). Certainly, the retreat of these insurers negatively impacts PPP financing, but it would be premature to conclude that the entire financial guarantee supply will evaporate. In fact, the I-595 Express Lanes project obtained a commitment of bond insurance from a bank when the concessionaire contemplated issuing PAB bonds (Project Finance, 2009). Further, a new

monoline company has been established recently and will start to underwrite deals in 2010 (Bond Buyer, 2009). Other credit enhancement products are the loan guarantee and standby lines of credit provided by the U.S. TIFIA program. But according to a report from U.S.DOT, those two products are not widely used (U.S. Department of Transportation, 2008).

3.3.2 Real toll projects with a variable concession duration

In a variable-duration concession, the contract ends when certain financial targets are met. The least present value of revenue (LPVR), a model championed by Engel et al. (2001), grants the concessionaire the right to collect tolls until the present value of the total revenue reaches an agreed level. This mechanism can allow adaptation to changing circumstances such as toll schedule and adding a competing facility without lengthy and costly renegotiation, which is difficult to accomplish in the standard fixed-duration contracts. Alternatively, the least present value of net revenue (LPVNR) takes the duration-dependent operation and maintenance costs into account and uses the net revenue as the threshold parameter instead (Nombela and de Rus, 2003). In both models, the uncertain concession duration, however, complicates financial planning and discount rate selection (Guasch 2004). Another approach has been adopted in Spain. In 2003, Spain modified its governing laws to allow modifications to concession durations, among other things, when ex-ante upper and lower revenue or traffic thresholds differ substantially from actual revenue or traffic values (Vassallo and Gallego, 2005).

3.4 Revenue guarantee put options

Due to the heterogeneity of PPP projects in terms of project needs and objectives, market conditions, and stakeholders' risk appetites, little evidence exists to suggest one mitigation method's preponderance over others. A revenue guarantee option is principally another risk management technique for a real toll project in which a concessionaire retains all or the majority of traffic risk and revenue uncertainty is a major concern. Revenue guarantee put options have been studied in previous research as a way to enhance a project's financial viability, such as Dailami et al. (1999), Ho and Liu (2002), Irwin (2003), Garvin (2005), Huang and Chou (2006), Cheah and Liu (2006), Matter and Cheah (2006), Chiara et al. (2007), and Brandao and Saravia (2008). While the majority of the research has focused upon valuation and/or computational issues, several have indicated that a revenue guarantee put option could function as a revenue

risk mitigation strategy in PPP projects. In practice, Chile has developed a minimum revenue guarantee program (Hemming, 2006).

If implemented within a project, a revenue guarantee put option would grant the concessionaire a right, but not an obligation, to claim a revenue subsidy from an option underwriter. The concessionaire and the underwriter choose an underlying asset, such as traffic volume or toll revenue, and negotiate the guaranteed value of the underlying asset (strike price), for example at level 2-2' in Figure 3-1. In the event that the actual value of the underlying asset falls below level 2-2', the concessionaire has the right to exercise the option and claim the subsidy for the loss paid by the underwriter under the pre-condition that it has fulfilled all its contractual obligations. If the actual value exceeds the guaranteed value, the option is out-of-the-money and expires without being exercised. Line 1-2'-3' represents the collected toll revenue, while line 1'-2'-3' represents the concessionaire's actual payoff. The actual payoff line overlaps with the collected revenue line beyond level 2-2' because the concessionaire does not receive any compensation from the underwriter—all of its payoff comes from the collected tolls. If the underwriter is the government, then a direct deal exists. If the underwriter is a financial institution, then it is a third-party deal.
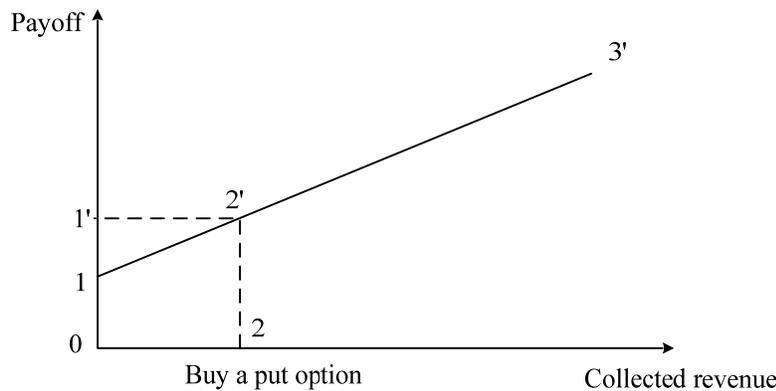
Figure 3-1: Concessionaire's payoff with a put option

3.5   Collar: a new type of revenue guarantee option

While many authors have focused generally upon valuation of such guarantees, a potential question is whether these options could be priced and sold? The major constraint of this type of

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option is that if it were to be priced and sold, then the concessionaire would need to pay a premium to the underwriter. Subject to the substantial value of infrastructure projects and high traffic volatility during the early stages of a project, the price of such an option, if sold, could be substantial. A concessionaire is usually reluctant to commit more monetary payments, so the option purchase becomes an extra burden that the concessionaire may not be willing or is unable to take. By contrast, a collar option demands less or no upfront payments.

3.5.1 Revenue collar

A collar, another type of guarantee option, is a more complex arrangement than a put option; it is a combination of a call option and a put option. In a revenue collar, the concessionaire buys a floor (a put option) from the underwriter to receive the protection against revenue below the floor, and simultaneously sells a cap (a call option) to the underwriter to defray the cost of the floor. In Figure 3-2, line 1-2'-3' still represents the collected revenue, but part of the concessionaire's payoff line 1'-2'-3'-4' differs from the case in Figure 3-1. The put option the concessionaire buys secures its minimum revenue at level 2-2'. The call option it sells forfeits its right to retain the excess revenue beyond level 3-3'; this excess revenue is then captured by the underwriter. Table 3-1 provides detailed information about the transactions in the put option and the collar. Brandao and Saraiva (2008) explored revenue guarantees and caps (equivalent to put options and call options). However, they considered the guarantees and caps separately and studied how different levels of each of them impact a project's NPV. This examination, on the other hand, combines a put option and a call option into a collar and investigates its characteristics, benefits and dynamics, particularly the flexibility of adjusting put and call strike prices as well as put and call payoffs, which are the essence of the collar notion and distinctive advantages of it.

Table 3-1: Revenue guarantee option's transaction detail

	Put Option	Call Option
Put Option	Buyer: the concessionaire	N/A
	Seller: the underwriter	
Collar	Buyer: the concessionaire	Buyer: the underwriter
	Seller: the underwriter	Seller: the concessionaire

If the collar is structured in a way that the premium received from the sale of the call option, V_{call},

completely offsets the purchase price of the put option, V_{put}, the collar has zero value, and the concessionaire pays no upfront cost. This type of collar is called a zero-cost collar.

An income-producing collar, on the other hand, sets a narrower band: the call strike price is closer to the put strike price, as shown in Figure 3-3. The lower strike price increases the value of the call option in excess of that required to defray the put option's cost, thus generating cash equal to $V_{call}-V_{put}$. Compared to the zero-cost collar, the income-producing collar is a more conservative approach to managing the risk. Although the concessionaire gives away more potential for larger profit, it is able to harvest immediate cash rather than less predictable gains in the future, the bird in the hand concept. If the concessionaire is confident in the project's future profitability, the zero-cost collar is a better strategy (Mayer and Levy, 2003).
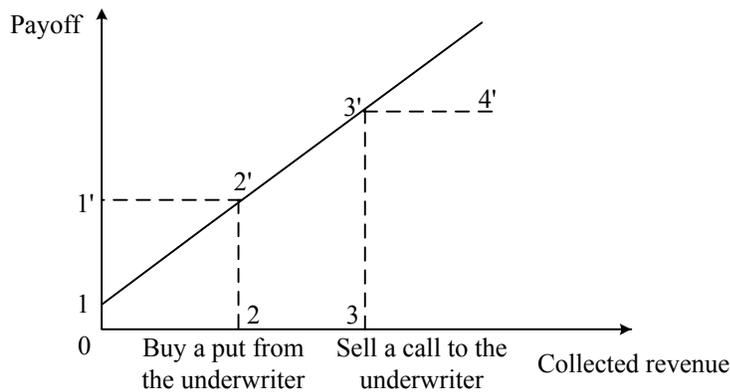
Figure 3-2: Concessionaire's payoff with a zero-cost collar
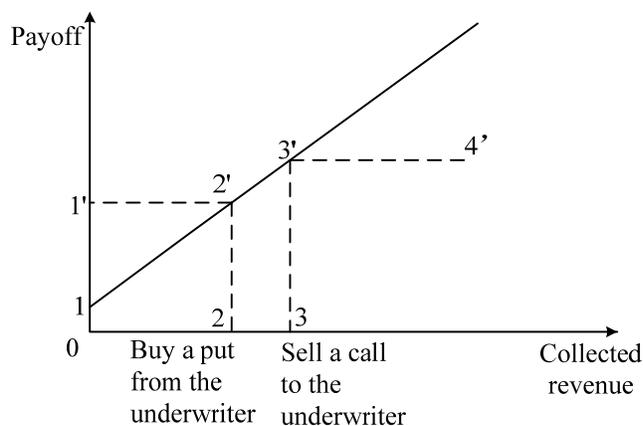
Figure 3-3: Concessionaire's payoff with an income-producing collar

3.5.2 Revenue collar terms and applicability

A concessionaire and an underwriter maintain their interests through arranging collar option terms in a flexible manner. For example, the probability that the concessionaire will need the underwriter's coverage to fulfill debt repayment obligations is higher in a transportation project's ramp-up phase. Similarly, the underwriter will expect the option duration to be long enough so that after the ramp-up phase, when traffic and revenue have stabilized, a project's cash flow is more likely to exceed the call option's threshold. Consequently, the underwriter can harvest the excess revenue to compensate it for the coverage paid earlier. In other words, in the early years the put option of the collar (the concessionaire buys) has a higher chance to be exercised and the same for the call option (the underwriter buys) in later years. Certainly, the possibility also exists that ex-ante traffic projections would strongly indicate that the total collected revenue throughout the project's lifecycle will not be sufficient to recoup the concessionaire's investment. In this case, a direct government subsidy is indispensible to make the project financially viable, so a collar option has limited applicability. The concessionaire will have a negative rate of return and so would the underwriter if it had written the deal. Revenue collars apply to projects where the cash flow is moderate or promising so that the underwriter can ensure itself of a chance of earning profits in the deal sooner or later.

Therefore, the two parties need to exercise due diligence to examine project conditions and external factors to decide whether or not to enter into the deal and subsequently determine mutually acceptable collar option terms. Factors worth consideration include, but are not limited to:

1) Traffic projection
2) Toll rate structure
3) Capital expenditure plan
4) Road capacity
5) Local economic market
6) Demographic conditions
7) Transportation network

Studying these factors is necessary to assessing a collar contract's value from the concessionaire's perspective and demonstrating the underwriting profits from the underwriter's perspective. In particular, a clause governing traffic projection accuracy would preclude the

likelihood of the concessionaire artificially inflating the projection and triggering a put option's execution.

3.5.3 Downside loss and upside windfall profit

The basic collar described above addresses the issues of allocating downside loss and upside windfall gain in a simple way: isolate the concessionaire from both sides of the revenue spectrum, obligate the underwriter to cover the entire loss while allowing it to capture all of the excess profits. This approach, however, has some issues worth considering.

Allocate downside losses

First, the concessionaire would be indifferent to the losses beyond the lower threshold. Although it is in the best position (other than the underwriter) to prevent further losses, it in theory has neither the obligation nor incentives to make efforts to do so. Engaging the concessionaire to share a certain percentage of losses is a win-win solution. The underwriter will provide less coverage if the concessionaire is motivated to actively reduce further losses. On the other hand, the collar can still have zero value when the upper threshold is raised to compensate the concessionaire from sharing potential losses.

Allocate windfall profits

Another issue relates to windfall profits. In a third-party deal, any excess revenue beyond the upper threshold is retained by the underwriter. However, ceding the right to share substantial excess profit is likely to be opposed by the general public and the government. As with the windfall profit tax imposed on giant oil companies, a demand by government to share revenues in PPP projects is not surprising. Sharing terms already exist in recent projects. For example, the Capital Beltway High Occupancy Toll (HOT) Lanes project in the U.S. has such an arrangement where the government captures a portion of the profit when the concessionaire's rate of return exceeds certain levels. A simple solution to incorporate the government's right is to let it be the underwriter and retain all of the excess revenue. An alternative is to allow the government to share the windfall profits with the underwriting financial institution. These solutions are illustrated in Figures 3-4, 3-5 and 3-6. Corresponding to the concessionaire's payoff in Figure 3-2, line 1-2-3-4 in Figure 3-4 depicts the underwriter's payoff. With sharing

partial loss and partial excess profit, the underwriter's payoff is represented by line 1-2-3-4 in Figure 3-5. The shaded area 1 is the loss shared by the concessionaire, and area 2 is the excess profit retained by the government. Clearly, the value of the partial call and partial put are different from the call and put respectively in the base case in Figure 3-2. However, as long as the value of the partial call equals the partial put, the collar still has zero value. The concessionaire's actual payoff is now represented by line 1'-2'-3'-4' in Figure 3-6.
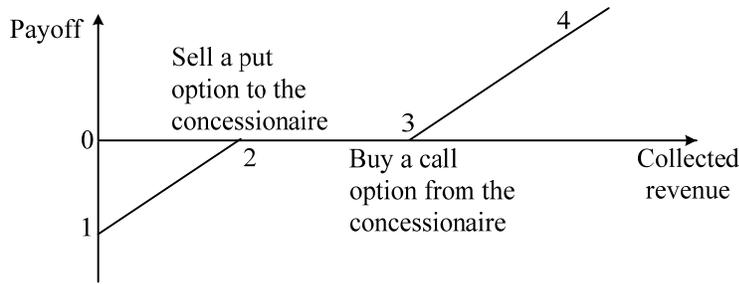
Figure 3-4: Underwriter's payoff with a zero-cost collar
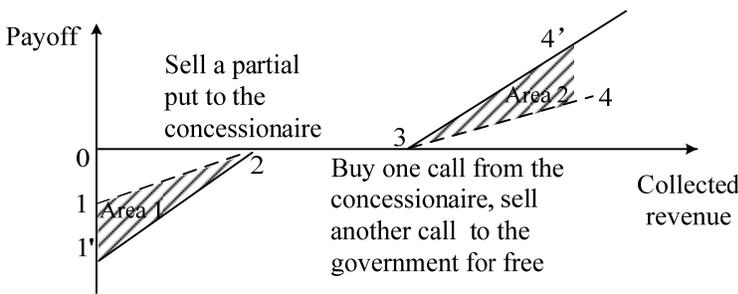
Figure 3-5: Altered underwriter's payoff with a zero-cost collar
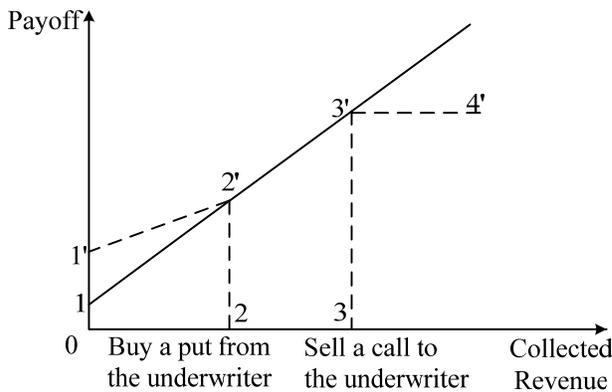
Figure 3-6: Altered concessionaire's payoff with a zero-cost collar

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3.5.4 Collar's benefits

Aside from the benefit of no upfront payment, the collar has some other advantages.

Incentives

Although theoretically in a basic zero-cost collar the concessionaire is indifferent about the project profitability beyond the upper threshold, the revenue zone between level 2-2' and 3-3'in Figure 3-2 still motivates it to improve performance. In addition, it reduces the concessionaire's risk and thus attracts more interested companies to participate in the procurement process. The enhanced project's financial viability reduces the concessionaire's credit risk, which in turn lowers the financing cost.

Flexibility

The two strike prices in a collar allow significant flexibility. By changing the values associated with the strike price band, the concessionaire can adjust the future and current cash flow to accommodate its financial needs. The different levels of the strike prices can also serve the concessionaire's risk appetite. For instance, if the concessionaire is willing to take on more risks, it may choose to set a lower put strike price and higher call strike price, expecting to use higher upside revenue to defray the larger downside losses.

In addition, with no upfront costs a zero-cost collar can be easily terminated, whereas in a put option deal the premium charged previously has to be refunded in order to cancel the contract. This flexibility is likely to be appreciated by the concessionaire when it is uncertain about the timeframe over which option hedging coverage is needed. However, this advantage may not be realized in an exotic collar whose payoff does not only rely on the current price but also previous or future prices, such as a path-dependent collar or multiple exercise collar (Chiara et al., 2007).

Accounting benefits

Prior to the release of SFAS 133 in 1998, the derivatives held by companies were recorded according to their historical costs. For example, option premiums were amortized over their time to maturity. SFAS 133, however, requires companies to recognize all derivatives as either assets or liabilities in their statement of financial position and measure those instruments at fair value.

Three accounting methods exist for changing the fair value of derivatives depending on the intended use of the derivative and the resulting designation: fair-value hedge, cash-flow hedge, and net-investment hedge (Ramirez, 2007). A plain vanilla option (such as a revenue guarantee put option) is designated as a fair-value hedge, whereas a collar is designated as a cash-flow hedge. For fair-value hedges, the derivatives are marked to market in earnings (reflected in the income statement); for cash-flow hedges, the effective portion of the hedge is recorded in other comprehensive income (OCI) and the ineffective portion goes into the current income. SFAS 133 greatly increased the volatility of financial statements. However, OCI is considered a better harbor for volatility. The reason is that the Generally Accepted Accounting Principles (GAAP) draws a distinction between OCI and earnings, and OCI does not affect current income and hence the earnings per share (EPS), which is a key variable that investors use to evaluate corporate performance. Therefore, from the perspective of accounting principles, the collar is a more desirable product than the plain vanilla put option.

3.5.5   Comparison of revenue guarantee option with alternative products

Bond insurance and letters of credit are common products to enhance a project's financial credibility for lenders. A revenue guarantee option fulfills the same objective but with significantly more flexibility. The two alternative products provide irrevocable guarantee of timely payment of scheduled principal and interest for either bonds or bank loans. They fully cover the potential default loss for insured lenders only, no more and no less (as shown on the left side of Figure 3-7). The revenue guarantee option (the collar type), on the other hand, permits reduction or extension of the guarantee coverage. First, it can stretch the protection line to equity investors. Setting a higher floor threshold (level 2-2' in Figure 3-2) secures not only timely debt repayment but also a minimum rate of return for equity. Conversely, setting a lower floor threshold would realize a partial debt guarantee that promises timely debt service to a predetermined amount. International Financial Corporation's partial credit guarantee product shares the same feature. This structure is applicable in a scenario where lenders are more confident in a project's operation performance and have more risk tolerance. The partial guarantee allows the concessionaire to achieve a lower all-in cost of funds and accordingly increase its return. It also allows more projects to access underwriters' limited credit exposure. The left side of Figure 3-7 demonstrates the coverage provided by alternative products, while the

right side demonstrates the coverage provided by the revenue guarantee option.

Financing Structure
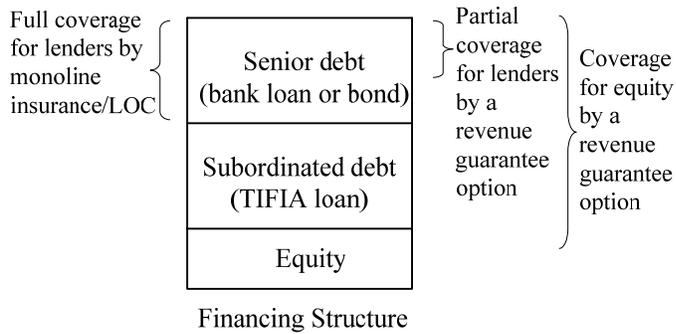
Figure 3-7: Financial guarantee products comparison

3.6   Numerical example

The promise of real option applications has spurred much academic discussion since Myers coined the term in 1977. The construction field has seen its share of research on real option valuation models. Revenue guarantee option pricing alone has been explored by many studies, as discussed previously. The inherent properties of the revenue guarantee, such as the underlying asset's distribution, path dependency, and non-stationary variance, can require quite elegant valuation models. Thankfully, the prolific financial derivative research has yielded many potential solutions that can be applied to the revenue guarantee option. Previous research (Copeland and Antikarov, 2001; Trigeorgis, 1998; Brealey and Myers, 2000) has endorsed a Marketed Asset Disclaimer or MAD approach for real options to address the absence of a replicating portfolio, a typical problem for real option pricing. The numerical example will use the Black-Scholes equation, a convergence of the binomial lattice method in the limit which the MAD method is built upon (Copeland and Antikarov, 2001).   This numerical example does not intend to refine existing option pricing techniques; instead, it aims to further demonstrate the zero-cost collar concept by illustrating a case which addresses the primary valuation issues particular to collars. The standard Black-Scholes equation's assumptions are used. Readers are referred to Amram and Kulatilaka (1999) and Copeland and Antikarov (2001) for a general exposition of the equation.

3.6.1   Case information and calculation method

The hypothetical case is a real toll highway concession that includes a 2-year construction phase

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and 35-year operation phase. The operation and capital assumptions are described in Table 3-2. It is assumed that the concessionaire structures a series of zero-cost collars to secure its absolute minimum return measured by free cash flow to equity (FCFE). The collars are arranged to cover the revenue risk in the ramp-up phase which is assumed to last 10 years. Each collar has a different set of strike prices and is valid for only one year. An explanation of the calculation method and key inputs follows.

Calculation method

The objective of the calculation is to find the strike prices of the put and call option for each collar for a particular year. The strike price of the put option is the minimum gross revenue in that year which is determined by the minimum acceptable rate of return. The put option value is derived given the strike price and other input assumptions, including the risk-free rate, volatility, and current prices. All the calculations are made in the start of the year that the facility opens for operations (Year 3 in Table 3-3). Accordingly, the economic values shown during the operating period are expectations. For each collar, the value of the call option is set equal to the put option. The call option's strike price (the revenue cap) is then calculated given the call option's value. The calculation process is demonstrated in Figure 3-8.
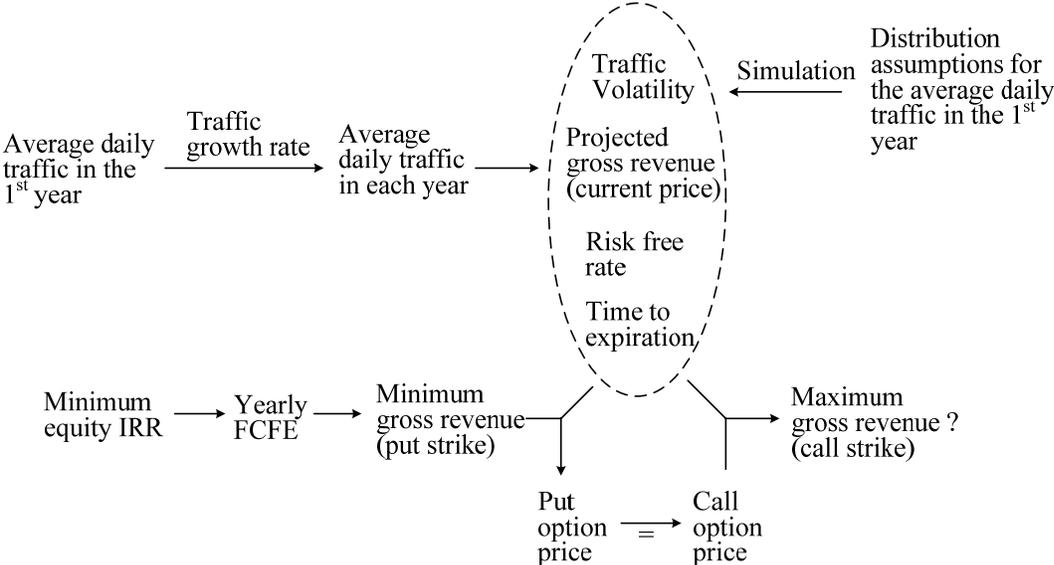
Figure 3-8: Calculation process

Underlying asset

Many choices are open for the collars' underlying assets: gross revenue, traffic volume, earnings before interest and tax (EBIT), and FCFE. They serve different hedging purposes. For instance, creditors are more concerned about the project's EBIT, while sponsors (shareholders) are more concerned about FCFE. This example takes the sponsors' perspective and attempts to determine the gross revenue thresholds that allow the sponsors to secure a minimum FCFE-base rate of return. The model assumes that the concessionaire is not granted any depreciation benefits for tax deduction purposes. FCFE is calculated in Equation 1.

$$\text{FCFE= Gross revenue - operating expenses - debt service - income tax} \qquad (1)$$

Current prices

Real revenue data does not exist, thus the estimated annual revenues are used as the current prices for the call and put option instead. The estimated revenue in each year is based on the initial traffic volume and annual traffic growth assumptions.

Put strike prices

The strike prices of the put are annual minimum revenues, which in aggregate guarantee that the equity investment can achieve an IRR equal to the risk-free rate (see Equation 2).

$$NPV = \sum_{i=1}^{35} \frac{FCFE_i}{(1+r)^i} - InitialEquityInvestment = 0 \qquad (2)$$

The initial traffic volume which results in a 7.5% rate of return (a nominal rate) for sponsors is found through a trial-and-error process. A constant traffic growth rate is then applied to calculate the traffic volumes and gross revenues in subsequent years. The derived gross revenues are the strike prices for the put options. The current prices and put exercise values are listed in bold in Table 3-3.

Volatility

The traffic volume in the first year of operation is the only defined uncertainty. Traffic volumes in subsequent years are products of the previous year's traffic and a traffic growth rate. Therefore, the initial traffic volume is unknown as well as the remaining traffic figures in subsequent periods. Although the expected traffic volumes are uncertain during the operations

period, the volatility of the expected annual traffic volume is assumed to remain constant. As mentioned previously, all calculations occur at the start of the operations period, year 3. The volatility is derived by simulating the traffic's distribution in the first year and applied to all the other years. A lognormal distribution under a 95% confidence level is assigned to the traffic volume with 10th and 90th percentile points of 16,600 and 32,000 respectively. The annual revenues' volatility is derived through a Monte-Carlo simulation, which is 25%. The put and call option have the same volatility, and the volatility remains constant over the first 10 years of operation. It is not difficult to incorporate other uncertainties such as growth rate in the calculation if necessary. For example, Cheah and Liu (2006) considered the growth rate as another random variable.

Table 3-2: Operation and capital information

Operating Variables:	
Initial Traffic Volume	25,000
Annual Traffic Growth Rate (year1-10)	6.00%
Annual Traffic Growth Rate (year11-20)	3.50%
Annual Traffic Growth Rate (year21-35)	2.00%
Initial Toll	$1
Annual Toll Growth Rate (year1-5)	5%
Annual Toll Growth Rate (year 6-10)	3%
Annual Toll Growth Rate (year 11-35)	2%
Initial O&M Cost	$6,500,000
Annual Growth Rate of Operating Exp.	3.00%

Capital Variables	
Capital Cost	$110,000,000
D/A	80%
Debt	$88,000,000
Equity	$22,000,000
Interest Rate	7%
Risk Free Rate	5%
Tax Rate	30%
Minimum Return of Equity	7.5%

Table 3-3: Calculation setup sheet

Period	Avg daily traffic	Toll rate	Gross revenue (current price)	Operating expenses	Capital expenditure	Total debt service	Tax	FCFE	Assumed daily traffic	Gross revenue (put strike price)	FCFE	Discounted FCFE
			Forecasted FCFE						FCFE (IRR=7.5%)			
1						(55,000,000)						
2						(55,000,000)						
3	25,000	1.30	11,862,500	6,500,000		11,586,667	0	(6,224,167)	19,647	9,322,579	(8,764,087)	(7,054,745)
4	26,500	1.37	13,202,963	6,695,000		11,205,333	350,789	(5,048,160)	20,826	10,376,031	(7,524,302)	(5,634,202)
5	28,090	1.43	14,694,897	6,895,850		10,824,000	852,514	(3,877,467)	22,076	11,548,522	(6,171,328)	(4,298,692)
6	29,775	1.50	16,355,421	7,102,726		10,442,667	1,403,009	(2,592,980)	23,400	12,853,505	(5,044,321)	(3,268,526)
7	31,562	1.58	18,203,583	7,315,807		10,061,333	2,007,933	(1,181,490)	24,804	14,305,952	(3,909,832)	(2,356,671)
8	32,667	1.63	19,405,930	7,535,281		9,680,000	2,417,195	(226,546)	25,672	15,250,860	(3,135,095)	(1,757,855)
9	33,810	1.68	20,687,692	7,761,340		9,298,667	2,848,305	779,379	26,571	16,258,179	(2,321,279)	(1,210,741)
10	34,993	1.73	22,054,114	7,994,180		8,917,333	3,302,780	1,839,820	27,501	17,332,032	(1,465,637)	(711,118)
11	36,218	1.78	23,510,788	8,234,006		8,536,000	3,782,235	2,958,548	28,463	18,476,812	(565,235)	(255,115)
12	37,486	1.83	25,063,675	8,481,026		8,154,667	4,288,395	4,139,588	29,459	19,697,206	383,059	160,829
13	38,235	1.87	26,076,248	8,735,456		7,773,333	4,630,237	4,937,221	30,049	20,492,973	1,028,928	401,860
......												
36	60,293	2.95	64,841,492	17,240,179			14,280,394	33,320,919	47,384	50,958,058	23,602,515	1,746,842
37	61,499	3.01	67,461,088	17,757,384			14,911,111	34,792,593	48,331	53,016,763	24,681,565	1,699,259
										Total FCFE	$22,000,000	
										NPV	$0	

3.6.2 Results

The parameters of the four selected collars in year 1, year 2, year 5, and year 10 are reported in Table 3-4. Take the collar in year 1 as an example to illustrate the calculation findings. The concessionaire's expected revenue in year 1 is $11,862,500, and its effective annual revenue falls in a range of $9,322,579 to $17,313,894. The benefit of the revenue shortfall protection provided by the put option is worth $154,070 as calculated using the Black-Scholes equation. The value of the put option equals the one of the call option that forfeits the concessionaire's right to retain revenue exceeding $17,313,894.

An alternative case was also run to evaluate the impact of a more modest (or pessimistic) traffic forecast upon the collar structure and the calculated outputs. The expected daily traffic in the first year of operation was reduced from 25,000 to 23,000 and the traffic growth rate from years 1 to 10 was dropped from 6% to 5%. The output results from these more conservative expectations are presented in Table 3-5. Compared to the original case, several differences are observed. First, the percent difference between the current price and the put and call strike prices narrowed, so the two thresholds of the collars have moved closer to the expected revenue levels. Second, the value of the puts and calls increases as a result of higher put strikes and lower call strikes; this is not surprising since the value of put tends to increase as the current price falls.

Clearly, if the expected traffic projection is even more pessimistic, then the spread between put and call exercise prices (corresponding to the values 2-2' and 3-3' respectively in Figures 3-2 and 3-3) will become narrower. Indeed, a traffic projection exists where the put exercise prices will be above the current prices (or in the money). In such a case, the underwriter is effectively guaranteeing the concessionaire a minimum rate of return under the expected scenario; the underwriter is unlikely to agree to such conditions even if some probability exists that current prices (or annual gross revenues) would increase above the call exercise prices. These observations reinforce the earlier discussions regarding the applicability and terms of a collar option. The underwriter needs to ensure itself of an acceptable traffic projection prior to entering a deal. While the applicability of the collar is limited to situations where expected traffic volumes permit a reasonable structure, a potential advantage of the collar structure not discussed previously is the market discipline that it could afford. Concessionaires and underwriters would need to carefully consider their risks and rewards in a marketplace for collars (as in any marketplace). Weak forecasts would discourage underwriters from participating in such deals while strong forecasts would typically preclude concessionaires from pursuing them; however, the volatility of a forecast could make the collar structure appealing to both concessionaires and underwriters.

Table 3-4: Base case output summary

Year[1]	Option Value	Current Price	Put Exercise Price (% Δ Current & Put)	Call Strike Price (% Δ Current & Call)
1	$154,070	$11,862,500	$9,322,579 (-21.4%)	$17,313,894 (46%)
2	$171,480	$13,202,963	$10,376,031 (-21.4%)	$19,270,363 (46%)
5	$236,427	$18,203,583	$14,305,952 (-21.4%)	$26,569,025 (46%)
10	$325,526	$25,063,675	$19,697,206 (-21.4%)	$36,581,659 (46%)

Table 3-5: Alternative case (modest traffic projection) output summary

Year*	Option Value	Current Price	Put Exercise Price (% Δ Current & Put)	Call Strike Price (% Δ Current & Call)
1	$357,915	$10,913,500	$9,639,738 (-11.7%)	$14,030,344 (28.6%)
2	$394,601	$12,032,134	$10,627,811 (-11.7%)	$15,468,456 (28.6%)
5	$528,803	$16,124,210	$14,242,284 (-11.7%)	$20,729,212 (28.6%)
10	$728,085	$22,200,682	$19,609,544 (-11.7%)	$28,541,094 (28.6%)

3.6.3 Additional discussion

Figure 3-9 illustrates the behavior of the put and strike prices relative to the current price for the base scenario. While the percent difference between these prices remains constant for both the put and the call, the rapid increase pattern for the strike prices is a reflection of the behavior of the Black-Scholes equation. A more refined model would be needed to evaluate how realistic this behavior is.
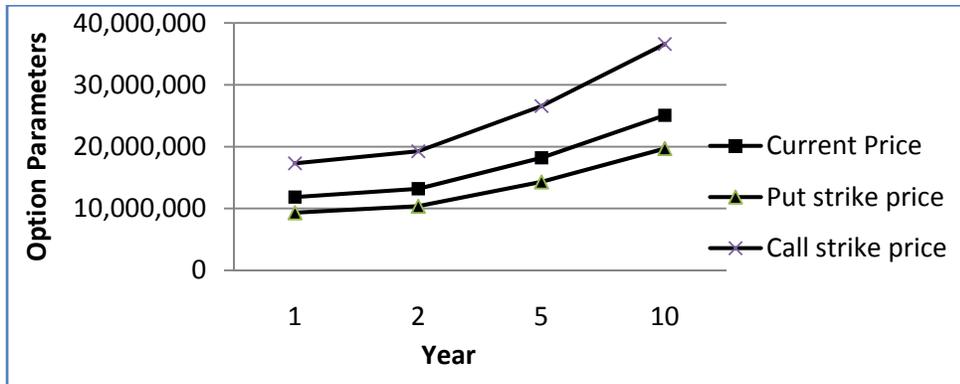
Figure 3-9: Option parameters' growth pattern

The validity of the assumptions in Black-Scholes equation used for real assets is open to debate. The Black-Scholes equation requires that the market where the underlying asset exists is complete so that a replicating asset can always be found whose value is perfectly correlated with the underlying asset's value. In other words, in a complete market the changes in the underlying asset's value can be spanned by the existing market securities (assets). The market completeness assumption is fairly challenging for real option valuation (Borison, 2005 and Lander and Pinches, 1998). Mattar and Cheah (2006) decomposed non-market risks into private risks and unique risks based on the investor's risk attitude and whether the investor is able to and willing to diversify them away (trade them). Mattar and Cheah (2006) suggest adopting the decision analysis approach to dealing with unique risks. Smith and Nau (1995) developed a hybrid method (decision analysis and binomial tree pricing) to handle unique and market risks similarly.

Alternative computational methods can be applied to replace the Black-Scholes equation and/or to alter the assumptions made. Smith and Nau's hybrid method could be used to calculate the call option and put option's prices respectively. However, adopting alternative methods to derive the put and call options' strike prices or incorporating several other uncertainties will not impact the valuation process presented in the numerical case; in other words, the valuation process

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illustrated in Figure 3-8 will not change. As explained earlier, the numerical case does not intend to refine the valuation process. Instead, it attempts to illustrate the calculation methodology and particularly focus on three issues unique to the proposed collar options: (1) choosing appropriate underlying assets; (2) setting up a cash flow model whose structure accommodates the valuation objectives, and (3) maintaining the zero-cost structure.

3.7   Revenue guarantee option's feasibility assessment

In order to investigate whether revenue guarantee options generally and collar options specifically are merely academic endeavors or can be endorsed by practitioners as a feasible tool, further research is on-going. Interviews are underway to obtain the perspectives of key stakeholders in PPP deals to include representatives of the government, concessionaires, financial institutions (underwriters in a third-party deal), financial advisors, and modeling service providers. The interview protocol was designed to assess each stakeholder's concerns based on their perspectives. For instance, a direct deal would require significant government financial expertise and experience, either in-house or available from consultants, to underwrite a guarantee option; this capacity is currently being assessed. From a concessionaire's perspective, the benefit and cost associated with the guarantee option is the primary concern, such as its risk profile (risk and return expectations) and perspectives on revenue sharing. In a third-party deal, an underwriter will need to consider the timing to expand its infrastructure investment portfolio, competition with alternative products, a minimum market demand to generate liquidity, and the government's commitment to honor the agreement. Last but not the least, modeling specialists' opinions on valuation techniques, availability of financial information and project data, and accuracy of traffic projections are also of great importance.

3.8   Conclusion

Revenue guarantee put options have been studied by previous research as a means of managing revenue risks in real toll PPP transportation projects. If implemented or utilized commercially within projects, a major constraint of this method is that it requires the concessionaire to pay a risk premium which it is likely reluctant or unable to do. A revenue collar can overcome this barrier. The opposite position in a put and a call option produces a collar with zero or less value. In addition to the removal (or reduction) of the upfront payment, the collar is worthy of

consideration for a number of other reasons, such as its embedded incentives, easy early termination, flexibility, and favorable tax treatment. The collar method is best suited for a project with moderate or promising cash flows and subject to revenue volatility throughout the lifecycle, especially in the ramp-up phase. Collar buyers and sellers need to examine the option terms and applicability prior to entering into a deal.

Two modifications to the basic collar enhance the risk management efficiency while addressing both practical and political issues in PPP projects: the downside loss is suggested to be shared by the concessionaire and the underwriter and the windfall profit is suggested to be captured by the government in a direct deal or shared by the government and the underwriter in a third-party deal.

The numerical example demonstrated how to determine the strike prices of the collar. The calculation method and the setup of key variables remain applicable even if a more sophisticated valuation approach is adopted. Subsequent research is on-going to seek practitioners' perspectives to assess the commercial potential of revenue guarantee options as well as the collar options described here.

4. Market perspectives of the feasibility of revenue guarantees in US P3 highway projects

4.1 Abstract

Revenue risk allocation is critically important for a successful Public-Private Partnership (PPP or P3) highway project. Funding methods such as real tolls and availability payments largely determine a project's revenue profile. In a real toll project where a concessionaire bears the majority of the revenue risk, risk management mechanisms need to be put in place to address the potential for low traffic demand and revenue fluctuations that are detrimental to a project's solvency. Some countries have used revenue guarantees as a revenue risk mitigation strategy, so this begs the question: can the same be done in the US market? Accordingly, revenue guarantees are discussed in the context of funding methods and revenue management techniques that contain downside loss protection and upside profit sharing mechanisms. Semi-structured interviews were then conducted to investigate the market's perspectives of the feasibility and impact of revenue guarantees.

4.2 Introduction

Risk allocation is of great importance for the success of P3 projects and the P3 market's development (Li et al., 2005; Ng and Loosemore 2007). Revenue risk allocation needs to be carefully examined because it influences a concessionaire's profitability and a public authority's budgetary planning. In real toll highway projects, some methods to reduce traffic risk that have been used abroad include using a variable concession length until a pre-defined investment objective is reached or allowing re-negotiation of contract terms. Another more direct approach is that the government provides a subsidy when a project's traffic/revenue does not materialize—a revenue guarantee approach. On the upper side of the revenue spectrum, governments may require concessionaires to share a portion of its profits beyond a certain level as a means of protecting the public's interest. For instance, the SH130 Segments 5 & 6 and the North Tarrant Expressway in Texas and the Capital Beltway project in Virginia have revenue sharing requirements. Those revenue management mechanisms reshape a project's risk and return profile to make it investable and protect the public's interest. The intricacy of a P3 megaproject that is bound by social and economic objectives, the government's financial conditions, and market competition, however, determines that selecting a revenue management

mechanism is by no means straightforward.

Generally speaking, with a revenue guarantee a concessionaire and a guarantor choose an underlying asset, such as traffic volume or toll revenue, and specify a guaranteed value of this underlying asset. In the event that the actual value of the asset falls below the guaranteed value, the guarantee compensates the concessionaire for its losses. Theoretically, the guarantor can be the government or a third-party financial institution. If the guarantor provides the downside risk protection, the concessionaire may be expected to pay for this insurance or transfer a portion of its upside revenue to the guarantor. Some countries such as Chile, Colombia, Korea and Spain, grant minimum revenue guarantees in exchange for sharing upside revenue (Mandri-Perrott, 2006). The purposes of these revenue guarantees are mainly threefold: to attract private capital and promote the local P3 market, to reduce the cost of capital, and to enhance a project's financial viability (Vassallo and Soliño, 2006).

Although the revenue guarantee has been utilized in some regions across the world, it is not currently practiced in the US. Market conditions, the political environment, economic policies, and P3 experience vary among jurisdictions. Therefore, one should not assert that the revenue guarantee concept will have (or not have) a market in the US, or that the mechanisms used in other countries can be readily applied to the US market. Some other developed countries that have mature P3 markets embrace a different principle. Australia and the UK have not chosen to provide such guarantees or direct operating revenue subsidies (Mandri-Perrott, 2006; Li et al., 2005).

With the backdrop that P3s are gaining more attention in the US and increasingly more projects are released for procurement, it is hoped that the revenue guarantee method can be an alternative tool in the risk management toolbox and be utilized to meet various project objectives. This research intends to investigate the prospects of revenue guarantees in the US. The balance of the article is organized as follows. First, it discusses the research background. Second, it explains why semi-structured interviews are chosen as a means of collecting information to assess revenue guarantees' feasibility, develops interview topics, and outlines the interview investigation process. Third, it presents interviewees' information and their background and

experiences. Fourth, it presents the interview investigation findings. Fifth, it discusses several issues pertaining to revenue guarantee implementation. Finally, it concludes the feasibility investigation and provides some suggestions.

4.3 Background

A principle followed throughout the research was that the feasibility of a revenue guarantee should not be assessed on a stand-alone basis; instead, it was explored in conjunction with funding method selection and upside revenue sharing requirements. These related topics impact the necessity of a revenue guarantee. For instance, if the availability payment approach takes a major share of the P3 market, then revenue risk would be less of a concern for concessionaires. Accordingly, the following is a brief introduction to funding methods. Integrated project delivery systems used in P3 highway projects include Design-Build-Finance (DBF), Design-Build-Operate-Maintain (DBOM), and Design-Build-Finance-Operate-Maintain (DBFOM), etc. (Buxbaum and Ortiz, 2009). With the DBFOM approach, a concessionaire is responsible for raising private capital, completing design and construction, and retaining long-term responsibility for operating and maintaining a facility; in return, the concessionaire is granted the rights to a revenue stream. Real toll projects, as its name suggests, charge user fees to fund a project. Shadow toll projects are free at the point of use, while a concessionaire is compensated by the government with a fixed fee per vehicle. In availability payment projects, the government reimburses a concessionaire with periodic payments which are typically subject to increase or deduction due to satisfactory or unsatisfactory service. These funding methods—real tolls, shadow tolls, and availability payments, in large part delineate a project's risk profile. A concessionaire bears virtually no traffic or revenue risk with availability payments while the risk increases with shadow tolls and real tolls.

Previous research has explored revenue guarantees from a conceptual and computational perspective. The authors have advanced this idea and studied the potential of implementing a guarantee. Shan and Garvin (2010) studied different funding methods along with existing revenue risk management strategies, compared the revenue guarantee approach with alternate credit enhancement tools, incorporated a revenue guarantee agreement into a project procurement process, and developed guarantee agreement terms. Shan et al. (2010) explored a

new revenue guarantee method—a collar option, a combination of revenue sharing and revenue guarantees. They examined the collar concept's advantages, to which projects it is applicable, and the dynamics of determining the levels of revenue sharing and revenue guarantee. It is important to recognize that an analysis based on a purely theoretical investigation may not accurately capture the industry's views or adequately address its concerns, which will ultimately determine the feasibility of revenue guarantees. Therefore, the author's prior research findings were synthesized to conduct a field investigation that reached out to agents in the market to seek their opinions. The prior work of the authors formed the basis of the topics and questions that were deemed important, as shown in Figure 4-1[2].
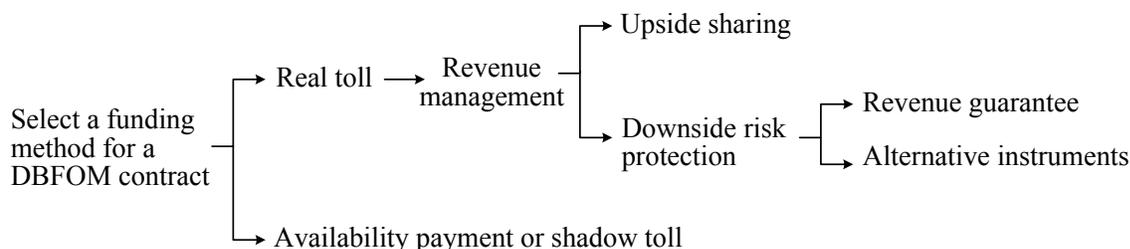
Figure 4-1: Investigation topics

4.4 Field investigation methodology

4.4.1 Data collection method—semi-structured interviews

It is important to choose an appropriate investigation method to solicit a maximum amount of information from practitioners while ensuring the validity and reliability of the information. Interviews and surveys (questionnaires) are two common methods to collect data. A semi-structured interview permits considerable freedom in question sequence, question wording, and in the amount of time and attention given to different topics. It offers the possibility of following up on interesting responses (Robson, 2007). In order to elicit the maximum amount of opinions and information, all topics explored in the data collection process should be open-ended questions. Answers to simple multiple-choice questions typically used in survey questionnaires, cannot fulfill this purpose (Robson, 2007). Therefore, this study used the semi-structured form of interview as opposed to surveys. In order to ensure the validity of the interview, the

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[2] Please find the interview topics' corresponding issues in Table 1-2.

interviews applied the criteria summarized by Campion et al. (1997) to design its interview protocols, such as:

(1) job relatedness: is the interview related to the content and objective of the task?

(2) reduced deficiency: does the interview elicit a large amount of useful information?

(3) reduced contamination: does the interview prevent contamination (e.g., false or irrelevant information) from entering the process?

The authors used judgmental sampling to determine which sectors and individuals would be approached for interview (Fellows and Liu, 2008). The judgment rationale is outlined in Figure 4-2, and the sampling will be explained along with the interviewees' information in the next section.

4.4.2 Interviewees' information

As shown in Figure 4-2, primary agents in a typical highway P3 deal include government officials (state DOT representatives), concessionaires, financial institutions (banks and other financial institutions), and advisors (legal, technical, and financial).[3] Government officials are procuring authorities and they may also provide public funds. Concessionaires contribute private equity and are ultimately responsible for a P3 project's services. Financial institutions are either lending agencies or play a key role in bond issues. Advisors assist government officials and/or concessionaires throughout the procurement process in various aspects. Although technical and legal advisors also participate in a deal, this study's focus on the revenue risk and financial aspects limited the interview sample to financial advisors only.
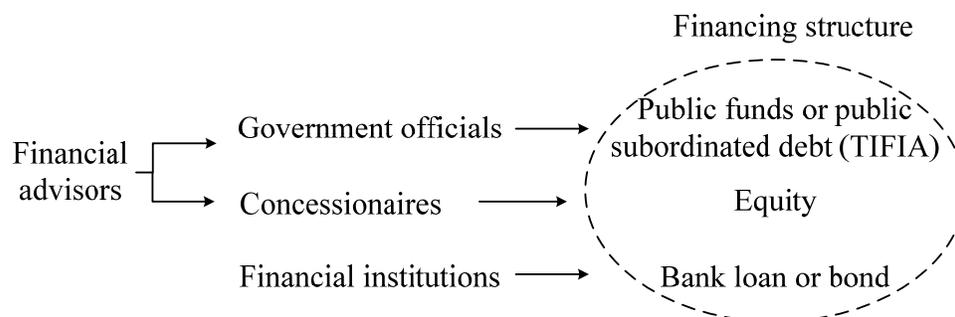
Figure 4-2: Primary agents

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[3] The financing structure in Figure 4-2 relates to the one in Figure 3-7.

Table 4-1 illustrates that the study solicited 43 people's interest in participating in the investigation and 20 people responded. These respondents' personal and organizational identities were kept confidential. Among the 5 interviewee categories, it was relatively difficult to arrange interviews with government officials due to the fact that only a handful of US states are active in P3 projects and few of them have the resources or experience to share opinions in financial matters associated with revenue risks. The scarcity of government representatives is remedied by the participation of 3 financial advisors who have worked closely with state DOTs in their P3 projects. As shown in Table 4-2, interviewees have ample experience in public finance and the P3 field: 12 interviewees out of the 20 participants have worked in project finance and/or the P3 field for more than 15 years; 14 interviewees have been involved with a project worth more than $2 billion; and 10 interviewees have participated in at least 10 project finance and/or P3 deals. Most interviewees hold senior positions in their organizations: they are program directors in state DOTs, managing directors in financial advisory companies and financial institutions, and executive officers in concessionaire companies.

Table 4-1: Interview respondents

Interviewees' Category	Contacted	Participate
Government officials	5	2
Concessionaires	16	7
Banks	13	4
Financial advisors (3 representing the government)	10	6
Other financial institution	1	1
Total	43	20

Table 4-2: Interviewees' individual background distribution in four categories

Years of experience	No.	P3/public finance deals	No.
>15	12	>10	10
10-15	4	>4	7
5-10	1	>2	3
< 5	3	<2	0
Highest contract value	**No.**	**Position**	**No.**
>2 billion	14	CEO/CFO/VP	4

>1 billion	2	Director	4
>500 million	4	Managing director	10
<500 million	0	Senior analyst	2

4.4.3 Interview process

The interview process is illustrated in Figure 4-3. Based on the broad interview topics identified, a set of protocols corresponding to each interviewee's sector was developed.[4] Subsequently, the protocol for each sector was modified slightly to account for each interviewee's organizational affiliation. For example, some organizations were involved in particular projects, so probing for their opinions in relation to these projects was expected to enhance the interview process. Two mock interviews were conducted to practice the primary investigator's interviewing skills as well as to test the interview protocols. The major interview questions as well as a brief introduction of revenue guarantees[5] were then sent to each interviewee in advance to allow her/him to prepare for the discussion. Not surprisingly, some interviewees offered unexpected but interesting and insightful comments. When appropriate the interviews were adjusted based on the interviewee's responses to 1) eliminate questions that had become less relevant or unnecessary and 2) spend the saved time in following up new and insightful comments to generate the most productive discussion within the limited time. Additionally, related questions were sequenced from broad to specific in order to lead interviewees into the discussion step by step in a more natural manner (Gubrium and Holstein, 2002).

Within a week after the interview, a transcription of the conversation was sent to each interviewee to ensure that it reflected his/her intention. Content was analyzed using interpretive techniques where a typological rubric was employed (Fellows and Liu, 2008).   As the investigation progressed, the authors observed that a few interviewees consistently mentioned several issues that were not contemplated by the authors previously, and some pre-developed questions were no longer relevant.

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[4] Protocols are shown in Appendix 1 to 4.
[5] Revenue guarantee introduction is shown in Appendix 5.
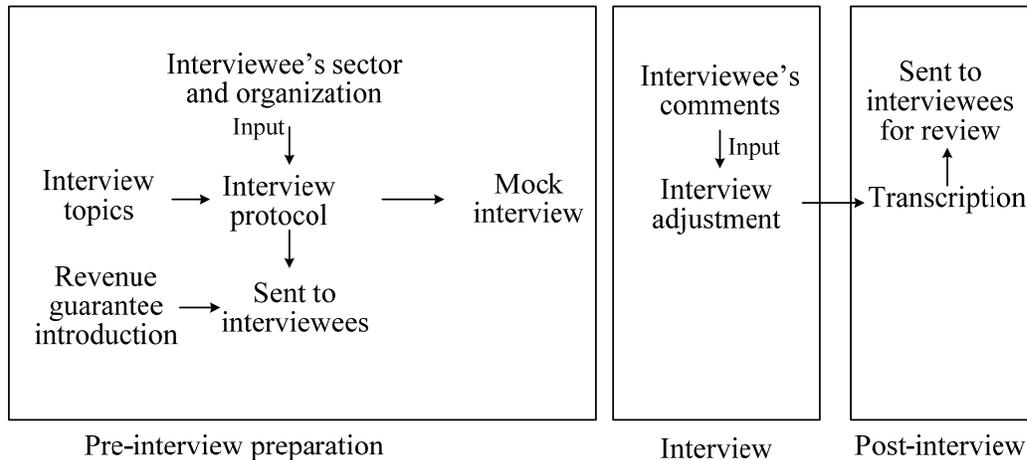
Figure 4-3: Interview process

4.5 Case projects' information

Throughout the interviews, two recent P3 projects—the I-595 Corridor Roadway Improvement project and the North Tarrant Expressway project, were frequently cited. Below is a summary of the projects' key facts.

I-595 Corridor Roadway Improvement project

The scope of the project includes the reconstruction, addition of auxiliary lanes, resurfacing the I-595 mainline, and a new reversible express lanes system in the I-595 median. The financing structure consists of $780 million bank loans, $665 million TIFIA loans, and $190 million equity. This project is the first US P3 to use the availability-payment model. The Florida Department of Transportation will impose variable congestion pricing on the new express lanes and will retain both the tolls collected and the project's demand risk (Project Finance, 2009).

North Tarrant Expressway project

This $2.02 billion project in Texas will rebuild and expand 13 miles along I-820 and SH 121/183 from I-35W to the SH 121 split. The financing structure consists of $573 million public funds, $427 million equity, $650 million TIFIA loan, and $400 million private activity bonds. It is the first real toll project that reached the financial close after the financial crisis. The unwrapped bond (without bond insurance) component suggests that concessionaires are no longer reliant on banks or bond insurance to help complex traffic risk projects access bond debt (Project Finance,

2010).

4.6 Interview results

The interviews explored four major topic categories: funding method selection, excess revenue sharing, current credit enhancement tools, and the feasibility of revenue guarantees. The interview findings are reported and analyzed below.

4.6.1 Funding method selection

Since there is little presence of shadow tolling in the US, the interviews focused on availability payments and real tolls. All of the interviewees were involved in or aware of projects procured using different funding methods, including real tolls and availability payments.

4.6.1.1 Appetite/preference for funding methods

Following the credit crisis in the financial market in 2008-09, lenders' risk appetite as well as lending capacity was greatly reduced. With the recent successful closing of two availability payments deals in the US, the I-595 Corridor Roadway Improvement project and the Port of Miami Tunnel project, more attention has been given to this type of funding method that essentially replaces demand/market risk with appropriation risk. If the availability payment method begins to dominate the market in the near future, then the revenue risk will be less of a concern and consequently, the revenue guarantee will become less applicable.

The interviewees were asked about their organization's appetite or preference for the funding methods. They consistently responded that a variety of funding methods should exist in the market. As shown in Figure 4-4 only 2 people representing financial institutions and concessionaires reported that their organizations are currently exclusively focusing on availability payment deals; others expressed that they do not preclude any particular funding methods, and they have the capacity to take real toll risks provided targeted projects have a reliable procurement framework and are financially investable. One interviewee (not a concessionaire representative) stated that he supports availability payments deals in general.
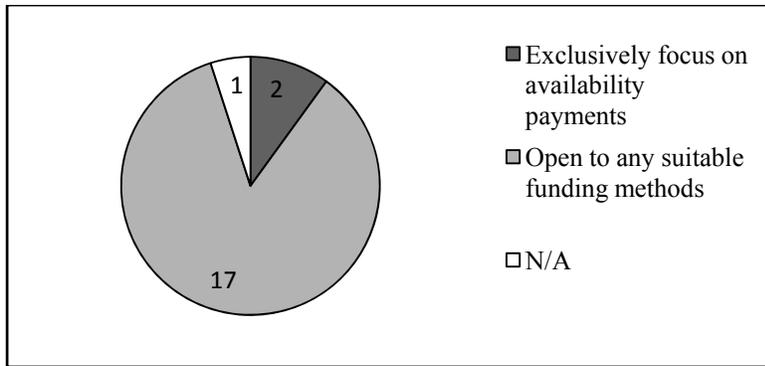
Figure 4-4: Poll question results—funding methods preference

4.6.1.2 Issues to consider when selecting a funding method

Following the general indication of the capacity for absorbing real toll risk, the interviews explored specific concerns of the government, private developers, and financial institutions over selecting a funding method.

Public sector perspectives

The government officials and their financial advisors explained that they consider project objectives, political acceptance, market competition, and funding availability.

- Project objectives

The government desires to achieve a number of objectives in a project. According to a report by the U.S Government Accountability Office (2008), the government typically attempts to keep tolls at a socially acceptable level, maximize the number of new facilities provided with limited public funds, potentially earn the largest up-front payment, and improve mobility. For instance, in the I-595 project, the primary goal of the procuring authority, the Florida Department of Transportation (FDOT), was to increase total throughput in the corridor (Jeffrey A. Parker & Associates, Inc., 2009). However, interested private developers revealed that a real toll structure would require them to maximize revenue. It conflicted with FDOT's goal because traffic forecasts indicated that depending on price elasticity, higher tolls could result in greater revenue but lower utilization. To eliminate private developers' concerns and fulfill the goal of increasing throughput, FDOT chose the availability payment method where the revenue risk is absorbed by the public sector.

- Political acceptance

In some jurisdictions, the government faces a strong objection from the general public against tolling. According to one interviewee, the UK is such a case. In a country where the general public is usually in favor of taxing as opposed to tolling, the availability payment method which builds infrastructure facilities with tax revenue encounters less political obstacles.

- Market competition

The pool of qualified private developers for a multi-billion dollar P3 highway project is small. If a project uses real tolls, the government will have to consider the impact of limited market competition on the contract value and terms.

- Funding availability

The government needs to evaluate its funding availability and consider how to efficiently use funds over time. It can either deploy immediate cash for a real toll project or commit future cash for an availability payment project.

Concessionaire perspectives

From a concessionaire's perspective, issues to be considered when participating in a P3 deal with one particular funding method include:

- The government's financial condition

In an availability payment deal, a concessionaire's future revenue is subject to the counterparty's creditworthiness as well as appropriation risks. It is wise to carefully examine the procuring authority's financial conditions at present and in the foreseeable future. A few interviewees indicated that they are much more comfortable working with states that have budgetary resources and are more likely to fulfill their future funding commitments. A concessionaire is reluctant to enter an availability payment deal with a state that is deep in debt.

- Ability to take risk

A private developer's past experience and organizational structure dictate its ability to take full

traffic risk.   Several internationally-recognized large private developers stated that they have been practicing in the P3 area for decades, so they understand traffic risk and are less uneasy about it. Another issue is that some large companies own a construction arm. The organizational structure allows them to jointly manage construction and operation risk. Operational losses can be offset by the savings earned during the construction period and vice versa. However, it might be difficult to transfer gains and losses across the units if companies have separate or less co-mingled units.

- Shareholder's investment policy

Companies' investment policies determine the type of investment and risk they can undertake. For instance, some construction contractors are restricted from bearing a great deal of traffic risk.

Financial institution perspectives

From financial institutions' perspectives, issues to be considered include:

- Past experience

Previous negative experience will impact financial institutions' future lending decisions. A concern expressed was that traffic projection models are notorious for producing inaccurate ridership projections for greenfield projects in which no previous traffic history exists. If the projected traffic does not materialize, the project could be in danger of failing to fulfill its debt service obligations.   For instance, the Lane Cove Tunnel project in Australia suffers from overestimated traffic forecasting and is currently undergoing a receivership process to be sold to another potential interested buyer. If a lender has gone through a similar ordeal, it is expected to be very conservative and would have a very limited appetite for real toll projects.

- Current capacity

Some institutions simply do not have the capital capacity and knowledge necessary to participate in real toll projects.

Other perspectives

The interviewees pointed out that the US has a unique bond market that issues tax-exempt bonds for infrastructure projects, while most of other jurisdictions do not. The US bond market is

mature and is comfortable with the government's appropriation risk. The North Tarrant Expressway project issued Private Activity Bonds without arranging any credit enhancements. This indicates that the bond market is recovering. On the other hand, the US lending institutions are not as sophisticated as their peers in European countries where, without a tax-exempt bond market, most of the P3 deals are financed by banks. These lending institutions are experienced in public finance and to some extent take the role of the municipal bond market in the US.

4.6.1.3   Other options for a real toll project with a low traffic demand

Some interviewees offered their opinions regarding what other options exist for a real toll project with a low traffic demand.

Hybrid of availability payment and real tolls

The A25 and A30 projects in Quebec, Canada utilized a method that combined availability payments and real tolls. The traffic was estimated to be too low to allow concessionaires to earn a reasonable rate of return. Availability payments were put in place to provide a form of subsidy to the concessionaires (obviously the availability payments also serve as an incentive for the concessionaires to perform their operation and maintenance obligations to a pre-determined quality level). The present value of the total availability payments was one of the bid selection criteria: the winning bid was expected to request a lower amount of total availability payments.

LPVR with revenue guarantees

The LPVR mechanism (least present value revenue) alleviates traffic risks borne by a concessionaire. A concessionaire is guaranteed to earn a certain amount of least present value from a project, and the concession length will be automatically extended until this objective is achieved. However, for a project with significantly low traffic, the concession length needed to generate the required net present revenue can be tremendously long. One interviewee argued that in some circumstances the present value of revenue in remote years is so low that extending the period would not make a meaningful difference to the total present value. As a result, LPVR is not sufficient to make some projects with a drastically inadequate traffic projection financially viable. A revenue guarantee could then be used to supplement the LPVR approach with a cap to the concession length. In the event that the least present value does not materialize at the end of

the maximum period, the government would pay the concessionaire the balance of the pre-agreed value. Another scenario is that traffic demand increases sufficiently to justify expansion by building an alternate route. The government can utilize revenue guarantees to terminate the concession early to release itself from any non-compete requirement, for example in the Route 68 concession in Chile (Engel et al., 2009).
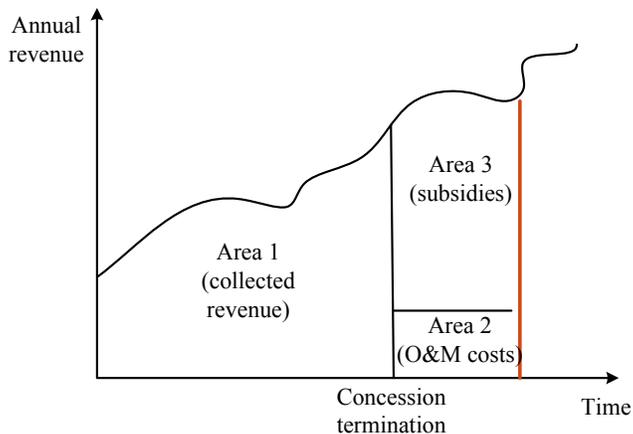
Figure 4-5: Revenue guarantee mechanism with a LPVR approach

Figure 4-5 schematically depicts how revenue guarantees are derived in Chilean projects. Whenever a concession is terminated either because a maximum operation period is reached or the government decides to terminate it early, the actual revenue earned by the concessionaire up to that point (area 1) will be compared against the pre-determined least revenue it is entitled to obtain (area 1+area 2+area 3), and the difference is the gross revenue shortfall (area 2 + area 3). The government will then deduct the portion of hypothetical O&M expenses (area 2) from the missing revenue and compensate the concessionaire with a cash payment worth area 3.

Other approaches

Several other options are available to make a project feasible. First, the government can scale down a project so that available funds are sufficient. Second, the government can make a larger amount of funding contribution to construction cost if the project is initially not feasible or it aims to keep toll rates at a socially acceptable level which is likely lower than that a concessionaire would request.

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4.6.2 Revenue sharing requirement

Revenue sharing allows the government to retain a portion of upside revenue in a real toll project. It relieves the general public's concern over a private entity reaping windfall profits from a P3 infrastructure project. All the interviewees indicated that this requirement is becoming more common in P3 deals, especially in the US. However, some concessionaires argued that the revenue sharing provision does not necessarily balance risk and reward very well and if their upside return is capped it is fair to expect a downside risk protection mechanism as well.

4.6.2.1 Revenue sharing trigger criterion

A criterion is pre-defined to determine when revenue sharing takes effect. Two of the most common criteria are internal rate of return (IRR) for equity investors and gross revenue. Interviewees were asked about the merits and shortcomings of each method. Advantages of IRR include:

- Alignment with equity investors' objectives

IRR creates a time period for equity investors to recover construction cost overrun and revenue losses during the ramp-up period. IRR is aligned with investors' fundamental objective in any investment—making profits measured by rate of return.

- Allow government oversight

How much profit investors earn in the end depends on how much gross revenue flows through to net income. With the right to audit and monitor operation expenses, the government is able to jointly manage and supervise the facility with the concessionaire. Several interviewees, however, had another opinion on this matter. They suggested that the US procuring authorities wish to shift risks to concessionaires to a maximum extent while still maintaining a significant amount of control. An example is a comparison of how quality assurance (QA) and quality control (QC) are managed in European countries and in the US. Following a European scan tour in 2001, the FHWA reported that the US public sector acknowledged the fact that QA and QC require many procedural revisions in more integrated delivery systems, such as design-build, and it concluded that more responsibility should be placed on contractors. European countries adopt International Organization for Standardization (ISO) standards throughout the supply chain which enables

substantial owner reliance on system audits rather than physical tests (Startin et al., 2008).

Disadvantages of IRR include:

- Unstable

IRR is an unstable parameter and subject to many factors, including capital structure and debt arrangement changes.

- Audit and monitoring burden

IRR creates an auditing and monitoring burden for the government. To prevent the concessionaire from manipulating accounting numbers, the government needs to carefully examine the reports prepared by the concessionaire, which takes a great deal of effort, especially for a complex megaproject.

- Changing risk allocation

The IRR method inherently shifts the concessionaire's performance risk back to the government. A concessionaire would be indifferent between a 10% IRR with a $100 million O&M cost and the same IRR with $150 million cost. A portion of increased revenue could have been shared by the government, but under the IRR scheme the revenue might be consumed with the O&M cost overrun caused by the concessionaire's inefficient performance.

On the other hand, gross revenue is transparent and objective. It also isolates the government from the concessionaire's operation performance. When asked about the favorableness of the two criteria, 11 people stated that they are in favor of gross revenue compared to 4 people in favor of IRR (shown in Figure 4-6)
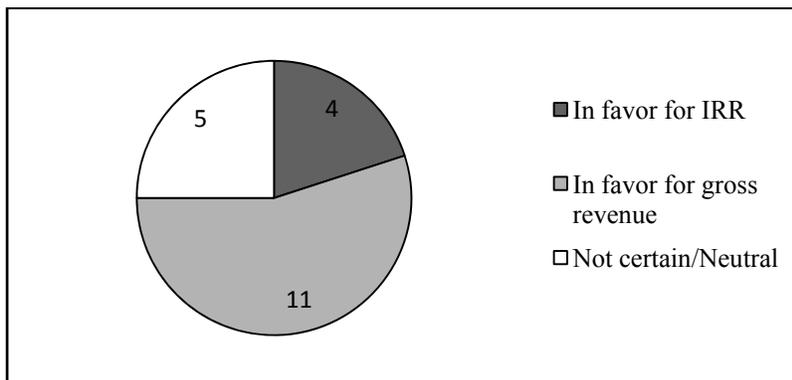
Figure 4-6: Poll question results—revenue sharing trigger criterion

4.6.2.2 Setting revenue sharing threshold

The interviewees discussed two ways of determining a revenue sharing threshold. The first approach is based on negotiation. The government proposes an IRR and invites opinions from interested concessionaires. If all concessionaires deem the rate is too low, the government can make revisions accordingly. The government will typically view a proposal requiring a higher IRR rate less competitive since it lowers the chance of it sharing revenue with a concessionaire. Another approach was implemented in the North Tarrant Expressway in Texas. The government requested bidding teams to submit their base financial models including base IRRs. Next, the bidding teams held every other item in the model constant except the gross revenue and derived a set of IRR trigger bands by solely changing the gross revenue. For instance, $1,000 million gross revenue generates a 10% IRR, and $1,500 million revenue generates a 15% IRR and that is the point where revenue sharing starts to take effect. With $1,500 million revenue, the concessionaire might actually earn an IRR in the range of 14% to 16%, but that is not the government's concern. Whenever the revenue reaches the $1,500 level, the revenue will be shared. In some sense, this method combines the IRR method and the gross revenue method. It still uses IRR as the final trigger criterion so that investors' interest and objectives are addressed, but it essentially leaves the performance risk to the concessionaire.

Several interviewees recommended that one should be aware of the relationship between revenue sharing and equity contribution. A lower sharing threshold increases the chance of profits being shared with the government in the future. To maintain an adequate revenue stream, a concessionaire has to either reduce investment or cut capital expenditure throughout the operating phase (another method is to increase revenue, but revenue is generally out of its control). Since it is difficult to reduce maintenance and upgrading expenses needed to maintain a facility's performance, reducing upfront investment is more plausible. If a revenue sharing requirement is imposed and consequently the concessionaire reduces its equity investment, the government may have to instill more public funds upfront. There then arises a question of how to trade present public funding contribution with future revenue sharing. The interviewees stated

that no clear-cut answers exist and the decision depends on public policies and objectives, and the funding situations of the public authority.

4.6.3 Current credit enhancement instruments

In parallel with other options for a real toll project with a low traffic demand discussed previously, external credit enhancement instruments address the revenue risk as well although they exclusively protect creditors. The interviewees were inquired of the status of the current instruments.

Letter of credit (LOC)

One of the major impacts of the credit crisis in issuing institutions was the need to find liquidity to fund the letters of credit they issued at the height of the crisis. A letter of credit is typically callable in a short time period. These institutions need to either guarantee that they are able to access the funding should the LOCs be called, or they have to rely on a portfolio which has relatively small exposure. Therefore, the overall appetite for LOCs has been reduced. Although these institutions are still willing to provide LOCs for valued clients, they may require cash securities as collateral and process LOCs more as loans.

Bond insurance

With the fall of monoline insurance companies, bond insurance is formidably hard to obtain at a reasonable cost. The insurance companies have a limited appetite for any full traffic risk projects. Two interviewees indicated that depending on a project's structure and conditions, the maximum insurance coverage is around $300 million, which is less than many revenue bonds' total value.

The $2 billion North Tarrant Expressway issued $400 million tax-exempt private activity bonds (PABs). The project is the second project in the US which issued PABs, the first one being the Capital Beltway project that closed prior to the financial crisis. The PABs in the project are not secured by a credit enhancement instrument. One of the reasons was that the bonds have a fixed coupon rate and thus there is no requirement for remarketing (re-underwriting the bonds) or a letter of credit.

Other instruments

The interviewees discussed several other credit enhancement options. The TIFIA program provides loan guarantees to non-federal lenders and a standby line of credit that instills a contingent federal loan to supplement project revenue during the first 10 years in the operating phase. The European Investment Bank (EIB) provides a loan guarantee instrument for Trans-European Transport Network Projects (LGTT). Under the LGTT the EIB accepts exposure to higher financial risks than under its normal lending activities. A concessionaire arranges a stand-by liquidity facility (SBF) which can be drawn on in case of an unexpected reduction in traffic income to assure the service of its senior credit facilities. The SBF provider can then call upon the EIB guarantee during a limited period of time (up to 7 years), and the EIB will reimburse the SBF provider and become a subordinated lender (EIB, 2009).

4.6.4 Revenue guarantee

15 people indicated that a revenue guarantee can be a viable tool to manage traffic risk as displayed in Figure 4-7. The remaining 5 people who were either uncertain or gave a negative answer were generally in favor of availability payment deals in which revenue guarantees are not applicable.
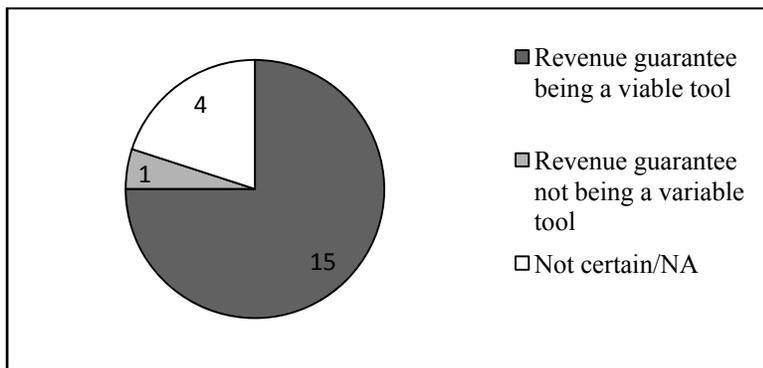
Figure 4-7: Poll question results—revenue guarantee's function

4.6.4.1 The objective of revenue guarantees

Revenue guarantees can be used as a means of providing subsidy and attracting interested concessionaires to participate or reducing a project's cost of capital. The interviewees were asked about the primary purposes of revenue guarantees if implemented in the US. 9 people

explicitly stated that revenue guarantees should only be utilized to close a funding gap in the operating phase as opposed to the construction phase as shown in Figure 4-8. Several interviewees, however, cautioned, that US procuring authorities desire to shift as much revenue risk as possible to concessionaires and would be reluctant to provide any subsidies unless absolutely necessary.
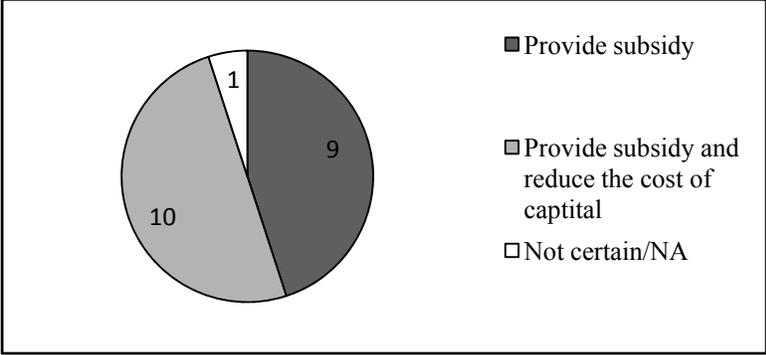
Figure 4-8: Poll question results—revenue guarantee's objective

4.6.4.2 Revenue guarantee provider

A potential revenue guarantor can be a public agency or a third-party financial institution. As depicted in Figure 4-9, 14 people thought the US government should issue a revenue guarantee. Some of the remaining 6 people believed that if the government has to take traffic risk, it may well use a traditional Design-Bid-Build method or availability payment deals. Establishing a revenue guarantee program requires a firm grasp of traffic risk. One interviewee was concerned about the US procuring authorities' knowledge and experience in project finance, which are essential to structure sophisticated revenue arrangements. It also needs to price the contingent liability and incorporate it into its fiscal plan. Another barrier is legislative restrictions that prevent a public entity from entering into future liabilities. If an availability payment is viewed as an actual liability, a revenue guarantee is a contingent liability. Both of them are subject to appropriation risks. In the US, there are many restrictions on which entity can guarantee what type of debt, how much debt it can issue, and for which purposes debt can be spent. In addition, many projects are not procured by state entities; they are on a region/county level which may not have any ability to guarantee debt.
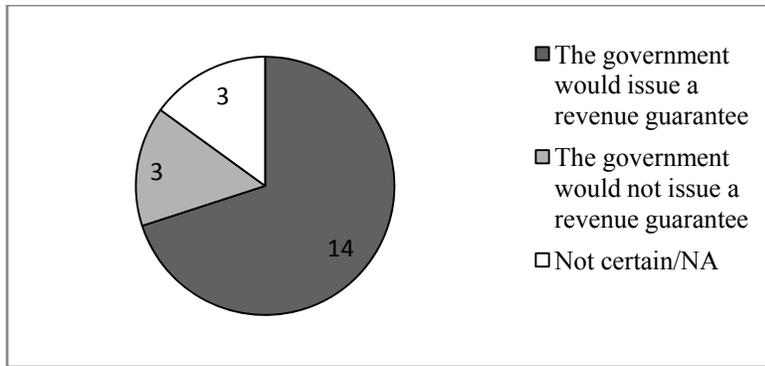
Figure 4-9: Poll question results—the government being a guarantor

All the interviewees who responded to the question of whether a financial institution would issue a revenue guarantee gave a negative answer. The reasons are explained as follows.

- Not core business

Revenue guarantees are not a financial institution's core business. Financial institutions might stand behind debt issues but not real assets relying on toll revenues.

- Uneasy about other institutions' credit risk

Subsequent to the financial crisis, most financial institutions have been uneasy about their counterparties' long-term creditworthiness. Theoretically, a bank lending funds to a concessionaire should demand a lower cost of capital if the concessionaire arranges a revenue guarantee with another entity. However, skittish lending institutions are concerned about whether the guarantor could maintain a strong credit rating and stand ready for the guarantee to be drawn at any time prior to the guarantee's expiration date.

- Regulatory barrier

One needs to refer to each individual state's laws and regulations to confirm insurance companies' eligibility to participate in revenue guarantees. Monoline insurance companies are subject to laws and regulations as to what type of insurance they can provide. For instance, N.Y. ISC LAW article 6901 stipulates five events where an insurer can compensate a guarantee policy, and revenue shortfall is not one of them.

- Informational disadvantage

If a financial institution issued a revenue guarantee, it should be confident in its understanding of the inherent risks associated with traffic uncertainties and its ability to price the risks. However, one interviewee suggested that a financial institution is at a disadvantage compared to the guarantee beneficiary—a concessionaire, in terms of information and knowledge in traffic and revenue. Without a firm understanding and ample experience, a financial institution will find it difficult to price the guarantee accurately.

- Valuation risk

Revenue guarantees are subject to modeling risks. It is common knowledge that traffic projection models oftentimes overestimate traffic volume. In addition, traffic specialists use similar models. If those models produce incorrect results, then all the revenue guarantees a financial institution issues will suffer losses.

- No diversification effect

Given the fact that there are few real toll P3 deals in the US, financial institutions would currently have difficulty in diversifying a revenue guarantee portfolio.

- Equity risk

Interviewees suggested that financial institutions would not take traffic modeling risks directly. The traffic projection risk should be retained by equity investors who make or provide traffic projections, and equity investors serve as a buffer before senior debt creditors draw upon any revenue guarantees. Depending on where the guarantee revenue level is set, a revenue guarantor effectively takes equity risk. The interviewees believed that most financial institutions do not want to enter into such a position.

- Uncontrolled risk

A revenue guarantee should only hedge risks associated with market forces; otherwise its value cannot be priced. Take toll rates as an example: if the toll rate is set completely at the government's discretion, its unilateral decision will impact the revenue stream behavior. In the event that revenue declines as a result of escalated tolls, it is impossible to isolate the impact of

the government's policy and determine to what extent the guarantor should be responsible for the loss.

4.6.5 Contingent liability accounting treatment

Another interesting issue discussed in the interviews is the accounting treatment of contingent liability. A revenue guarantee has been considered a type of contingent liability for a long period of time. However, the term is problematic. According to the International Accounting Standard Board, liabilities arise only from unconditional (or non-contingent) obligations. An obligation that is contingent or conditional on the occurrence or non-occurrence of a future event does not by itself give rise to a liability. It proposes to use the term 'contingency' to refer to uncertainty about the amount that will be required to settle a liability, rather than uncertainty about whether a liability exists. It also does not permit contingent liabilities to be recognized but requires them to be disclosed unless the possibility of any outflow of economic resources in settlement of the liability is remote. These accounting standards are important in that they determine whether a revenue guarantee will be recorded on a government's balance sheet and thus impact its fiscal situation.

4.6.6 Revenue guarantee implementation

The interview findings reported in the previous section focused on the feasibility of revenue guarantees in the US market. Although the interviews did not go further and explicitly discuss revenue guarantee implementation, the information drawn from the interviewees' comments can be used to infer some implementation suggestions.

Guarantee threshold

One of the common rationales of using P3 is to access private capital and spend less public funding for infrastructure needs. Revenue guarantees address the issues of risk allocation and project feasibility. However, it begs the question of whether the government has sufficient resources for its commitment. One interviewee commented "if the government is able to issue a full revenue guarantee to lift the actual revenue to the expected level, it might just choose availability payments." From a developer's perspective, the cost of a higher guarantee threshold

may be too high to generate a reasonable rate of return. One possible solution is that a concessionaire only demands a guarantee that is adequate for its debt repayment obligations. For instance, assume a project's expected revenue is $100 million, $70 million is the minimum income needed in order to repay its debt. A developer will retain the risk of revenue falling in a range of $70 to $100 million. A concessionaire's equity is by definition at risk and should accept the possibility of a $30 million revenue shortfall.   In addition, a partial guarantee allows more projects to access the government's limited funding pledged for revenue guarantees.

The revenue guarantees used in Korea and Chile are usually coupled with a revenue sharing requirement, and the two thresholds are symmetric to the expected revenue level in most of the projects: for example, share when actual revenue is 130% of the expected revenue and subsidize when it is 70% of the expected revenue. This symmetrical structure should, however, depend on a project' conditions and both parties' objectives.

Guarantee length

A concessionaire should consult with the government and decide when to start a revenue guarantee and how long it should last. A guarantee can be effective through the ramp-up phase in a greenfield project or until all debts are paid off.

Guarantee trigger criterion

Revenue guarantees and revenue sharing are two activities targeting the two ends of a revenue spectrum. Since gross revenue is deemed more effective as a revenue sharing trigger criterion, it might also be used as a revenue guarantee trigger criterion. When both revenue guarantees and sharing are arranged in one project, using the same criterion will keep the calculation straightforward and consistent.

Coverage eligibility

The government can set a subsidy eligibility criterion as an incentive for a concessionaire to exercise its due diligence to produce a traffic projection within a reasonable range of accuracy. For example, the concessionaire is only eligible to claim the guarantee under the condition that the actual revenue is between the forecasted level and 40% below the forecasted level. This way,

the government's losses are capped. However, the two parties need to negotiate to exempt the concessionaire from extraordinary events such as natural disaster or severe economic recession.

4.7 Discussion

4.7.1 Reflection

Reflection on the interviewees' responses prompts the following observations.

Revenue sharing

Most of the interviewees indicated a growing trend for revenue sharing, but they did not discuss why. The authors speculated as to why a revenue sharing requirement was excluded from some previous P3 projects, and arrived at three possible reasons. One is that the estimated future revenue was too low for revenue sharing to be meaningful and effective. The second is that the government preferred to receive a larger upfront payment by not placing such requirement. The third reason is that a monopoly position gives a few concessionaires the bargaining power to reject the requirement. Analyzing these reasons and their applicability to the future US P3 market provides a possible explanation for the revenue sharing requirement's upward trend. It would not hurt to place a revenue cap for a project with low traffic demand. What makes a meaningful difference is the revenue sharing level. Although a cash-constrained government desires more upfront cash, the strategy of exchanging future revenue for upfront payment has been criticized for not protecting the general public's interest properly. Therefore, the second rationale would face more political challenge. Since market interest is adequate in the US, it is less likely for any concessionaire to establish a monopoly position, so the third reason is no longer applicable. The three reasons are becoming less relevant in today's P3 market, which supports the interviewees' opinion that revenue sharing agreements will become more common in the future. In addition, numerous bills have been introduced by the U.S. congress in recent years to impose a windfall profits tax on oil companies whose excess income is not earned by any additional effort but due primarily to record crude oil prices set in the world oil marketplace (Coswell, 2009). It is unlikely that transportation authorities would ignore a similar issue in highway P3s and make no effort to address the concern.

Incentive regulation has long been adopted in industries such as telephone, water, electricity, etc.

(Braeutigam and Panzar, 1993; The World Bank Group, 1996; U.S. Department of Energy, 1997). There are two main approaches to preventing monopolistic infrastructure firms from charging excessively high prices: price cap regulation and rate-of-return regulation. The rate-of-return approach has been widely used in the U.S., Japan and Canada as opposed to the U.K. where price cap regulation is preferred (The World Bank Group, 1996). The U.S. has started to adopt other systems, such as price-cap and revenue-cap regulation. Braeutigam and Panzar (1993) noted that during its transplantation to the U.S., price-cap regulation is combined with rate-of-return criteria by most regulators, which is similar to the approach adopted in the North Tarrant Expressway case.

Extend sampling pool

The most unexpected response from the interviews was the unanimous negative opinion on financial institutions' willingness to issue a revenue guarantee. Since all the financial institutions interviewed are based in the US, would the response be different if it was given by European institutions? As discussed, European banks have been providing funds for P3 projects for decades and are more comfortable with the P3 mechanism and traffic risk than their peers in the US. Maybe they are less concerned with the issues raised by the interviewees? Maybe there is no legislative restriction on the revenue guarantees or future regulation support can be built relatively easily?

Closer partnership

It was not surprising to observe that each interviewee's opinions were affected by their own perspectives.[6] For example, most of the support for gross revenue as the revenue sharing trigger criteria was voiced by financial advisors who do not have a vested interest in the actual criteria used, and therefore this opinion's objectivity is somewhat assured. However, the support for the free put option structure of the revenue guarantee was voiced by a mix of financial advisors and concessionaires. As revenue sharing requirements driven by political concerns become more common in the current P3 market, concessionaires are left with little choice but to accept the requirement. They could, however, push for downside revenue protection as compensation for

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[6] One exception may be financial advisors who usually have no direct interest in a deal and thus can objectively discuss both the public and private sides' perspectives.

the forfeited upside revenue. The free put option exactly meets their needs.

It is reasonable for each agent to protect or pursue its own interests, and in some circumstances, conflicts of interest are unavoidable. However, a balance needs to be established in order to promote the prosperity of the P3 market. One interviewee stated:

> "Both sides (public and private) have to understand their counterparty's expectations. Otherwise, you won't be able to manage the risks…… In many instances they (P3 agents) are failing because they don't understand what the other party is seeking."

Responses revealing risk appetite

The fact that no guarantees for projects with moderate traffic demand are desired by most of the interviewed concessionaires indicates that they prefer to retain and manage traffic risk and harvest the associated additional return. Real toll projects are the most lucrative investments and viable proposals will be pursued by capable concessionaires.

This same risk appetite also results in the preference for guarantees only in the ramp-up phase. As a result, the collar option structure's applicability may be undermined given this preference: collar options cannot last only during the ramp-up phase since the call option is most likely out-of-money and the government would not be able to share any revenue in the ramp-up period.

Responses impacted by the interviewees' previous experience

Understandably, the interviewees' responses could be impacted by their previous experience. It is interesting to see the comment on the necessity of the revenue guarantee that was offered by an interviewee whose company's previous business was primarily in a country where no failed projects have been bailed out by the government:

> *"I am not sure we would agree with the statement at the start*
> *that suggests states are required to put in cash to keep projects*
> *up and running…… This is the market managing this loss – there*

is no cash infusion from government.”[7]

An interviewee from a country where an availability payment method dominates the local P3 market commented:

> *“I am personally not keen on real tolls because revenue growth*
> *is vastly driven by geographic factors: economic growth and*
> *transport policy, and the private sector is not in control of either*
> *of those risks. Therefore, you can't possibly price the risks if the*
> *private sector accepts them.”*

Although these comments are legitimately reasoned, it is wise to analyze to which degree they are colored by regional and/or national issues and how similar other P3 markets are to the US market. If other P3 markets' features are less likely to repeat in the US market, it is necessary to isolate these region-oriented elements from other convincing arguments.

4.7.2   Limitations

As shown in Table 4-3, due to time constraints the interviews did not thoroughly discuss specific details of revenue guarantee implementation. Future research may conduct another field investigation to seek additional market perspectives on guarantee valuation and guarantee frequency. In addition, to explore revenue guarantees' implementation in other regions, future research may extend the interviewee sampling pool to include participants from other jurisdictions.

A general challenge in interviews is to ensure replicability of interview results: the ability to duplicate interviews regardless of the interviewer (Steward and Cash, 2005). In semi-structured interviews, adjusting interview questions and the process based on responses from interviewees received in real time is unavoidable, so replicability is more difficult to achieve. To address this challenge, the authors contemplated interviewees' possible answers to each question and prepared a set of probing questions which were used to follow up different answers. All the probing questions serve the same investigation purposes. The more complete the probing

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[7] For the purpose of confidentiality, some content of this comment is abridged.

questions are, the less likely it is that the conclusions of the interviews conducted by another investigator would be different. Although different investigators might use different follow-up questions when deviating from the original protocol, this field investigation's replicability was enhanced by focusing subsequent questions on the same subjects.

4.8 Conclusion

Revenue risk management is a central focus in P3 highway projects. A concessionaire relies on an adequate revenue stream to earn its target investment return; the government intends to appropriately allocate the risk to successfully procure a project while fulfilling its social and economic objectives for transportation development. Allocating revenue risks between a resource-constrained government and a concessionaire who is generally reluctant to make any unjustified additional investment, unfortunately, is not an easy task.

This research investigated the potential of a revenue guarantee to serve as an alternate tool for revenue risk management for the stakeholders in the P3 market. Based on the interview findings, the study has reached two conclusions. Figure 4-10 summarizes these two conclusions.
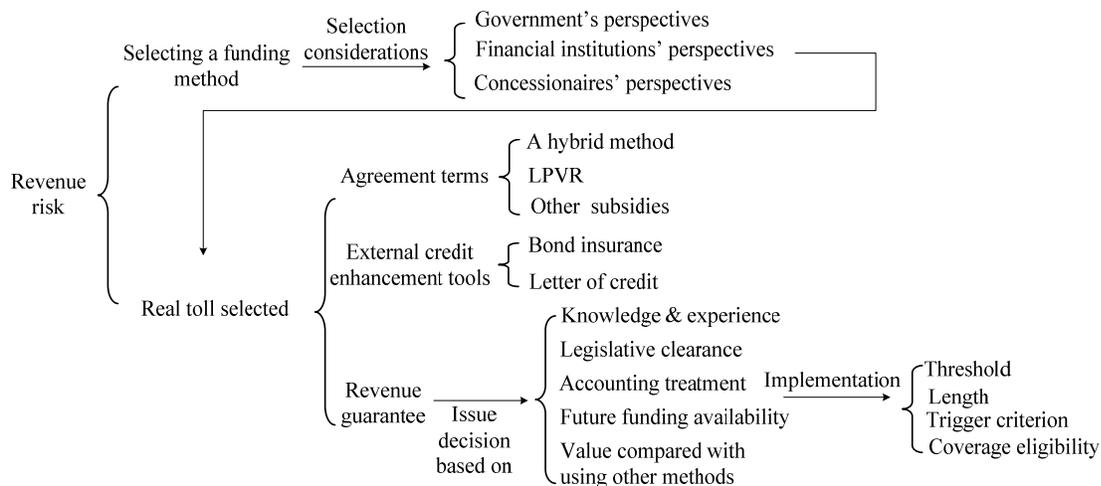
Figure 4-10: Revenue risk management

First, the majority of the interviewees suggested that a revenue guarantee shows promise as a viable tool, and the US government would be willing to provide one. However, this does not imply that the government can or should provide it for every real toll project. It is in the best interest of the government to evaluate the value for money derived from a revenue guarantee in a

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broader risk management picture as illustrated in Figure 4-10. Start with the funding methods: different funding methods serve different purposes, and there is no clear market trend toward one funding method. The government is advised to determine whether one particular funding method is aligned with its objectives and conduct budgetary planning as well as consider other stakeholders' concerns to ensure the project is procured in a competitive manner. Once it decides to apply the real toll method, it should examine the factors influencing its ability to provide a revenue guarantee in conjunction with alternative risk mitigation approaches, such as certain favorable agreement terms and external credit enhancement tools.

Second, if a revenue guarantee is used, it should be provided by the government. The revenue guarantee is expected to be free of monetary charge. But it is permissible, and perhaps even wise, to include a revenue sharing requirement as a means of trading upside revenue profits with the downside risk protection. A revenue guarantee is most likely to be used during the ramp-up phase in greenfield projects.   Both parties should evaluate the guarantee coverage length in accordance with their risk objectives and the project's economics. The guarantee's triggering criterion should be gross revenue or quasi gross revenue.   A coverage eligibility term may be put in place to prevent a concessionaire from inflating traffic projections.

Although the proposed revenue risk management process in Figure 4-10 speaks from a public agency's perspective, a concessionaire can easily apply the conclusions as well.   A concessionaire usually has no authority to determine a funding method,[8] but they can negotiate with the public agency for a specific risk mitigation strategy in a real toll project.   The consideration process is similar: the concessionaire compares alternative methods with revenue guarantees, evaluates the public agency's capacity of issuing a guarantee, and then reviews the guarantee terms suggested by the public agency.

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[8] They can express their opinion by showing interest or not participating the deal, which will impact the funding method selection's choice.

5. Conclusion and recommendation

5.1 Conclusion

In the search for new funding sources, federal, state, and local government officials in the US have been recently exploring P3. Prior to the economic downturn that began in 2008, the interest in P3s for infrastructure, and particularly highways, was substantial. Given the fact that the need for private capital still exists, if not expands, it appears that the P3 market not only survived the financial crisis but has found more state DOTs are entering into this market and private developers' interest in this type of deal has not waned. While promising, P3s are neither a panacea nor a temporary trend. Given the large variation in the efficiency and effectiveness of P3s in past projects, it is urgent to learn the lessons of the past and refine the P3 system in order to continue to gain legitimacy from the general public and confidence from all stakeholders involved. With no doubt, risk management and allocation is critically important to the success of any P3 project. There are a number of risks to be carefully considered in P3 planning. The most obvious and significant one is the revenue risk. Revenue risk can be placed upon concessionaires investing in the project; if the estimated traffic does not materialize, the concessionaire is in danger of not meeting its debt obligations, let alone its expected rate of return. If the risk is placed in the government, then taxpayers will ultimately bear the potential revenue loss.

Although a revenue guarantee method has been utilized in some regions across the world, there is no practice in the US. Market conditions, political environment, economic policies, and P3 experience vary among jurisdictions. Therefore, one should not assert that the revenue guarantee concept will have (or not have) a market in the US and the mechanism used in other countries can be readily applied to the US market. This research focused on highway projects through P3s in the US market and studied the implementation feasibility of a revenue guarantee option to mitigate revenue risks. It explored various aspects of the guarantee option, synthesized the results to conduct a field investigation, and used semi-structured interviews of practitioners to investigate general revenue risk management, revenue guarantee feasibility, and a revenue guarantee implementation framework.

The comparison of the preparatory studies and market perspectives is demonstrated in Table 5-1.

They are in agreement on a few topics. Market perspectives, however, are either more certain or more detailed in most of the topics. This result fulfills the field investigation objective set in Chapter 1: the field investigation answered the questions pertaining to revenue guarantees' feasibility, indicated the market's preferences for options developed for each implementation issue, and suggested other alternatives that were not examined in the preparatory studies.

Table 5-1: Summary and comparison of the preparatory studies and market perspectives

Category	Preparatory study (P)	Market perspective (M)	Comparison
Revenue risk management			
Funding method utilization	Each serving different purposes		Same
Revenue sharing requirement	A growing trend		
Existing credit enhancement tools	Costly		
Funding method selection criteria	N/A	• Different stakeholders' concerns	M more certain
Other options for low traffic demand	LPVR	• A hybrid method • LPVR • Other subsidies	
Revenue guarantee feasibility			
Revenue guarantee functionality	A tool in the toolbox		Same
Feasibility of revenue guarantees in the US	Uncertain	Possible	M more certain
Revenue guarantee applicability	• Low traffic demand • Medium traffic demand	More promising in a low traffic demand scenario	
The government's concerns over providing a guarantee	• Experience • Reluctance of retaining responsibilities	• Experience • Funding availability • Legislative clearance • Accounting treatment • Value compared with using other methods	M more detailed
Financial institutions' concerns over providing a guarantee	• Demand size • Valuation risk • Investing in P3 infrastructure projects	• Demand size • Valuation risk • Counterparty's credit risk • Not core business • Regulation constraints • Information disadvantage • Concentration risk	
Revenue guarantee implementation			
Guarantor	• The government • A financial institution	The government	M more certain

Guarantee purchase requirement	• Mandatory • Selective	Selective	
Guarantee purpose	• Reduce cost of capital • Provide contribution	Provide contribution	
Guarantee length	• Ramp-up phase • Until all debt is paid off	Ramp-up phase preferred	
Underlying asset (triggering criterion)	• EBIT • Gross revenue • Traffic volume • FCFE	Gross revenue preferred	
Revenue guarantee type	• Put option • Collar option (collar preferred)	• Free put option • Collar option	
Collar option advantages	• Flexibility • No premium charged • Accounting benefits	No premium charged	P more detailed
Guarantee purchase time	• Before a bid is awarded • After a bid is awarded	N/A	
Option structure	• Multiple European option • Multiple-exercise Australian option	N/A	
Collar option valuation	• Determine thresholds	N/A	
Coverage eligibility	• Maximum subsidy measured by a certain percentage of expected revenue	• Maximum subsidy measured by a certain percentage of expected revenue	Same

5.1.1 Revenue risk management

Both the preparatory study and the market perspective results suggest that different funding methods including real tolls and availability payments serve different social and economic purposes, and each has unique strengths to meet a particular project's requirements. The interviewees discussed the factors to be considered when selecting a funding method from the perspectives of the government, concessionaires, and financial institutions.

Following the financial crisis, most financial institutions that provide credit enhancement instruments have tightened their insurance policies and started to demand higher insurance premiums or higher collateral value. As a result, existing instruments such as letters of credit and

bond insurance have become cost-prohibitive. Arranging a credit enhancement instrument for a large debt or loan facility is particularly ineffective.

As far as other options for a real toll project with low traffic demand are concerned, in addition to the LPVR method, the interviewees recommended that the government consider using a hybrid of real tolls and availability payments or providing alternate non-monetary contributions such as right-of-way acquisition.

Both the preparatory study and the market perspective results indicate that there is a growing trend towards revenue sharing requirements in the US market. Several recently closed P3 highway deals, such as the Capital Beltway project, the SH130 Segments 5 and 6 project, and the North Tarrant Expressway project, support this finding.

5.1.2 Revenue guarantee feasibility

Revenue guarantees are viewed as the government's funding contribution during a project's operation phase. It improves a project's financial viability and is a tool in the toolbox for real toll projects with a low traffic demand.

A revenue guarantor can either be the government or a third-party financial institution. The preparatory study suggested that the barriers for the government to issue a revenue guarantee included inadequate knowledge and lack of experience in complex financial arrangements and its reluctance to retain this type of responsibility. The interviewees believed that the government would be able to provide a guarantee under the condition that it is knowledgeable and obtains legislative clearance. However, it is in the best interest of the government to evaluate the value for money derived from a revenue guarantee with the inherent risk and compare it with alternate methods prior to making a decision to use revenue guarantees.

In an unexpected deviation from the preparatory study findings, the interviewees did not believe a financial institution would even consider providing such a product in the foreseeable future. The financial crisis hit financial institutions hard, but the interviewees perceived that tightened credit policies are not the primary reason. The interviewees reported that potential barriers for

financial institutions were limited demand size, informational disadvantage, concentration risk, valuation uncertainty, counterparty's credit risk, regulatory restrictions, and concerns about dealing in a non-core business area.

5.1.3   Revenue guarantee implementation

Based on the findings of the feasibility assessment, if revenue guarantees were implemented, the government is likely to be the guarantor.   To obtain the downside loss protection, a concessionaire should perhaps be expected to pay for the insurance in a put option deal or transfer its right of claiming a portion of upside revenue to the guarantor in a collar option deal. The preparatory study indicated that the collar option method has a higher chance of being accepted because it requires no upfront premium. The interviewees agreed with this perspective. The interviewees suggested that if no revenue sharing requirement is imposed, it is likely that the government will provide an indirect funding contribution through revenue guarantees with no charge.   While revenue guarantees may serve multiple purposes in other countries, its main usage in the US market would be to provide a funding contribution (a subsidy) for a P3 project with low traffic demand.

With a collar option, a concessionaire is free to move the maximum loss line up and down based on its risk appetite as opposed to purchasing default insurance that provides exact coverage for the debt or loan facility. It creates a revenue band and motivates the developer to generate more revenue by improving performance. It is flexible in that a concessionaire is able to adjust future and current cash flow to accommodate its financial needs and easily terminate the deal. Favorable tax treatments make the collar option more cost-effective. The interviews did not delve into a collar option's advantages. However, the interviewees' comments reflected that the collar option shows promise due to the fact that its structure inherently includes the revenue sharing requirement which is a growing trend in the US.

Two categories of issues associated with revenue guarantee implementation were examined in the preparatory study. One relates to how the option transaction is incorporated in a project procurement process and the other one relates to option terms. Two or three alternatives for each question were proposed and evaluated from both the government and concessionaires'

perspectives. Some alternatives are beneficial for the government while others favor concessionaires. When designing a revenue guarantee option, one needs to balance both a public agency and a concessionaire' interests in mitigating revenue risk in an effective and efficient manner. The market perspective indicated that a revenue guarantee should be selective and primarily used in the ramp-up phase of a project. It confirmed the necessity of a coverage eligibility requirement. Gross revenue is preferred over other underlying assets as a triggering criterion.

5.1.4 Limitations of the research

The limitations of the research include:

(1) Option pricing: although the research did not focus on the accuracy of option valuation, this challenge is critical. If revenue guarantee and revenue sharing cannot be calculated within an acceptable accuracy level, guarantees or collars will not be well structured. Future research needs to seek valuation specialists' opinions regarding this matter.

(2) Field investigation's scope: 20 people were interviewed in the field investigation. If more people participated, especially government officials and pricing specialists, the interview conclusions would be more reliable and general. Future research also needs to approach people with more diversified geographic backgrounds in order to investigate the feasibility of revenue guarantees being used in other regions and to eliminate any potential geographic bias.

(3) Revenue's volatility: due to time constraints, the field investigation did not probe for the interviewees' opinions on the revenue's volatility level. A project's risk can be delineated based on two parameters: expected revenue level and volatility level, as shown in Figure 5-1. The interviewees did indicate that they preferred not to request revenue guarantees or collars with moderate traffic demand. However, the question is would their answers be different if revenue volatility were considered? Would a concessionaire be more concerned with a project with moderate revenue that is subject to high volatility? A project with low expected revenue is in greater need of a risk mitigation approach. But would the risk mitigation approach be different for revenue with higher volatility versus lower volatility? The author suspects that with lower volatility there is less uncertainty of the project's profitability and upfront public funding might be more appropriate. Higher volatility increases the value of guarantee options and thus put options or collars are more appropriate. Nevertheless, this

view should be discussed with interviewees in subsequent research.

Low revenue and low volatility	Moderate revenue and low volatility
Low revenue and high volatility	Moderate revenue and high volatility
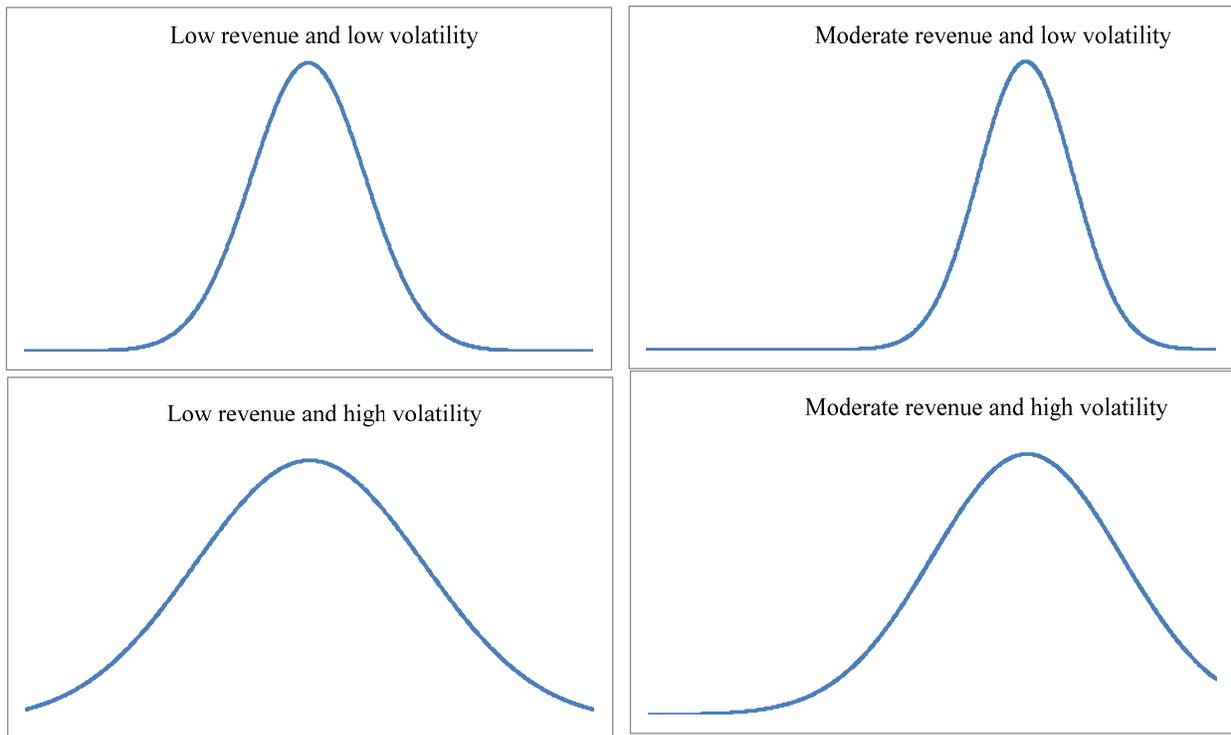
Figure 5-1: A project's risk profile categorization

5.2   Recommendation

A decision as to implement a revenue guarantee cannot be made in isolation of other issues. It is in the best interest of the government to evaluate the value for money derived from a revenue guarantee in a broader risk management picture, for example whether a selected funding method is aligned with its objectives and budgetary planning. The government should also consider other stakeholders' concerns so that the project is procured in a competitive manner. It should also examine the factors influencing its ability to provide a revenue guarantee in conjunction with alternative risk mitigation approaches, such as certain favorable agreement terms and external credit enhancement tolls.

Giving public agencies flexibility in funding projects is essential for creating an efficient P3 program, especially when these projects are not self-sustainable. To insulate legislators from the riskiness of these projects, many restrictions are placed to prevent public agencies from using public money to help fund private operation and to limit methods of deploying committed public

funds. While revenue guarantees are viewed as a viable tool, for it to have practical contributions, states must allow more freedom in their P3 statutes to avoid judicial challenges to financial plans.

Arranging a revenue guarantee requires a solid background of project finance and the P3 system. Based on the interview experience, it is safe to conclude that the US government officials need to continue to enhance their understanding in those areas. Although they can rely on financial advisors for particular aspects of a deal, as decision-makers they should be knowledgeable in revenue guarantees' concepts, merits and associated challenges.

Another field investigation is needed to probe market perspectives of revenue guarantee implementation issues that were not thoroughly discussed in this research.

Lastly but not least, once the government and a concessionaire decide to arrange a revenue guarantee, the next step would be to determine a guarantee threshold. Given the fact that a collar option structure is viewed as more plausible, both the downside protection threshold and upside sharing threshold need to be set. The research has discussed the implication of different guarantee levels. From the government's perspective, a higher upside threshold lowers the chance of it sharing revenue with a concessionaire while a higher protection threshold increases the likelihood of paying guarantees to the concessionaire. The opposite applies to the concessionaire. Both parties are advised to evaluate a project's conditions and their financial situations to negotiate for a range that balances their respective interests. Once both parties come to an agreement on the thresholds, the remaining work boils down to option price computation; they should have similar expectations of the guarantee's value. Due to resource constraints, the research was not able to access modeling specialists in the field investigation to evaluate the modeling barriers of revenue guarantees. Several countries have established a valuation system for a put option deal, but there is limited evidence that the existing methods are valid and accurate, and are applicable for a collar option deal. Modeling specialists' opinions should be collected to valuate real projects' assumptions that are usually more complicated than used in academic research.

5.3   Concluding thoughts

Analysis of revenue guarantees vs. upfront public funding

If public agencies or concessionaires find the real option concept a bit difficult to comprehend, they can resort to the traditional discounted cash flow method for the revenue risk analysis. One alternative to revenue guarantees is public funding provided by the government in the construction phase. If the revenue sharing requirement is imposed, the forfeited future revenue should also be considered. A concessionaire first estimates the potential shared revenue (S_i) and subsidy guaranteed by the government (G_i) in year *i*. Then it estimates the probabilities associated with S_i and G_i –P_{Si} and P_{Gi}. The expected shared revenue is the product of S_i and P_{Si}, and the expected subsidy is the product of G_i and P_{Gi}. For example, in year 3 the estimated shared revenue is \$4 million and the probability of it occurring is 0.15, therefore the expected shared revenue is \$0.6 million (\$4*0.15). From the concessionaire's perspective, S_iP_{Si} is cash outflow while G_iP_{Gi} is cash inflow. Their difference represents net cash flow as a result of the revenue guarantee and sharing arrangements in year i. The sum of each year's difference discounted at the concessionaire's cost of capital[9] is the net present value. If this net present value is greater than the public funding contributed by the government, an alternative method to revenue sharing and revenue guarantees, then the former is more appealing to the concessionaire.

$$\sum_{i=1}^{n} \frac{G_i * p_{Gi} - S_i * p_{Si}}{(1+r)^i} \geq \text{Public funding} \qquad (3)$$

Where:

i = the ith year;

n = concession length;

G_i = estimated guarantee subsidy in year i;

P_{Gi} = the probability of actual revenue falling below the guaranteed level in year i;

S_i = estimated shared revenue in year i;

P_{Si} = the probability of actual revenue exceeding the sharing trigger level;

$E[G_i] = G_i * P_{Gi}$, $E[S_i] = S_i * P_{Si}$,

r = the concessionaire's cost of capital

---

[9] When shared revenue is greater than a subsidy, the difference can be considered an opportunity cost which could have been reinvested at the cost of capital rate; when shared revenue is less than a subsidy, the difference is treated as the concessionaire's normal revenue which should be discounted by the cost of capital rate as well.
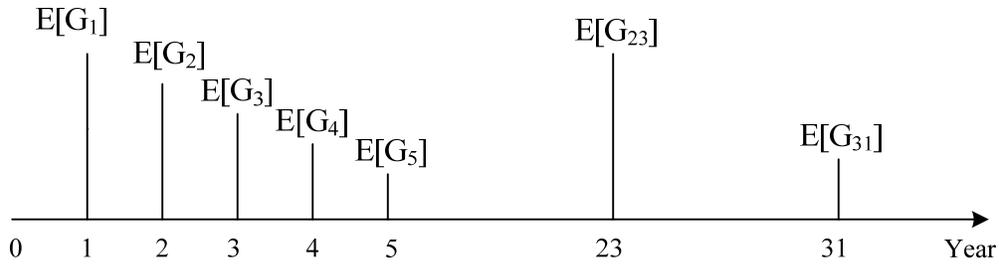
Figure 5-2: Revenue guarantee distribution
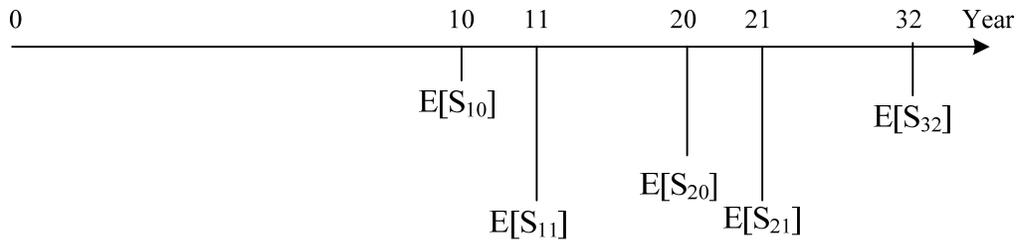
Figure 5-3: Revenue sharing distribution

Correlation between a real toll project with a collar option and an availability payment project

In a real toll project, the position of the two thresholds of a collar option can be changed. When they move closer to the estimated revenue, the higher guarantee revenue level and the lower sharing level make both the put option and the call option become more valuable. If the two thresholds converge at the estimated revenue level, a concessionaire' future income is no longer uncertain; instead it is fixed at the estimated revenue level. Does this scenario look familiar? By adjusting the thresholds in this manner, this real toll project has effectively become an availability payment project.
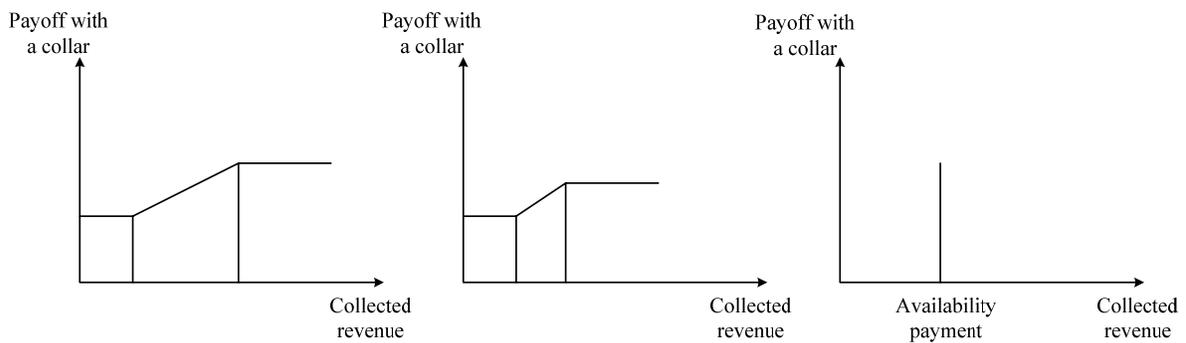
Figure 5-4: A real toll project with a collar option vs. an availability payment project

Figure 5-4 tells us that a collar option must contain a revenue band of a certain width in order to

maintain its collar feature.

An availability payment deal as a forward contract

Apply an availability payment structure to a forward contract. In finance, a forward contract is an agreement between two parties to buy or sell an asset at a specified future time at a price agreed upon today (Hull, 2008). The forward price may be higher or lower than the asset's price in the spot market (spot price). A concessionaire who finances and constructs a facility can be viewed as the asset owner or the forward seller. The concessionaire agrees to sell the asset to a public agency at an agreed price today—periodic availability payments. What is the spot price then? It is the annual toll revenue (if the facility is tolled).

An availability payment deal can also be viewed as a floating-for-fixed swap contract, a series of forward contracts. From the perspective of revenue risk, an availability project is a revenue-guaranteed deal. If we consider an availability payment as a real toll project with fixed income, then in essence the concessionaire swaps the toll revenue it hypothetically collects with a periodic fixed payment from its counterparty—the government.

Bidding strategies for availability payment projects

In an availability payment project, interested private developers bid for the maximum availability payment (MAP). A traditional way for developers to propose the MAP is to base it on their construction costs and later operating and maintenance expenses; in large part the requested MAP is irrespective of future traffic volume or toll revenue.[10] However, as mentioned above, from the perspective of revenue risk, an availability payment project is a revenue-guaranteed real toll deal, and if we consider an availability payment as a forward contract or a swap contract, the bidding strategy might be different. The forward price (MAP) is an expectation of a future spot price (future revenue) and the fixed rate in a swap contract (MAP) is derived from a series of expected future floating rates (future revenue again). Therefore, when a concessionaire contemplates the MAP amount it can incorporate its expectation of the traffic volume and/or toll revenue in the future. However, this strategy may be limited to very few cases. The current availability payment approach has some distinctive merits that cannot be replaced by the real toll

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[10] A facility usage level impacts operating and maintenance expenses.

method, such as maximizing traffic flow, accommodating complex traffic network, and ensuring operation performance. If the MAP depends on future revenue expectation, the scheme of availability payment approach is changed.

A centralized revenue option, forward, or swap market?

The government is the collar seller, forward buyer (availability payment), and fixed-rate payer. To promote the agriculture forward market's development, in early 1800s the government established laws and regulations and ensured the clearing house's functionality. Would it be possible to establish a centralized revenue option and forward market? Probably not. The government's primary objective to govern the agriculture market was to assure adequate food supply and remove price volatility caused by the cyclical nature of production. However, toll rates are typically set and controlled by the government, and therefore from the standpoint of protecting the general public's interest, existing P3 mechanisms are adequate. In addition, the government at either federal or state level lacks the ability to take the short position in the collar or availability payment forward structures, simply because transportation projects cannot be standardized.

Focus on availability payment projects?

To attract market interest to its newly established P3 market, the Korean government offered substantial subsidies to concessionaires in order to hedge revenue risks in the mid-1990s. If the availability payment structure is less complex and can be operated by most concessionaires, would it be helpful if the US market focuses on this structure to promote its development? The answer is most likely negative as well. First, as concluded earlier, the appetite for revenue risk exists. Second, the success of the North Tarrant Express in Texas, a complex full revenue risk project following in the shadow of the financial crisis and two successful prominent availability projects, demonstrated that the market has the interest and the capability for real toll projects. The co-existence of the financial option and the forward market is also an implication that real toll projects with a collar option and availability payment projects are unlikely to replace each other. Just as options and forwards offer different levels of hedging, so do their corresponding strategies in the P3 field.

Near-term future of the U.S. highway P3 market

In the near term, the author anticipates that U.S. highway P3 will become more mature in two ways. First, the public and private sectors have started to realize the importance of each other's expectations and needs. Second, with a growing understanding of the P3 system, the U.S. market has been exploring different risk management techniques that exist in other countries such as availability payment deals and shadow tolling. Additional evidence is the evolvement of the revenue sharing requirement: from no sharing clause in the Chicago Skyway lease project, to a simple sharing clause in the Capital Beltway project, to a more effective method used in the North Tarrant Expressway project. The author also anticipates that more private sector players will enter into the U.S. market. Most concessionaires have enormous interest in the U.S. market; with the market becoming more mature and the U.S. government's knowledge gained through practice, the political risk for concessionaires is reduced. Increased market competition is beneficial for procuring authorities. State DOTs are under more pressure to establish and maintain an effective P3 procurement system in order to attract concessionaires and deliver best value for projects. In addition, as consistent with the fundamental goal of a company—maximize stakeholders' wealth, concessionaires have never ceased to pursue higher profits. Risk appetite for real toll projects will continue to exist.

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7. Appendix

7.1 Interview protocol for government officials

1. Greetings and introduce the interview purpose.

2. Confirm interview length.

3. Read confidentiality agreement and explain the post-interview follow up process.

4. Request an audio-recording permission.

5. Today's agenda

   - Your background

   - Prevalence of different funding methods

   - Revenue sharing

   - Feasibility of revenue guarantee option

6. Briefly tell me your experience in infrastructure projects

   - Years of experience in infrastructure projects

     ☐ > 15 years ☐ > 10 years ☐ > 5 years ☐ > 2 years

   - Highest contract value

     ☐ > 1B ☐ > 500 m ☐ > 200 m ☐ > 100

   - Role

     ☐ Project manager ☐ Procurement officer ☐ Engineer
     ☐ Financial advisor ☐ Management consultant ☐ Other

   - Number of PPP projects

     ☐ >= 4 ☐ 3 ☐ 2 or 1 ☐ 0

     Project (name and role): _____

     _____

7. There are several fund methods for highway PPP projects. Real toll, shadow toll, and availability payment. Do you foresee any funding methods have more prevalence in the future?

     ☐ Availability ☐ Real toll ☐ Other ☐ Depends

     _____

     _____

     _____

8. How do you select a funding method for a project?

    _____

    _____

    _____

9. What are the existing revenue risk mitigation practices in tolled projects that you know about?

☐ MRG	☐ Revenue reserve fund	☐ Financial credit enhancement (monoline, LOC)	☐ TIFIA
☐ Hybrid methods	☐ Gov equity		

    _____

    _____

    _____

    _____

    From your observation, which one has more prevalence?

    _____

    _____

    _____

10. Let's move to the other side of the revenue spectrum, the upside revenue or windfall profits. Is revenue sharing a clause that you must have in future agreements?

    ☐ Yes _____

    ☐ No, it depends _____

    _____

    _____

11. What are the common revenue sharing trigger criteria? What are their advantages and disadvantages?

    _____

    _____

    _____

    _____

12. Moving to the revenue guarantee method that I proposed in my research. I sent you a brief introduction? Do you want me to refresh the idea for you now?

> Yes
>
> No

13. What do you think about this method? What issues must be addressed before you permit the deal?

_____

_____

_____

_____

> *Probing questions*

(1) ☐ I don't have a problem, as long as there is demand and supply.

_____

(2) Do you want to provide (sell) the guarantee? Are you able to do it?

☐ Yes, yes _____

☐ No, no _____

☐ Yes, no _____

(3) Would you charge for the guarantee?

☐ yes _____

☐ no _____

☐ depends _____

(4) Would you mandate the purchase?

☐ yes _____

☐ no _____

☐ depends _____

(5) Any legislature restrictions?

☐ yes _____

☐ no _____

14. Last question, if a third-party underwriters the option, and as a return for his protection against the revenue shortfall, he demands retaining the upside revenue, rather than being

paid a fixed amount upfront premium by the concessionaire. Are you comfortable with allowing him to capture all the upside revenue?

☐ yes   _____

☐ no   _____

☐ depends   _____

15. Thank you.

7.2 Interview protocol for concessionaires

1. Greetings and introduce the interview purpose.
2. Confirm interview length.
3. Read confidentiality agreement and explain the post-interview follow up process.
4. Request an audio-recording permission.
5. Today's agenda

   - Your background
   - Prevalence and selection of funding methods
   - Allocation of revenue risks between a public sector and a private sector and mitigation practices
   - Feasibility of revenue guarantee option

6. Before we get started, briefly tell me your experience in infrastructure projects

   - Years of experience in infrastructure projects

     ☐ > 15 years ☐ > 10 years ☐ > 5 years ☐ > 2 years

   - Highest contract value

     ☐ > 1B ☐ > 500 m ☐ > 200 m ☐ > 100

   - Role

     ☐ Project manager ☐ Procurement officer ☐ Engineer
     ☐ Financial advisor ☐ Management consultant ☐ Other

   - Number of PPP projects

     ☐ >= 4 ☐ 3 ☐ 2 or 1 ☐ 0

     Project (name and role): _____

     _____

7. There are several fund methods for highway PPP projects, such as real tolls, availability payments and shadow tolls. Which funding method do you see has more potential in the near future? How do you determine the type of funding method that you want to participate in?

   ☐ Availability ☐ Real toll ☐ Other ☐ Depends

   _____

   _____

   _____

9. Are you aware of any mitigation practice for the revenue risk in tolled projects?

☐MRG   ☐ Financial credit enhancement (monoline, LOC)   ☐ Revenue reserve fund   ☐ self-retain

_____

_____

_____

_____

10. Let's move to the other side of the revenue spectrum, the upside revenue or windfall profits. We see the government required private developers to share upside revenue in several past projects? What is your take on this requirement?

_____

_____

_____

11. What are the common revenue sharing trigger criteria? What are their advantages and disadvantages?

_____

_____

_____

12. Moving to the revenue guarantee method that I proposed in my research. I sent you a brief introduction? Do you want me to refresh the idea for you now?

    Yes

    No

13. From your perspectives, what issues should be addressed for you to consider arranging such an agreement?

_____

_____

_____

_____

Probing questions:

(1) Who do you want to be the guarantor and why?

☐ Gov   _____

☐ FI   _____

☐ no preference _____

(2) What expectations do you have for other stakeholders?

☐ Honor the agreement _____

_____

_____

(3) What's reaction if the government mandates the purchase of this product.

☐ Won't bid _____

☐ Accept   _____

☐ Depends   _____

(4) Fair price

☐ Blackbox, need to be assured that sellers offer fair price

_____

_____

(5) ☐ the decision depends on whether the option can provide the better value for money than other alternative revenue mitigation methods do (LOC, insurance)

_____

_____

10. If a third-party underwriters the option, and as a return for his protection against the revenue shortfall, he demands retaining the upside revenue, rather than being paid a fixed amount upfront premium by you. Are you comfortable with this alternative arrangement?

☐ Put   _____

☐ Collar _____

☐ Depends _____

11. Thank you.

7.3 Interview protocol for financial institutions

1. Greetings and introduce the interview purpose.
2. Confirm interview length.
3. Read confidentiality agreement and explain the post-interview follow up process.
4. Request an audio-recording permission.
5. Today's agenda
   - Your background
   - Financial guarantee products
   - Feasibility of the product (market demand, pricing accuracy, market discipline)
6. Briefly tell me your experience in infrastructure projects
   - Years of experience in infrastructure finance

     ☐ > 15 years   ☐ > 10 years   ☐ > 5 years   ☐ > 2 years
   - Highest contract value

     ☐ > 1B   ☐ > 500 m   ☐ > 200 m   ☐ > 100
   - Role
   - Derivative products

     ☐ No   ☐ Yes (name and role)
7. There are several fund methods for highway PPP projects, such as real tolls, availability payments and shadow tolls. Which funding method do you see has more potential in the near future?

   ☐ Availability   ☐ Real toll   ☐ Other   ☐ Depends

   _____

8. Are you aware of any financial products that can enhance the financial viability of the project directly or indirectly? What are their advantages/disadvantages?

   ☐ Don't know any
   ☐ Yes, I know. _____

   _____

   Probe for:
   ☐bond insurance_____
   ☐ LOC _____

☐ other agreement terms

9. Moving to the revenue guarantee method that I proposed in my research. I sent you a brief introduction. Do you want me to refresh the idea for you now?

    Yes

    No

10. The guarantee option is a new product. When a proposal of a new product, like the revenue guarantee option, is put on your desk right now, what are the factors that you would consider before you decide to sell this product?

    _____

    _____

    _____

    _____

    _____

Probing questions:

(1) How big the market should be in order for the option product to be developed?

- *Number of projects executed*

☐ >20   ☐ >15   ☐ > 10   ☐ >5
☐ less than 5

- *Annual toll revenue per project (underlying asset value)*

☐ >$300m   ☐ >$100m   ☐ > $50m   ☐ >$20m
☐ less than $20m

- *Average revenue volatility*

☐ >20%   ☐ >15%   ☐ > 10%   ☐ >5%

- *Agreement length*

☐ >15 yr   ☐ >10 yr   ☐ > 5 yr   ☐ doesn't matter

(2) Is pricing for this type of option a barrier? What issues concern you?

Pricing technique _____

_____

Historical data _____

    Other _____

_____

(3) What expectations do you have for other stakeholders, the concessionaire and government?

☐Honor the agreement_____

_____

_____

_____

(4) Uncontrollable risks

(5) Capacity and experience

(6) Legislature restrictions

11. Instead of paying a premium, the concessionaire chooses to give up a certain upside revenue in exchange for your protection against the shortfall. Which one is more appealing to you (upfront payment or trading revenue) and why.

☐Put   _____

☐ Collar_____

☐ Depends_____

12. Thank you.

7.4 Interview protocol for financial advisors

1. Greetings and introduce the interview purpose.
2. Confirm interview length.
3. Read confidentiality agreement and explain the post-interview follow up process.
4. Request an audio-recording permission.
5. Today's agenda
   - Your background
   - Prevalence of different funding methods
   - Revenue sharing
   - Feasibility of revenue guarantee option
6. Briefly tell me your experience in infrastructure projects
   - Years of experience in infrastructure projects

     ☐ > 15 years   ☐ > 10 years   ☐ > 5 years   ☐ > 2 years
   - Highest contract value

     ☐ > 1B   ☐ > 500 m   ☐ > 200 m   ☐ > 100
   - Role
   - Number of PPP projects

     ☐ >= 4   ☐ 3   ☐ 2 or 1   ☐ 0

     Project (name and role): _____

     _____

7. There are several fund methods for highway PPP projects. Real toll, shadow toll, and availability payment. Do you foresee any funding methods have more prevalence in the future?

   ☐ Availability   ☐ Real toll   ☐ Other   ☐ Depends

   _____

   _____

   _____

8. How to select a funding method for a project from a public agency and a concessionaire's perspectives?

_____

_____

_____

9. What are the existing revenue risk mitigation practices in tolled projects that you know about?

☐ MRG	☐ Revenue reserve fund	☐ Financial credit enhancement (monoline, LOC)	☐ TIFIA
☐ Hybrid methods	☐ Gov equity		

_____

_____

_____

_____

From your observation, which one has more effective?

_____

_____

_____

13. Let's move to the other side of the revenue spectrum, the upside revenue or windfall profits. Is the revenue requirement becoming more common?

☐ Yes _____

☐ No _____

_____

_____

14. What are the common revenue sharing trigger criteria? What are their advantages and disadvantages?

_____

_____

_____

_____

15. Moving to the revenue guarantee method that I proposed in my research. I sent you a brief introduction? Do you want me to refresh the idea for you now?

Yes

No

16. What do you think about this method? What issues do you think a concessionaire and a guarantor will consider? Are you aware of the similar practices abroad?

_____

_____

_____

_____

_____

_____

17. Last question, if a third-party underwriters the option, and as a return for his protection against the revenue shortfall, he demands retaining the upside revenue, rather than being paid a fixed amount upfront premium by the concessionaire. How do you think the government would respond to this proposition?

☐ Yes

☐ It depends

☐ No

18. Thank you.

7.5   Revenue guarantee introduction

Below is a hand-out sent to each interviewee prior to the interviews.

Revenue Risk Management

In user-fee based Public-Private-Partnership (PPP) transportation projects, revenue level is a vitally important issue. A lucrative revenue stream increases competition for a project by eliciting more interest from private sectors; however, revenue windfall leads to controversy on how to allocate excessive revenue. On the other hand, revenue shortfall undermines the project's financial viability and in some cases may require cash infusion from the government as a subsidy to keep the project afloat.

Revenue Guarantee Option—a New Method of Managing Revenue Risk

A revenue guarantee secures the concessionaire's minimum revenue. In exchange, the concessionaire compensates a guarantor with either an upfront monetary premium (similar to car insurance) or access to future excess revenue. For example, in a toll road project the concessionaire may pay the guarantor $10M in order to gain the right to claim a subsidy from the guarantee if the annual revenue falls below $80M for a certain period of time. Alternatively, it can transfer the right of retaining any revenue beyond $150M to the guarantor as a means of compensating it for securing the $80M revenue. In this case, the concessionaire's effective revenue ranges from $80M to $150M.
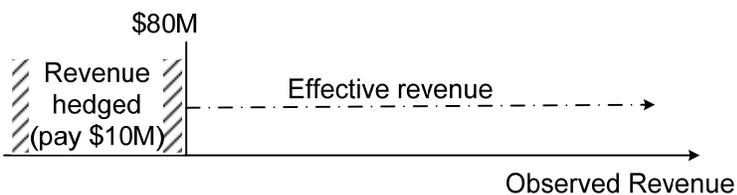
Concessionaire's payoff with monetary payment
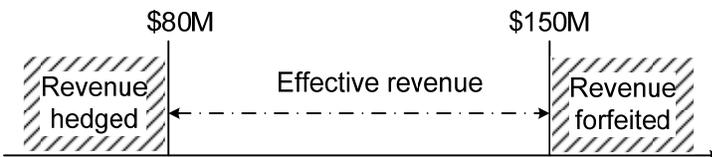
Concessionaire's payoff with exchanging upside revenue