Improving Public-Private Partnership Contracts through Risk Characterization, Contract Mechanisms, and Flexibility

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Academic abstract

Public-private partnerships (PPPs) have become a significant global phenomenon as governments seek alternative strategies to satisfy mounting infrastructure requirements. PPPs bundle asset development and service provision into a single, long-term contract; consequently, a concessionaire participates in all of a project's major tasks. Bundling shifts more risk and responsibility to concessionaires, so they theoretically should have ample incentive to enhance project quality and services. However, contract theories indicate that bundling's advantages depend on empowering concessionaires with ownership or decision rights. Absent this, they are apt to act opportunistically, so public agencies will preclude such action through intensive monitoring and control. Bundling, therefore, complicates the principal-agent relationship and heightens the contract's significance as a governance mechanism. Clearly, a PPP project contract's design is vital since it: (i) determines how risks are allocated and managed, (ii) directs how parties interact as projects evolve, and (iii) affects the alignment of parties' interests.

Despite their centrality, very little research has used PPP contracts directly as a data source. This dissertation remedies this by examining 21 US highway PPP contracts in three studies. The first study employed a content analysis framework to determine how 31 risks were allocated in the contract data set. The results confirmed that project lifecycle risks were transferred to concessionaires; however, risk sharing in the US highway market was more prevalent than in international jurisdictions. While some risk allocation consistency was found, project context created variance in allocation, especially for endogenous risks.

The second study extended the first to assess contract design practice along two avenues; one explored the tension between public sector control versus concessionaire empowerment while another further examined risk sharing mechanisms to

determine whether they were designed for ex ante treatment or ex post resolution. The findings demonstrated that public agencies employ various methods to monitor and control concessionaires; hence, concessionaire empowerment was hardly evident. Plus, risk sharing mechanisms were intricate and weighted toward ex post resolution, which may expose both parties to high transaction costs and opportunistic behavior during PPP implementation.

The final study capitalized on a revenue guarantee uncovered in the I-77 PPP project contract to examine the comparative advantages of exotic option structures. Quantitative analysis based on I-77 project data showed that exotic options can reduce a government's expected loss and improve a project's credit risk while not significantly affecting a developer's residual cash flow. Hence, revenue risk measures that incorporate exotic features can increase project stakeholders' degrees of freedom to better serve their collective interests.

Together, the three studies shed light on the state of PPP practice, demonstrating that contracts: (i) place lifecycle performance responsibility in the hands of concessionaires, but utilize extensive monitoring to govern their actions; (ii) employ risk sharing structures that rely extensively on ex post resolution, increasing the scope of plausible outcomes; and (iii) could benefit from revenue risk sharing structures that incorporate exotic option features.

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General Audience Abstract

Public-private partnerships (PPPs) have become a significant global phenomenon and governments are utilizing them more frequently to deliver projects that satisfy increasing societal demands in infrastructure sectors such as highways. Compared to traditional project delivery approaches, PPPs are long-term contracts between the public and the private sectors, where the private sector is engaged in more project tasks and accepts more risks. However, due to their long-term and complex nature, PPP contracts face many issues. Consequently, each project's contract becomes vital to project success because it: allocates risks, governs project relationships, and can align parties' interests. This dissertation examined 21 project contracts in the US highway PPP market to investigate risk allocation; contract designs and risk sharing mechanisms; and revenue risk guarantees. Using a content analysis framework, the allocation of 31 risks associated with highway PPPs was determined. These risks were mostly transferred to the private sector or shared between public and private parties, and project context had a significant influence on risk allocation. Assessment of contract designs indicated that the public sector imposes extensive monitoring and retains a majority of the decision rights to preclude opportunistic actions by the private sector; further, risk sharing mechanisms were complex and largely dependent on resolution during project implementation, which likely increases ex post transaction costs. Finally, revenue guarantees, commonly structured as standard options to mitigate revenue risk, were redesigned to incorporate exotic option features; quantitative analysis revealed that exotic structures can better serve chief PPP stakeholders' interests through increased robustness and flexibility.

To my father and my mother

my wife

and my two sons

Acknowledgements

"Life is the sum of all your choices." (Albert Camus);

or in a negative manner,

"If you'd come back to fix all the mistakes you've made, then you've have erased yourself." (Louis C.K.)

Indeed, all the made decisions, by me and by others (about me), have led me to where I am now.

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For all the people whose paths have crossed with mine:

that all makes sense to me and

I hope ours will cross again.

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Preface

Contributions of co-authors of each manuscript in this dissertation:

Chapter 2: Risk Allocation in U.S. Public-Private Partnership Highway Project Contracts

- Nguyen, D. A.: conducted the research and was lead author

- Garvin, M. J.: advised on research design and implementation; reviewed, and copy-edited the manuscript

- Gonzalez, E. E.: served as second rater in the study and reviewed the manuscript

Chapter 3: Contract Design in US Highway Public-Private Partnerships: Assessing the State of Practice

- Nguyen, D. A.: conducted the research and was lead author

- Garvin, M. J.: advised on research design and implementation; reviewed, and copy-edited the manuscript

Chapter 4: Beyond Standard Revenue Guarantees in PPPs: Enhancing Revenue Risk Sharing with Exotic Options

- Nguyen, D. A.: conducted the research and was lead author

- Garvin, M. J.: advised on research design and implementation; reviewed, and copy-edited the manuscript

- Kumar, R.: provided input on the option structures and modeling and reviewed the manuscript

1 Chapter 1: Introduction

1.1 Infrastructure Development and Public-Private Partnerships

Infrastructure is fundamental to an economy. As an economy grows, the scale and complexity of infrastructure demands multiply. Consequently, conventional approaches to infrastructure delivery may become insufficient. The rise of Public-Private Partnerships (PPPs) worldwide is arguably evidence that traditional methods of infrastructure development are inadequate. Essentially, a PPP "is a long-term contractual arrangement between the public and the private sectors where mutual benefits are sought and where ultimately (a) the private sector provides management and operating services and/or (b) puts private [equity] at risk." (Garvin and Bosso 2008). PPPs are argued to have advantages compared to conventional delivery methods such as access to private capital and experience, the transfer of risks to the private sector, and the ability to enhance transparency (Flinders 2002; Gaffney et al. 1999; Pollock et al. 2001; Shaoul 2003).

PPPs have increasingly accounted for large infrastructure projects around the world (*Public-Private Partnerships Reference Guide: 2nd Edition* 2014). In the highway sector, PPPs in developed regions are most mature in the UK, Australia, and Canada, so policy and practice in these jurisdictions is generally considered mature. The US, by comparison, has implemented PPPs to deliver highways relatively late; one of the earliest contemporary efforts was the Dulles Greenway project in 1993. A few projects followed, such as SR-91, but they were sporadic. The US highway market did not become active until the first decade of the 21st century; more than twenty PPPs reached financial close between 2005 – 2016. The total investment in this market exceeded $34 billion. In terms of policy development, 33 states, Washington DC and Puerto Rico have enabled PPPs through legislation, allowing varying levels of utilization of PPPs as delivery methods in infrastructure development. Figure 1.1 depicts the current state of highway PPPs in the US, illustrating projects by type, size and location as well as states and territories that have enabling PPP legislation.

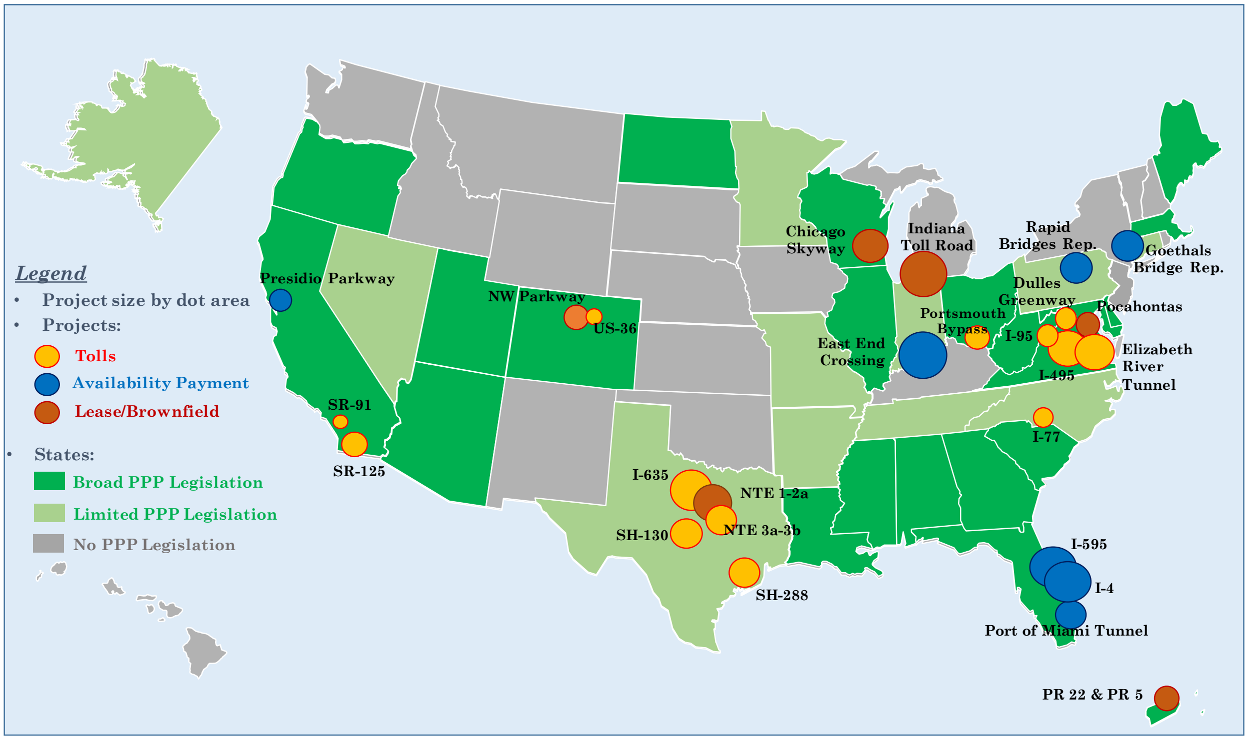

Figure 1.1. Current state of highway PPP development in the US

Alternative project delivery approaches, including PPPs, are expected to continue to draw attention due to: growing demand, the widening gap between public funding and transportation needs, the opportunity to increase revenues and cost-effectiveness, and the increase in liquidity of existing tolled facilities (Federal Highway Administration 2007).

However, PPPs are intricate arrangements, so they are also challenged by many issues that are characteristic of the PPP model: long time horizons, uncertainty, high sunk costs, multilateral relations, and complexity. These challenges require continuous attention from academics as well as practitioners and policy makers.

1.2 Benefits and Challenges of PPPs

In many respects, PPPs are based on the concept of bundling, which combines multiple aspects of a project into a single contract between a public agency and a private entity – the private entity is typically termed a concessionaire that is organized as a special purpose vehicle (SPV) where multiple private proponents come together to deliver the contracted services. Thus, a concessionaire's responsibility is extended beyond just *designing* and *building* an asset as in a conventional approach to include *financing*, *operating*, and *maintaining* it as well. Consequently, a project's contract becomes long-term, often 30 years or more. Bundling is expected to generate potential PPP advantages such as: transfer of risks, incentives to emphasize lifecycle productivity that improve value for money, and new sources of funding. Essentially, the tasks and risks of infrastructure development and service provision are assumed by a concessionaire *in expectation* of improved overall lifecycle performance.

Bundling via contracts, however, also introduces multiple challenges over a project's lifecycle. The duration of a PPP contract, among other factors, increases the levels of uncertainty that contractual parties must consider at the time of contract formation; this in turn impacts their ability to gauge risks, so ex ante risk allocation and management strategies may become dysfunctional ex post as uncertainty is resolved or reduced. In addition, a PPP is a complex transaction rather than a simple one, so aligning interests of the contractual parties over long time horizons is challenging; essentially, PPPs create rather unique principal-agent problems.

1.3 Examining PPPs through Contractual Frameworks

The sorts of issues that bundling introduces in PPPs have increased the emphasis on project governance. For instance, Henisz et al. (2012) argued that a combination of regulative (e.g. contracts), normative (e.g. social norms) and cognitive (e.g. shared identities) strategies are necessary for one-off, multi-phase projects such as PPPs. Indeed, all three may be necessary, but the centrality of contracts in PPPs suggests that they will remain an anchor of this archetype. Consequently, my research is focused on PPP contracts, which are the foundation of the relationship between public and private entities. PPP contracts: (i) determine how risks are allocated and managed, (ii) direct how the parties interact as projects evolve, and (iii) affect the alignment of the parties' interests.

Risk Allocation and Contractual Design

As discussed, PPPs bundle asset development and service provision, which entails the transfer of significant lifecycle responsibilities and risks to a concessionaire.

Moreover, the PPP Value for Money proposition is premised, by and large, on appropriate risk transfer and improved lifecycle performance. Consequently, risk allocation is a critical success factor in PPPs (Li et al. 2005). Inappropriate allocation of risks leads to project management inefficiency, high transaction costs (Dudkin and Välilä 2006), high frequency of disputes (Bing et al. 2005), and can reduce participation of the private sector (Chou and Pramudawardhani 2015).

Past research has relied on case interviews and practitioner surveys to gauge PPP risk allocation. Further, the US market has not received the attention that other jurisdictions have, such as the UK and Australia, with respect to this topic. Certainly, anecdotal evidence of US practice in the highways sector may be found in Federal Highway Administration (FHWA) primers and reports. Yet, a clear state of practice is relatively unknown. As Figure 1.1 illustrates, many jurisdictions that have just begun or have yet to implement PPPs would benefit if risk allocation strategies were better understood. Further, this knowledge would facilitate assessing methods for improving lifecycle risk management and performance.

Bundling not only influences risk allocation, but it also impacts overall contractual design. As discussed, agency theorists would generally contend that PPPs exacerbate the principal-agent problem, so it "is essential to design activities to elicit correct information from 'agents' responsible for delivery, and to put in place structures so that the incentives facing the agents coincide with society's objectives" (Grout and Stevens 2003). Alternatively, incomplete contract theorists recognize the limitations of contracts in complex, long-term transactions, so they contend that ex post opportunistic hazards are best handled through (a) counterparty renegotiation or (b) empowering concessionaires with ownership/decision rights (Crocker and Masten 1991; Hart 1995; Hart and Moore 1988; Chung and Hensher 2016). Hence, PPP contractual designs must address two related issues: (i) alignment of principal-agent interests through information revelation vs. agent empowerment and (ii) ex ante vs. ex post treatment of contingent circumstances. With respect to the first issue, one might expect that PPP contractual designs would favor concessionaire empowerment in light of the transfer of lifecycle risks, and hence the concessionaire's responsibility for lifecycle performance; in fact, Hart (2003) concluded that bundling promoted advantageous investments overall as long as service requirements were adequately specified. Simply put, a reasonable expectation is that a concessionaire's assumption of greater risks and responsibilities would bring proportional levels of decision rights. This is depicted schematically in Figure 1.2 where the expected influence of bundling on the distribution of risk allocation and ownership/decision rights in a typical PPP contract design, where each are placed relatively close to one another. However, concessionaire empowerment without reasonable oversight may allow concessionaires to act opportunistically to choose short-term gains through construction and operation and maintenance (O & M) cost cutting over long-term quality of project assets and services (Hart 2003). As a consequence, the anticipated closeness between risk/responsibility and decision rights may not reflect actual practice. To date, research that has examined whether the expected influence of bundling is aligned with actual contract designs is limited to a single case study by Chung and Hensher (2015). With respect to ex ante versus ex post treatment of contingent situations, limited research has explored this issue.

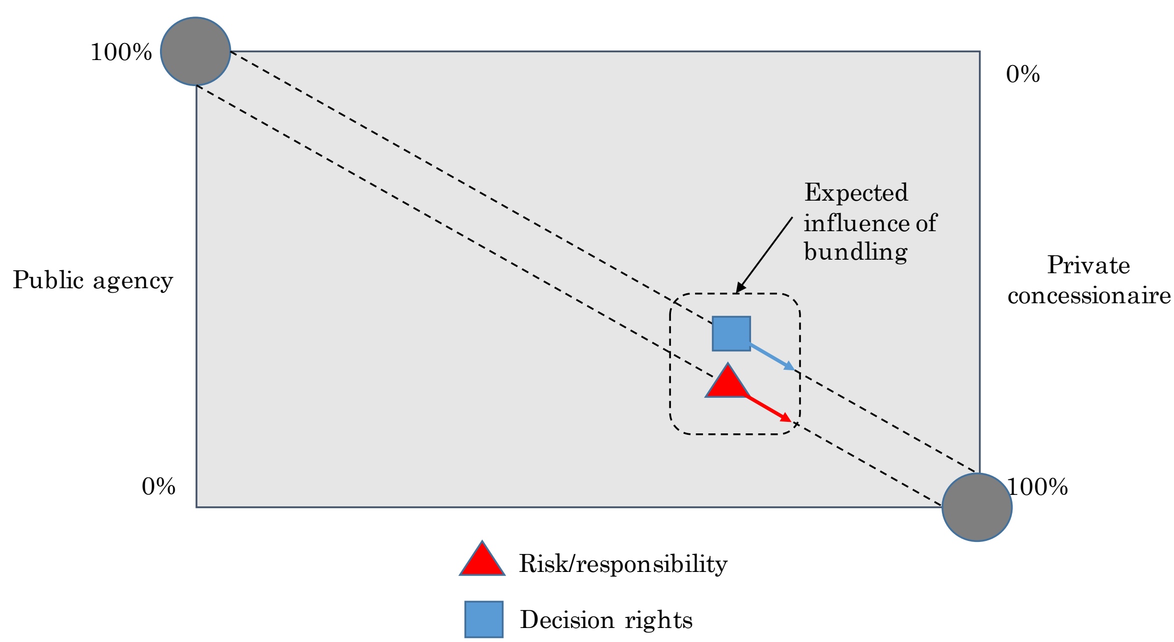

Figure 1.2. Expected distribution of Risk/Responsibility and Decision rights in PPPs

Revenue Risk

Bundling in PPPs often includes the transfer of revenue risk from a public agency to a private concessionaire as is the case in tolled highway concessions. This can promote various conflicts of interest: a public agency typically desires affordable toll rates while a private concessionaire favors revenue-maximizing ones; private concessionaires lobby for downside risk protection whereas public agencies want a share of any windfall profits. This situation represents a common interest alignment problem that a public agency and a concessionaire have to resolve via contract mechanisms.

To cope with this risk, revenue guarantee structures have been introduced in theory and practice; these structures are designed and governed through project contracts. Most structures, however, employ standard option features, which have a number of limitations. Moreover, proposed or implemented structures have not utilized butterfly or collar designs, which can allow public entities to provide fiscal support when revenue shortfalls occur and to gain when revenues exceed necessary private sector rates of return. Exotic options have the potential to overcome such shortcomings.

1.4 Research Approach and Structure

Based on the issues arising from bundling, this dissertation addressed contractual issues by investigating actual highway PPP contracts in the US. The data includes 21 contemporary contracts, ranging from 2005 to early 2016 with a cumulative total investment of $31.5 billion (also referred to the contract data set). The contract data set offered opportunities to examine risk allocation and contractual design, particularly how PPP bundling influenced contractual frameworks and mechanisms to deal with agency problems. One particular project (I-77) in the data set used a revenue guarantee, which was structured like a standard put option. This project offered the opportunity to examine the application of exotic structures to enhance a revenue guarantee's effectiveness. These complementary inquiries were investigated in three studies.

Study 1: Investigation of contracts to establish a risk allocation baseline

Risk allocation is a critical success factor in PPPs (Li et al. 2005). Inappropriate allocation of risks leads to project management inefficiency, high transaction costs (Dudkin and Välilä 2006), high frequency of disputes (Bing et al. 2005), and can reduce participation of the private sector in PPPs (Chou and Pramudawardhani 2015). Through past research, risk allocation has not been examined directly from the contracts at project level. The US highway PPP market, despite its significant size, has been under the radar as well.

This study established where the baseline for risk allocation and provisioning is among contemporary PPP contracts in the US. Further, parametric and comparative analyses among various project parameters and over time are presented to identify trends and areas of variance and convergence with respect to risk allocation and treatment. Hence, this study provides greater understanding about the practices of risk management in existing PPP contracts.

Study 2: State of practice in PPP contract design

Study 1 explored the question "who bears what risks", so Study 2 built off it to investigate contracting practice and determined how PPP contractual frameworks are designed, answering the question "how are the contracts structured to function". Through the lens of contract theories and proposed solutions for known transactional problems, two specific avenues of inquiry were followed. The first avenue explored *the tension between strategies for aligning principal-agent interests*. The second avenue examined risk-sharing mechanisms found in Study 1 to gauge *the propensity to specify ex ante treatments versus ex post resolution*; this also provided an indication of the timing of transaction costs.

Study 3: Enhancing Revenue Risk Sharing with Exotic Options

To date, standard put and call option-like structures have been dominant in the literature examining revenue guarantees. However, these structures also have potential drawbacks. First, standard put and call options provide their underwriters and holders with only a few payoff scenarios. Second, the purpose of revenue guarantees is to have the government bear some of the downside risk; thus, revenue guarantees are only useful when projects are experiencing revenue shortages to pay debts (Irwin 2007). The two drawbacks of guarantee structures with standard put and call options can only be mitigated if structures are designed to improve standard options where only the real time price/value of the underlying assets matters. Fortunately, exotic options, which are another class of options found in both literature and practice, can potentially enhance guarantee structures. Exotic options can generate many payoff scenarios and take into consideration not only real time price/value of the underlying assets but also many more variables such as how price/value evolves, which increases the degrees of freedom when designing an option's structure. Consequently, this research focused on enhancing revenue guarantee structures in the context of highway PPPs by exploring the utilization of exotic options. It utilized data from a standard revenue guarantee structure employed in the I-77 PPP project in the metropolitan area of Charlotte, NC and assessed whether exotic option risk sharing structures have comparative advantages over standard put/call options for major PPP project stakeholders.

2 Chapter 2: Risk Allocation in U.S. Public-Private Partnership Highway Project Contracts[1]

2.1 Abstract

Risk is often discussed in connection with Public-Private Partnerships (P3s), and risk allocation is likely a determinant of P3 success or failure. Despite being central to the delineation and allocation of risks, contracts have not been used directly to examine risks in P3s, particularly in the US. Employing a systematic content analysis framework, the allocation of 31 risks in 21 US highway P3 contracts was determined. These contracts represent the entire population of US highway P3 projects from 2004 through first quarter 2016 with the exception of one project whose contract was not made available. The results were internally validated through inter-rater testing and externally validated using Bond Offering Statements. Hence, the investigation is unique in its approach and comprehensive scope. The allocation results demonstrate that some risks were retained by the public sector, but the majority of the 31 risks were either transferred to the private sector or shared. The former outcome is not unexpected since risk transfer is generally viewed as fundamental to the P3 value proposition; however, the prevalence of sharing in the US market is greater than that conveyed in the literature examining risk allocation in other large markets such as Australia and the United Kingdom. Risk sharing arrangements uncovered ranged from deductible schemes to event mechanisms with the latter employed quite frequently; hence, contract designers rely on ex post remedies to address risks once an event, such as a change in law, occurs. Parametric analysis did not reveal any dominant trends in risk allocation, but examination by the most active jurisdictions (Florida, Texas and Virginia) and source of risk (exogenous vs. endogenous) illustrated that project context influences risk allocation.

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[1] Nguyen, D.A., Garvin, M.J. and Gonzalez E.E. (2017). "Risk Allocation in U.S. Public-Private Partnership Highway Project Contracts". *Journal of Construction Engineering and Management*. In review.

While some consistency was found in the treatment of the 31 risks, the variation in allocation is further evidence that project-specific factors and environments will continue to challenge efforts to create uniformity in P3 contractual provisions. Additionally, the scope of this investigation has important practical implications. With the US P3 market still evolving, the results provide practitioners implementing P3s or considering their implementation a comprehensive overview of risk allocation practices and contractual language across a variety of project characteristics. Consequently, the results can inform practitioner decisions regarding risk allocation and contract design.

Key words: Public-private partnerships, Contract, Risks, Risk Allocation, United States, Highways, Content Analysis

2.2 Introduction

Public-private partnerships (P3s) create a long-term investment relationship between the public and the private sectors where the engagement of the private sector is higher than in conventional delivery (Garvin and Bosso 2008; Kwak et al. 2009; Miller 1999). P3s are argued to have advantages compared to conventional delivery methods such as access to private capital and experience, the transfer of risks to the private sector, and the ability to enhance transparency (Flinders 2002; Gaffney et al. 1999; Pollock et al. 2001; Shaoul 2005). Yet, P3s are not without costs and impediments; significant issues are also possible: social, political, and legal risks; unfavorable economic and commercial conditions; inefficient public procurement methods; lack of mature financial-engineering techniques; and other problems related to the public and private sectors (Zhang 2005).

Risk is abundant in P3s and is at the root of a variety of problems. The causes of risks arise from aspects inherent in the investment and delivery approach: the nature of the underlying assets, the environment, the initial cost, the complexity of the involved system, and the length of the investment (Grimsey and Lewis 2002). Risk and uncertainty are associated with any phase in the life of a P3 and significantly influence a project's outcomes (Akintoye et al. 1998; Chan et al. 2010a; Grimsey and

Lewis 2002). When confronted with risks, a stakeholder in a P3 may elect one of four common strategies: avoid, transfer, share, or manage (ISO31000: 2009). Avoidance is not atypical as some parties will walk away from a P3 due to its overall risk profile. Those electing to enter into a P3 contract, however, are left with one of the three remaining basic strategies with respect to each and every risk. Parties to the contract must agree on a risk allocation strategy, which dictates how risks are treated. The contract, therefore, becomes the central governance mechanism since it stipulates each party's rights and responsibilities, allocates risks and rewards, and addresses other necessary conditions.

Consequently, risk allocation is a critical success factor in P3s (Li et al. 2005). Inappropriate allocation of risks leads to project management inefficiency, high transaction costs (Dudkin and Välilä 2006), high frequency of disputes (Bing et al. 2005), and can reduce participation of the private sector in P3s (Chou and Pramudawardhani 2015). Past research certainly has targeted P3 risk allocation. However, two noteworthy features of past work stand out. First, interviews and surveys were used extensively in the research methodologies employed. Utilizing surveys and interviews has value since these methods allow input from the broad experiences of many P3 stakeholders (i.e. the public sector, the private sector, policy makers, and the consultants). However, with regard to investigations of past complex projects, these methods have some limitations such as recall or sampling bias. Whereas, contracts can provide direct evidence of how risks were allocated and treated by the contractual parties. Second, most of the research in this area has focused on international P3 markets such as the United Kingdom (e.g., Bing et al. 2005, Ke et al. 2010), Australia (e.g., Chung et al. 2010; Chung and Hensher 2015; Hodge 2004b), and China (e.g., Chan et al. 2010b; Ke et al. 2010) as well as other international markets such as India (Thomas et al. 2003), Indonesia (Chou and Pramudawardhani 2015), and Singapore (Hwang et al. 2013). Surprisingly, the US P3 market has not received similar attention in the literature.

This study will address these issues by assessing P3 project contracts in the US highway market. This is one of the first known efforts to examine risk allocation directly from contractual provisions in a targeted infrastructure sector. Specifically, the study focuses on contemporary US highway P3s, which includes 21 projects with a cumulative contract value of $31.5 billion. The research establishes where the baseline for risk allocation and provisioning is among contemporary P3 contracts in the US. Further, parametric and comparative analyses among various project parameters and over time are presented to identify trends and areas of variance and convergence with respect to risk allocation and treatment. Hence, this research provides greater understanding about the practices of risk management in existing P3 contracts.

2.3 Review of P3 Risk Literature

2.3.1 Risk Identification

Key risks associated with P3s have been identified by multiple scholars (Akintoye et al. 1998; Bing et al. 2005; Chan et al. 2010b; Grimsey and Lewis 2002; Hood and McGarvey 2002; Iyer and Sagheer 2009; Thomas et al. 2003; Yescombe 2011; Zou et al. 2008). Yescombe (2011), however, presented a rather comprehensive listing and characterization of P3 risks, which aligns well with prior literature and has some practical advantages since risks are categorized by project phase. Additionally, Bing et al. (2005) distinguished the source of risks as exogenous (caused by factors *outside* a project's system boundaries) and endogenous (caused by factors *within* a project's system boundaries). Quiggin (2004), distinguished P3 risks as idiosyncratic or unsystematic (can be pooled and diversified so that no single party bears significant risk) and systematic risks (highly correlated so that pooling and diversification have little effect on how much risk a single party bears). Though the nature of these two distinctions is different, P3 risks that are endogenous are typically idiosyncratic, and those that are exogenous are usually systematic; this follows corporate finance principles that project-level risks are unsystematic while macro/global risks are systematic (Brealey et al. 2016). Table 2.1 synthesizes the work of Yescombe and Bing et. al. to identify key P3 risks and their corresponding source.

Table 2.1. P3 risk identification (Yescombe 2011) and source (Bing et al. 2005)

Risk	Source	Risk	Source
Socio-political opposition to project	Exogenous	Construction Subcontractor's risks	Endogenous
Change in law	Exogenous	Revenue during construction	Endogenous
Interest rates	Exogenous	Delay by Construction Subcontractor	Endogenous
Inflation	Exogenous	Other causes of delay	Endogenous
Site acquisition	Endogenous	Design	Endogenous
Ground conditions	Endogenous	Performance	Endogenous
Permits	Endogenous	Usage/demand risk	Endogenous
Environmental permits & risks	Endogenous	Network	Endogenous
Archaeology and fossils	Endogenous	Revenue payment	Endogenous
Access, rights of way & easements	Endogenous	Availability and service	Endogenous
Connections to the site	Endogenous	Operation expenses	Endogenous
Protesters	Endogenous	Maintenance	Endogenous
Disposal of surplus land	Endogenous	Latent defects	Endogenous
Construction Subcontract	Endogenous	Project Company default	Endogenous
Construction Subcontractor	Endogenous	Termination by the Public Authority	Endogenous
Price adjustments	Exogenous	Force Majeure	Exogenous
Changes by the Public Authority	Endogenous	Residual value	Endogenous

2.3.2 Risk allocation

It is well established that risks should be allocated to the parties that have the best ability to manage them (e.g., Beidleman et al. 1990, Quiggin 2004, Roumboutsos and Anagnostopoulos 2008); however, some authors have argued that P3 risk allocation is far from optimal (Quiggin 2004 and Chung et al. 2010). Given this, it is not surprising that risk allocation is emphasized in P3 research.

First, some authors have proposed theoretically optimal models of risk allocation. Ball et al. (2003) attributed the causes of risk transfer problems to asymmetry issues; for example, the upside of risks, such as excess revenues, and the downside of risks, such as the loss of revenues, are not balanced. Iossa and Martimort (2012) mathematically compared the cost/benefit effects of bundling versus unbundling project activities. They concluded that bundling often gives better outcomes only if the private party can assess all of the project risks well. Scholars have also used real options theory in addressing risk allocation problems. For instance, Chiara et al. (2007a), Alonso-Conde et al. (2007), and Park et al. (2012) treated governmental guarantees as real options so that they could calculate the option value of the risk to each party using real option techniques. Quiggin (2006) proposed to add more flexibility to overall risk allocation by considering the whole project as an option (put or call): the private party (put holder) could sell back the project, whereas the public party (call holder) could buy back the project at pre-agreed expiration dates.

Second, empirical research has investigated the practice of risk allocation in P3s. Through surveys and interviews with practitioners involved in actual projects, researchers have identified the preferred risk allocations in different countries, including large (e.g. the UK, Australia, China, India) and small P3 markets (e.g. Singapore, Indonesia, Greece). Table 2.2 combines risk allocation results in research for large P3 markets while Table 2.3 indicates and characterizes the archival references shown in Table 2.2.

Table 2.2. Synthesis of previous risk allocation research in large P3 markets

Risk	Australia			UK			China			India		
	Pu	S	Pr	Pu	S	Pr	Pu	S	Pr	Pu	S	Pr
Unstable government		*		*			*			*		*
Poor public decision-making	*			*			*					
Political opposition	*			*	*	*	*			*		*
Change in legislation	*	*		*	*		*					
Change in tax regulation					*	*	*	*	*			
Change in construction law						*			*			

Risk	Australia			UK			China			India		
	Pu	S	Pr	Pu	S	Pr	Pu	S	Pr	Pu	S	Pr
Land acquisition	*			*			*	*	*	*		
Expropriation				*			*					
Financial attraction to												
Financing costs			*			*			*			*
Design risk			*			*			*			
Unproven technology			*			*						
Delays of approvals	*			*	*	*	*					
Construction cost overrun			*			*			*			*
Delays in construction		*				*			*			*
Contract variation				*	*	*		*				
Material/labor availability			*			*			*			
Poor quality of workmanship			*			*			*			
Late design changes	*							*				
Demand		*	*	*		*	*	*	*	*		*
Network	*	*										
Operation cost overrun			*			*						*
Maintenance cost			*			*						
Project organization			*			*		*				
Third party liability						*		*				
Staff crises			*			*			*			
Poor financial market						*		*				
Bad economic events						*			*			
Force majeure			*		*	*		*				
Environment	*					*			*			
Inflation						*			*			
Interest rate risk			*			*			*			
Geotechnical conditions	*					*			*			
Weather						*			*			
Residual						*			*			

(Pu: Public bears; S: Shared; Pr: Private bears; R = Reference 1, 2, 3, 4, 5, 6, 7, 8, and 9; see Table 3)

Table 2.3. Previous risk allocation investigations in large P3 markets

No.	Paper	Targeted P3 Market	Research Method
1	Hodge (2004)	Australia	Case study
2	Quiggin (2004)	Australia	Case study
3	Ng and Loosemoore (2007)	Australia	Case study
4	Chung et al. (2010)	Australia	Interviews
5	Chung and Hensher (2015)	Australia	Case study
6	Bing et al. (2005)	UK	Survey
7	Ke et al. (2010)	UK; China	Survey
8	Chan et al. (2010b)	China	Survey
9	Kalidindi and Thomas (2003)	India	Survey

Both risk identification and risk allocation have varied among these markets. For instance, the public sectors in the UK and China tend to retain more exogenous risks such as political opposition and change in law than Australia. Endogenous risks, such as construction risks, in the UK have been borne by the private sector while these risks have been commonly shared in China. The US highway P3 market, despite its size, is not among previous research efforts. Furthermore, direct investigation of contractual provisions across a comprehensive set of projects has not been done. Though interviews (directly or within case studies) and surveys are methods that can provide understanding from multiple perspectives of various project participants, these methods do rely on the recall of project participants and potentially anecdotal evidence. The case study method can provide deep understanding typically for a small scope of specific projects, but the extent of broader generalization possible to an entire market segment is limited.

In summary, risk allocation in P3s has been an active research topic for scholars, particularly studies in international settings. However, existing research has not (1) targeted the US, though it is a large market or (2) utilized contracts extensively as the basis of the investigation even though *risk allocation is agreed and manifested in contracts*. Hence, systematic examination of contracts within the US offers an opportunity to further knowledge of P3 risk allocation in an unexplored market.

2.4 Research Methodology

2.4.1 Research questions

As discussed, gaps in the literature indicate a need to examine contracts as the basis of risk allocation and provisioning within US P3 projects, which leads to a set of research questions:

(1) What risks are provisioned?

(2) How are risks allocated?

(3) How has risk allocation varied across project parameters?

The answers to the first and second questions can be yielded directly from the contracts. The third question can be explored by consequently performing parametric and comparative analyses of risk allocation results.

2.4.2 Data

Based on the characterization of P3s provided by Garvin and Bosso (2008), twenty-two projects were identified as contemporary highway P3s in the US over the period of 2004 to 2016. Table 2.4 depicts these projects that are spread across ten states and one territory. These projects represent the entire population for US highway P3s from 2004 through first quarter 2016.

Table 2.4. P3 Highway Projects in the US

Project	**Jurisdiction**	**Commercial Close**	**Value ($mil)**
Chicago Skyway	Chicago	2004	$1,800
Indiana Toll Road	Indiana	2006	$4,600
CO NW Parkway	Colorado	2007	$600
I-495 Capital Beltway Express	Virginia	2007	$2,068
SH 130: Segments 5 & 6	Texas	2007	$1,380
I-595 Express Lanes	Florida	2009	$1,760

Project	Jurisdiction	Commercial Close	Value ($mil)
Port of Miami Tunnel	Florida	2009	$651
North Tarrant Express (1 & 2A)	Texas	2009	$2,000
I-635 LBJ Managed Lanes	Texas	2009	$2,600
PR-22 & PR-5	Puerto Rico	2011	$1,136
Elizabeth River Tunnels	Virginia	2011	$2,100
Presidio Parkway (Phase II)	California	2011	$362
I-95 Express Lanes	Virginia	2011	$922.6
East End Crossing	Indiana	2012	$763
North Tarrant Express (3A & 3B)	Texas	2013	$1,350
Goethals Bridge Replacement	NY & NJ	2013	$1,500
US 36 Managed Lanes - Phase 2	Colorado	2013	$175
I-4 Ultimate Improvements	Florida	2014	$2,323
I-77 HOT	North Carolina	2014	$655
Rapid Bridge Replacement Program	Pennsylvania	2015	$1,119
Southern Ohio Veterans Memorial Highway	Ohio	2015	$819
SH 288 Toll Lanes	Texas	2016	$425

Generally, contracts (also known as project or concession agreements) were obtained from publicly available sources or by requests to public agencies. For the Goethals Bridge Replacement project, the contract is not publicly available and requests for the contract were not answered in a timely manner. Hence, 21 projects were included in the analysis. Most of the contracts are structured with main sections plus appendices, which further explain provisions inside the main documents or provide technical specifications. Each contract's main document length ranged from 200 to 400 pages. Total length of all related documents for a contract was as much as 2,000 pages.

2.4.3 Content analysis approach

Careful investigation of each contract was necessary to extract information from provisions related to key project risks. Extracted information was then analyzed to determine risk allocation and the nature of contractual provisions. Content analysis methods were employed for this purpose. Content analysis is a systematic, replicable technique for condensing text into content categories based on explicit rules of coding (Krippendorff 1980; Weber 1990). This method can be used with either qualitative or quantitative data and in an inductive or deductive way (Elo and Kyngäs 2008). Categories are derived from the data in inductive content analysis whereas a theory or model moves from the general to the specific in deductive content analysis (Grove et al. 2012).

The analysis process involved the identification of risk-related provisions, determination of risk allocation, and recognition of mechanisms for risk management stipulated in the contracts. Each contract differed somewhat in the way it structures information, and contract clauses were expressed using diverse vocabulary. This can challenge attainment of reliable results. Therefore, a well-structured content analysis approach that maintained flexibility to allow some process refinements was necessary.

Figure 2.1 depicts the overall methodology. First, a risk matrix was built from literature; the risks presented in Table 2.1 were the basis of this matrix. However, the risk matrix needed further refinement – such as updates of risk definitions – to reflect issues specific to US highway P3 projects. Incremental refinements continued as the initial set of contracts were analyzed. Second, an analysis rubric was devised as a guideline for contract investigation. For each risk, the rubric indicated: the risk's definition, its typical location within a contract, and related keywords or terms. Third, qualitative analysis software, QSR NVivo (Bazeley and Jackson 2013), was utilized to organize and analyze all of the contract data. For each risk, the relevant contractual provisions were identified, the text segments of these provisions were assessed, supplementary notes were taken, and the allocation of the risk was recorded (public, private or shared). If the allocation was shared, the sharing mechanism was described and then categorized.

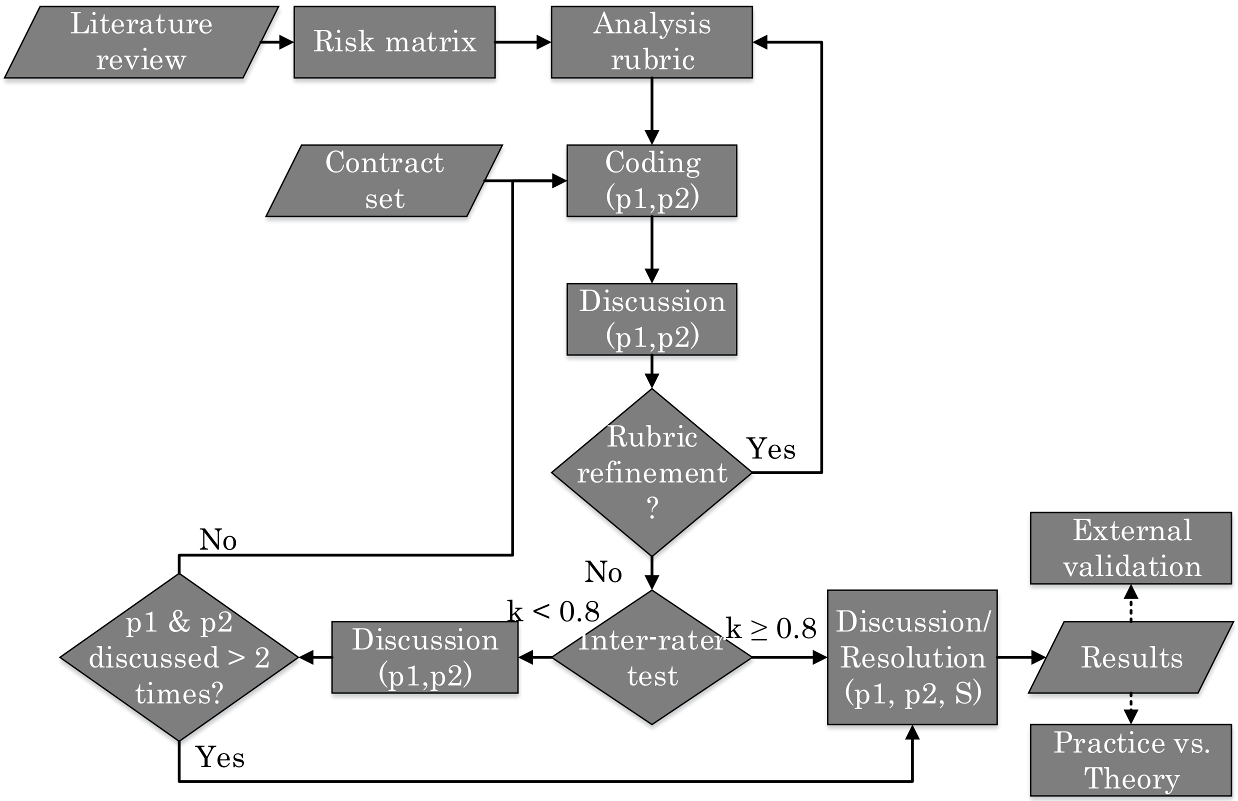

Figure 2.1. Overview of methodology

2.4.4 *Inter-rater methods and internal validation*

Analyses of the contracts involved three research participants: two analysts (p1, p2) and a supervisor (S). Using the analysis rubric and QSR NVivo software, an iterative process was followed. The two analysts first reviewed a set of three contracts, took notes (e.g. suggestions for improving the rubric based on actual contracts), and determined the allocation for each risk. Subsequently, agreement on risk allocation between the two analysts was measured by Cohen's kappa (Cohen 1960) since it is appropriate for nominal data (Krippendorff 2004).

$$\kappa = \frac{F_o - F_c}{N - F_c}$$

where: N – the total number of judgments made by each coder

F_o – the number of judgments on which the coders agree

F_c – the number of judgments for which agreement is expected by chance

According to Landis and Koch (1977), when κ approaches or exceeds 0.8, agreement is considered sufficient based on its strength. The κ calculation assesses the reliability of content analysis: "different people should code the same text in the same way" (Weber 1990, page 12). If the process is consistent, and therefore reliable, then it is internally validated (Kolbe and Burnett 1991; Krippendorff 2004). Further, the initial kappa calculated provided some indication of each contract's clarity of structure and language.

The initial κ for the three contracts analyzed was: 0.76, 0.95, and 1.00. Discrepancies were discussed to facilitate shared understanding between the analysts as well as improvements to the rubric. Then, the same three contracts were reviewed again, and the resulting κ was 0.86, 1.00, and 1.00. Based on the strength of these agreements, the rubric was considered valid, though minor refinements were made to the rubric and risk matrix as subsequent contracts were analyzed. The discrepancies remaining between the two analysts after the second round of review and discussion were left for resolution with the supervisor. The analysts then proceeded to the remaining contracts and the process was repeated. Table 2.5 depicts the final risk matrix.

In this study, nearly perfect agreement between analysts, $\kappa \geq 0.8$, was not sufficient since an absolute determination of the allocation of each risk was necessary. Hence, if $\kappa < 1.0$ for any contract after two rounds of analyst review and discussion, then the supervisor was involved. The three participants reviewed and discussed all remaining discrepancies. In most instances, the analysts and the supervisor came to a joint agreement on the ultimate allocation determination. In a few cases, however, the supervisor made the final decision based on the contractual language.

2.4.5 External validation

2.4.5.1 Bond offering statements

Internal validation of the content analysis only fulfills a part of the "trustworthiness" requirement for research; external trustworthiness is also necessary (Graneheim and Lundman 2004). Whereas internal trustworthiness is related to "reliability" measured by the inter-rater testing done, external trustworthiness is related to "validity". To increase the study results' validity, Denzin and Lincoln (1994), Hollway (1995), and Roberts (1997) suggested triangulation. Researchers can employ triangulation by comparing internal results with another source of results that ideally employs the same investigation method (i.e. contract analysis). This additional source of results was obtained from Bond Offering Statements, which are prepared by the underwriters of project bonds to provide information to potential investors. A Bond Offering Statement often includes two sections relevant to this study: *Risk Factors* and *Summary of Provisions of Comprehensive Agreement*. These sections are written in plain language, emphasize risks in each project and indicate how the project agreements allocate them. However, not all the risks studied are discussed inside these statements since they focus primarily on key risks that directly affect a project's ability to service debt.

Among the projects in the data set, thirteen (62%) had bond offering statements available (SH-288, Rapid Bridge Replacement, Portsmouth Bypass, North Tarrant Express 1-2A, North Tarrant Express 3A-3B, US-36 Phase 2, Elizabeth River Tunnels, I-95, I-495, I-77, IH-635, I-4, and East End Crossing). These project bonds were often co-underwritten by two to three financial firms such as J.P. Morgan, Citigroup, Barclays, BoA Merrill Lynch, Goldman Sachs Co., and Wells Fargo. Each has significant experience in project finance and their interests are closely associated with their reputation, which is built on how adequately they have described projects to investors. Using the same investigation method (contract analysis) in related matters, the statements are a valuable source to validate the results of this study.

2.4.5.2 Assessing results with theoretical principles of risk allocation

In addition, the risk allocation results can be assessed against the sources of risk – endogenous and exogenous. The sources of risk do not necessarily suggest an allocation of a risk to one party or another; however, risk allocation in theory should vary less across contracts for exogenous risks than endogenous risks since they are far less sensitive to a project's context. One might expect that a "universal" precedent has emerged for exogenous risks because they are more global in nature. If the results do not agree with this expectation, then this opens up opportunities for further research.

Table 2.5. Developed risk matrix, incorporating all refinements after contractual risk analysis

Risk	**In**	**Description**
Financing	General	Difficulty in finding financial investors and/or favorable terms for the project developer and/or the sponsor when they have capital needs during a project's lifecycle.
Socio-political opposition and protesters		Opposition to the project by government agency or citizens, e.g., political issues, protests, strikes.
Change in law		(a) the adoption of any law after the contract's effective date, or (b) any change in any law or in the interpretation or application thereof by any governmental authority after the effective date. Discriminatory change in law is differentiated from other changes in law since a discriminatory change only affects the project or comparable projects, the project developer/contractor, or only the highway/bridge/tunnel industry sector.
Refinancing		The risk that the project developer and/or the sponsor may face when they want to change their current financial structures or agreements to better suit their needs (e.g. changes in interest rates, stricter agreement).
Inflation		High inflation drives up the cost of construction and operation while it reduces the real value of money.
Interest rates pre financial close	Pre fin. close	Changes in interest rates after commercial close but before financial close.
Design	Construction	Inadequate or defective design impacts may emerge in the construction and operation phases.
Rights of way & easements		Difficulties in acquiring necessary right of way (ROW) and easements for the project.
Additional properties		Any difficulty in acquiring properties outside of ROW but deemed necessary for the project.
Site geology		Site geology may be different from what is known by the project developer and/or sponsor at the time of commercial close. The differences can among other things increase costs and cause delays.
Environmental risks		Presence of known or unknown environmental conditions (e.g., hazardous materials, contaminated site); these are exclusive of more general site geology conditions.

Risk	In	Description
Archaeology, fossils, or protected species		Discovery of important archaeology, fossils or endangered species on the project site that may seriously delay construction or require revisions of the construction plans.
Access and adjustment to utilities		Difficulties in coordinating with third parties during utility adjustments and relocation, permitting, etc. throughout the project.
Permits		Difficulties and delays in getting general permits from authorities or other third parties.
Environmental permits		Difficulties and delays in getting environmental permits from authorities.
Commodity price adjustments		Changes in commodity (i.e. materials, fuel, etc.) prices over time.
Changes by the Public Authority		Changes in project specifications, scope, schedule, etc. made by the Public Authority after financial close.
Revenue during construction		During construction, revenues from project related assets (if applicable) may deviate from expected. This affects project stakeholders if these revenues are a source of funding for the project.
Performance		Project fails to meet milestones or fails to perform as specified.
Usage/demand risk	Operation	Demand may be lower than projections due to factors such as inaccurate forecasts of demand elasticity, onset of economic recession, or changes in local population/demographics.
Network		Unplanned or planned changes in transportation policies or plans by the public authority (e.g., the building of competing roads) that can affect usage or performance of the project.
Payment for services		Failure of public authority to make timely payments according to contractual obligations (e.g. due to shortage of budgetary funds).
Availability and service		Facility fails to meet specified availability or service standards/measures.
Operation expenses		Increase in actual operation expenses.
Maintenance		Unscheduled maintenance that impairs availability or higher than expected maintenance costs.

Risk	In	Description
Latent defects		A fault in the facility that is not patent, i.e. the fault could not have been discovered ex ante through reasonable investigation.
Transfer		Changes in organizational or financial structure of parties to the contract (e.g., change in ownership).
Project Company default		Termination due to project company default.
Termination by the Public Authority		Termination due to the public authority's decision.
Force majeure		Unusual events that cause temporary interruption or irrecoverable damages to the project.
Residual value		At end of contract duration, the facility (quality or value) does not meet specified requirements.

2.5 Risk Allocation Results

Table 2.6 depicts the risk allocation results for each project; the table is sorted by payment mechanism, state, and year. The first seven projects utilized availability payments (AP) in CA, FL, IN, OH and PA between 2009 to 2015. The next four projects are leases in IL, CO, IN and PR between 2004 and 2011, while the final ten projects are toll concessions in CO, NC, TX and VA between 2007 and 2016.

2.5.1 Risks predominantly borne by the public sector

Scrutiny of Table 2.6 indicates that the public sector has retained some risks from project to project, but no particular risks are consistently borne by the public sector – except *usage-demand* and *network* risks in AP projects, which are characteristic of this P3 structure. This overall outcome is not surprising since P3s emphasize risk transfer. The most prevalent risk borne by the public sector is *changes by the public authority*; again, this is not unexpected since placing the responsibility for impacts of adjusting contractual conditions post financial close with the public sector is reasonable and common.

2.5.2 Risks predominantly borne by the private sector

Table 6 illustrates that risks related to major project tasks such as finance (*financing*, *refinancing*), construction (*design*, *performance*), operation (*availability*, *operating expenses*, *maintenance*), project ownership (*transfer*), and handback (*residual value*) were allocated to the private sector in all cases. These allocations underscore the nature of P3s. The private developer is responsible for acquiring the necessary financing for the project and is solely responsible for any refinancing. Moreover, many contracts required the developer to share any gains from refinancing with the public sector but any losses are borne by the private sector. A representative provision from SH-130's contract in Texas follows:

Table 2.6. Risk allocation in the US highway P3 contracts

Projec	Stat	Paymen mechanisr	Commercial clo	Financin	Socio-political opposition	Change in lav	Interest rates pre fin. clo	Refinancing	Inflatio	Design	Right of way & easement	Access additional propertie	Site geology	Environmental risl	Archaeology & fossil	Access and adjustment to utilitie	Permit	Environmental permi	Commodity price ad	Changes by the PA	Revenue during const	Performance	Usage-demand risl	Networl	Payment for service	Availability and servi	Operating expense	Maintenanc	Latent defect	Transfe	SPV defaul	Termination by the P	Force Majeur	Residual valu
Presidio PW	CA	AP	2011	Private	Shared	Shared	Public	Private	Public	Private	Public	Public	?	Shared	Shared	Shared	Shared	Shared	Public	Public	X	Private	Public	Public	Shared	Private	Private	Private	Shared	Private	Shared	Shared	Shared	Private
I-595	FL	AP	2009	Private	Shared	Shared	?	Private	Shared	Private	Shared	Shared	Private	Shared	Shared	Shared	Shared	Private	Private	Shared	X	Private	Public	Public	Shared	Private	Private	Private	Shared	Private	Shared	Shared	Shared	Private
Port of Miami Tunnel	FL	AP	2009	Private	Shared	Shared	?	Private	Shared	Private	Shared	Private	Shared	Shared	Shared	Shared	Shared	Shared	Private	Shared	X	Private	Public	Public	Shared	Private	Private	Private	Shared	Private	Shared	Shared	Shared	Private
I-4	FL	AP	2014	Private	Shared	Shared	?	Private	Shared	Private	Public	Public	Shared	Shared	Shared	Private	Private	Private	Shared	Shared	X	Private	Public	Public	Shared	Private	Shared	Shared	Private	Private	Shared	Shared	Shared	Private
East End Crossing	IN	AP	2012	Private	Shared	Shared	Public	Private	Shared	Private	Public	Private	Shared	Shared	Shared	Shared	Shared	Private	?	Public	X	Private	Public	Public	Shared	Private	Private	Private	Private	Private	Shared	Shared	Shared	Private
Portsmouth Bypass	OH	AP	2015	Private	Shared	Shared	Public	Private	Shared	Private	Public	?	Shared	Shared	Shared	Shared	Shared	Shared	?	Public	X	Private	Public	Public	Shared	Private	Private	Private	Private	Private	Shared	Shared	Shared	Private
Rapid Bridge Rep	PA	AP	2015	Private	Shared	Shared	?	Private	Shared	Private	Public	Public	Shared	Shared	Shared	Shared	Shared	Shared	Private	Public	X	Private	Public	X	Shared	Private	Private	Private	?	Private	Shared	Shared	Shared	Private
Chicago Skyway	IL	Lease	2004	Private	Shared	Shared	?	Private	?	?	X	X	X	Shared	X	?	Shared	Shared	X	Public	X	X	Private	Private	Private	Private	Private	Private	?	Private	Shared	Shared	Shared	?
Colorado NW	CO	Lease	2007	Private	Shared	Shared	?	Private	Private	?	X	Private	?	Public	X	Private	Shared	Shared	?	Public	X	X	Private	Shared	Private	Private	Private	Private	Shared	Private	Shared	Shared	Shared	Private
Indiana TR	IN	Lease	2006	Private	Shared	Shared	?	Private	?	Private	Shared	Shared	Private	Shared	X	Private	Shared	Shared	X	Public	X	X	Private	Shared	Private	Private	Private	Private	Public	Private	Shared	Shared	Shared	Private
PR-22 & PR-5	PR	Lease	2011	Private	Shared	Shared	Shared	Private	Private	Private	Shared	Shared	X	Shared	Shared	Shared	Shared	Shared	Private	Public	X	X	Private	Shared	Private	Private	Private	Private	Private	Private	Shared	Shared	Shared	Private
US-36	CO	Tolled	2013	Private	Shared	Shared	?	Private	?	Private	Public	Public	Shared	Public	Public	Shared	Shared	?	?	Shared	?	Private	Private	Shared	Private	Private	Private	Private	Shared	Private	Shared	Shared	Shared	Private
I-77	NC	Tolled	2014	Private	Shared	Shared	Public	Private	Shared	Private	Shared	Shared	Shared	Shared	Shared	Shared	Shared	Shared	Shared	Shared	X	Private	Shared	Shared	Private	Private	Private	Private	Shared	Private	Shared	Shared	Shared	Private
SH-130	TX	Tolled	2007	Private	Shared	Shared	Private	Private	Private	Private	Private	Private	Shared	Shared	Shared	Private	Shared	Public	?	Public	X	Private	Private	Shared	Private	Private	Private	Private	Private	Private	Shared	Shared	Shared	Private
I-635	TX	Tolled	2009	Private	Shared	Shared	Public	Private	Private	Private	Public	Private	Shared	Shared	Shared	Private	Shared	Public	Private	Public	X	Private	Private	Shared	Private	Private	Private	Private	Private	Private	Shared	Shared	Shared	Private
NTE (1-2A)	TX	Tolled	2009	Private	Shared	Shared	Public	Private	Private	Private	Private	Private	Shared	Shared	Shared	Shared	Shared	Public	?	Public	X	Private	Private	Shared	Private	Private	Private	Private	Private	Private	Shared	Shared	Shared	Private
NTE (3A-3B)	TX	Tolled	2013	Private	Shared	Shared	Shared	Private	Private	Private	Shared	Shared	Shared	Shared	Shared	Shared	Shared	Public	?	Public	X	Private	Private	Shared	Private	Private	Private	Private	Shared	Private	Shared	Shared	Shared	Private
SH-288	TX	Tolled	2016	Private	Shared	Shared	Shared	Private	?	Private	Shared	Private	Shared	Shared	Shared	Private	Shared	Public	?	Public	X	Private	Private	Shared	Private	Private	Private	Private	Private	Private	Shared	Shared	Shared	Private
I-495	VA	Tolled	2007	Private	Shared	Shared	Shared	Private	Private	Private	Shared	Private	Shared	Shared	Shared	Private	Shared	Shared	?	Shared	X	Private	Private	Private	Private	Private	Private	Private	Private	Private	Shared	Shared	Shared	Private
Elizabeth River	VA	Tolled	2011	Private	Shared	Shared	Public	Private	Private	Private	Shared	Shared	Shared	Shared	Shared	Private	Shared	Shared	Private	Shared	Private	Private	Private	Shared	Private	Private	Private	Private	Shared	Private	Shared	Shared	Shared	Private
I-95	VA	Tolled	2011	Private	Shared	Shared	Shared	Private	?	Private	Shared	Private	Shared	Private	Shared	Private	Shared	Shared	Private	Shared	X	Private	Private	Shared	Private	Private	Private	Private	Private	Private	Shared	Shared	Shared	Private

Public | Shared | Private | ? Silent or indeterminate | X Not applicable to the project

"Developer is solely responsible for obtaining and repaying all financing, at its own cost and risk and without recourse to TxDOT, necessary for the acquisition, design, permitting, development, construction, equipping, operation, maintenance, modification, reconstruction, rehabilitation, restoration, renewal and replacement of the Facility" (SH-130, Section 4.1.2). This study, however, did not consider governmental support such as subsidies or federal government loans (under the TIFIA program) as grounds for sharing financing risks since all contracts had express and clear provisions indicating that the private sector held the risk of financing acquisition and repayment.

The construction and operation risk allocations confirm the developer's responsibility for the quality of construction and operation services. Bearing these risks, the developer must balance operating requirements with construction phase demands, such as a goal of a low cost, efficient delivery with high quality assets that need minimal maintenance and repair in operation. From the same contract (SH-130), illustrative provisions follow:

- *Developer shall furnish all aspects of the Design Work and all Design Documents, including design required in connection with the operation and maintenance, Renewal Work or Upgrades, and shall construct the Facility and/or Utility Adjustments included in the Construction Work as designed, free from material defects, and in accordance with (a) Good Industry Practice, (b) …FCA* [Facility Concession Agreement] *Documents, (c) the Milestone Schedule and Facility Schedule, (d) all Laws, (e) … all Governmental Approvals, (f) the approved Facility Management Plan…* (Section 7.2)
- *at all times during the Operating Period, Developer shall carry out the O&M Work in accordance with (a) Good Industry Practice, as it evolves from time to time, (b)…the FCA Documents… (c)… the requirements, terms and conditions set forth in all Government Approvals…* (Section 8.1)

Within the contracts, project ownership was addressed consistently; public owners expect project developers to uphold their long-term commitments. Public sector oversight of transfers of controlling interests was manifested in the approvals necessary before any potential transfers. The language in I-495's contract is indicative of contracts examined: "From time to time during the term of this Agreement, the Concessionaire has the right, at its sole cost and expense, to pledge, sell or otherwise transfer solely the Toll Revenues available for Distribution in connection with a Permitted Securitization…"; however, this right was constrained by the public agency: "The Concessionaire shall not Transfer, or otherwise permit the Transfer of, any or all of the Concessionaire's Interest to or in favor of any Person (a "Transferee") during the Lockup Period" [the 10-year period commencing on the concession's Closing Date and ending on the tenth anniversary of the Closing Date] and "following the Lock-up Period, the Concessionaire shall not Transfer, or otherwise permit the Transfer of, any or all of the Concessionaire's Interest to or in favor of a Transferee, unless the Department has approved…" (I-495, Section 20.01). These conditions are not unreasonable since the constraints require the developers to maintain their interests in the project for a specified time period and to identify and obtain approval of appropriate substitutes for their interests thereafter.

Residual value is the value of the project's assets during handback to the public sector at contract termination. The provisions examined provide another example of contractual measures that drive the developer to sustain project quality over the contract's duration. For all projects (except the Chicago Skyway where the contract is silent or indeterminate), the approach used for securing this value was collateral deposited into a "handback account". The contracts required mandated annual deposits from the developer, usually starting in the fifth year prior to the end of the contract. If the residual value of the project ultimately does not meet specified requirements, then the "handback account" is used to restore the quality of the project assets. The developer is entitled to any funds remaining in the account during contract close-out.

2.5.3 Risks predominantly shared

The contracts shared a number of risks; they tended to share risks during the construction phase (*permits, environmental risks, archaeology-fossils and protected species,* and *site geology*), at termination (*project company default* and *termination by public authority*), and *force majeure* – a risk that can happen during any phase. In most cases, the public sector retained some aspects related to the risk of *socio-political opposition and protesters* to assist private developers in the event of project opposition that impacts completion or operation.

Many of the shared risks were treated by event mechanisms: relief events (or delay events) and compensation events. Relief events (or delay events) typically extend a project's construction period and/or operation duration, which can facilitate recovery of lost revenues. Compensation events generally involve payments from one party to another for damages incurred. For instance, risks such as *change in law* and *archaeology-fossils and protected species* were often treated as compensation events. In the Portsmouth Bypass contract, it dictated that a "Qualifying change in law" is a compensation event, whereas "any change in law that is not a qualifying change in law" is a relief event. A qualifying change in law was defined as: "*(i) a discriminatory change in law and (ii) a general change in law which involves capital expenditure*" (Portsmouth Bypass, Exhibit 1, page 59).

Force majeure was commonly defined as the occurrence of qualifying events "that materially and adversely affects performance of Concessionaire's obligations, provided that such events (or the effects of such events) could not have been avoided by the exercise of caution, due diligence, or reasonable efforts, by any Concessionaire-Related Entity" (I-4, Exhibit 1, page 29); qualifying events typically included war, riot, terrorism, fire, nuclear explosion, earthquake, floods caused by a nature event, and named windstorms. In all contracts, the private developers were obligated to buy insurance for force majeure events. In case the events are uninsurable or the insurance plan fails to cover all the loss, the remaining loss was usually treated as a relief event.

A frequently used sharing mechanism was a deductible. A deductible is the amount of loss that a party must solely bear before it can claim damages and ask for compensation from the counterparty. As an example, the I-4 contract (Section 4.17) stated "Concessionaire shall solely bear (a) the first US$500,000 of Extra Work Costs directly attributable to damage caused by such Relief Event and (b) an amount equal to Delay Costs for the first five (5) days of delay…".

Another mechanism was employed for *project company default* and *termination by the public authority*. If the public authority elects to terminate a contract, it will typically compensate the private developer an amount based on "fair value" of a project. In case of *project company default*, the public authority will have all the rights to step in and cure the project using its own mechanisms. The private developer may be compensated, but the amount of compensation is subject to the public authority's decision and perhaps negotiation.

Other sharing methods were also utilized. The *prorated* method typically split any costs (or gains) related to a risk into fixed percentages for each party; this method is illustrated through sharing of the risk *right of way and easements* in the Elizabeth River Tunnels contract (Section 8.05):

> *"(A) ROW [right of way] Acquisition Costs Overage. (1) the Concessionaire will pay 100% of the ROW Acquisition Costs up to 110% of the ROW Baseline Cost; (2) the Concessionaire and the Department each will pay 50% of the ROW Acquisition Costs in excess of 110% but less than or equal to 120% of the ROW Baseline Cost; and (3) the Department will pay 100% of the ROW Costs in excess of 120% of the ROW Baseline Cost."*

Finally, negotiation, often cited with "in good faith", was also employed for risks where neither party could accurately predict the timing or consequence of a risk such as right of way and easements, project company default, termination by the public authority, and force majeure.

2.5.4 Validation with Bond Offering Statements

The risk allocation results were compared with risk allocations described in the available bond offering statements. In the 13 statements, on average 20 risks were covered, including:

- Financing and refinancing risks
- Construction commencement and quality risks (*right of way, access additional properties, utilities, design*)
- Construction delay risks (*socio-political opposition, permits, environmental risks, archaeology and fossils, performance*)
- Project revenue risks (*usage/demand, network, payment for services*)
- Operation risks (*maintenance, operating expenses*); and
- Other project company risks (*change in law, changes by the public authority, force majeure*).

As stated previously, Bond Offering Statements are clearly written and generally easily understood since they are written for potential investors. Consequently, the process of comparing this study's risk allocation results with those in the statements was fairly straightforward. The agreement between the study's risk allocation results and the risks covered in each project's statement was conclusive.

For instance, the allocation of *network* risk for the SH-288 contract was determined as "shared". The project's Bond Offering Statement described this risk:

> *"[T]he Developer is only entitled to receive from the Department monetary compensation for toll revenue losses arising from the construction of any unplanned limited access main lane of a highway…*" and "*Other than for these limited, non-excepted facilities... including additional or improved free roads, bus lanes, HOT/HOV lanes, light rail, heavy rail and freight rail… will not*

entitle the Developer to compensation from the Department" (Tax-exempt Senior Bonds – SH-288 – Series 2016, page 32).

The statement describes a "sharing" of the *network* risk that matches the study's finding; the developer is entitled to compensation for lost revenue **only if unplanned construction** of limited access highway main lanes occurs. Hence, protection is afforded to the developer, albeit limited, for the *network* risk while the public agency is free to build any planned surface routes.

2.6 Parametric & Comparative Analysis Results

2.6.1 Parametric Analysis

2.6.1.1 General

Figure 2.2 depicts the distribution of projects over time. Given the ebb and flow in the market, one might expect some diffusion of practices over the period. Examining risk allocation by time, however, did not yield any noticeable trends except for the Chicago Skyway, the earliest contract in the study, where the *residual value* risk was not directly addressed, so the contract was silent. Similarly, no evident trends were found when sorting by other parameters such as project type (fixed crossing, arterial, managed lanes), contract duration (30 years to 99 years) or contract value ($175 million to $4,600 million).

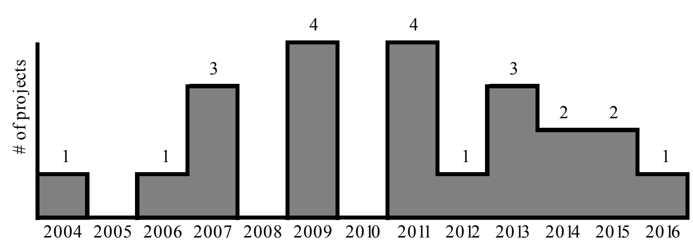

Figure 2.2. Time distribution of contemporary projects

2.6.1.2 Variations by payment mechanisms

The payment mechanism obviously accounts for variation in allocation of the *usage/demand* risk; in availability payment projects, *usage/demand* risk is retained by the public sector; correspondingly, it also retains the *network* risk. Alternatively, the private developers accept the *usage/demand* risk in toll concessions (and in leases). Consequently, ridership directly impacts the developers' revenues. A unique arrangement was structured in the I-77 project, where the *usage/demand* risk was shared. This contract included a provision called a "DRAM" (developer ratio adjustment mechanism), so the public agency agreed to financially support the private developer if revenues fall short during the payback period of the project's TIFIA loan. Key language about the DRAM follows:

> *"…NCDOT will provide limited credit enhancement support for the Project and to facilitate the financing of the Project ('Developer Ratio Adjustment Mechanism'). The Parties acknowledge that the Developer Ratio Adjustment Mechanism is not intended to guarantee a minimum return on investment to the Equity Members…"* (I-77 Contract, Section 13.3)

The DRAM is in effect over a limited period from when "all Project Sections have achieved Substantial Completion and ending on the Final Maturity of the TIFIA Loan." (I-77, Exhibit 1, page 21); additionally, the DRAM's payable amounts are limited as well: "in no event shall annual payments exceed $12 million" and "no DRAM amount will be payable during the 3-year period following Substantial Completion of all Project Sections ("Ramp Up Period") if the Ramp Up Reserve has not been fully depleted" (I-77 Contract, Section 13.3). The uniqueness of this clause in the US bears monitoring during implementation and as future projects emerge.

The project's payment mechanisms also influenced how *inflation*, *network,* and *payment for services* risks were handled in the contracts. For instance, in AP projects, availability payments from the public authorities are adjusted for inflation, so this risk is usually shared since developers need not speculate about future inflationary impacts. In tolled and lease projects, inflation impact is often integrated in a fixed schedule of toll rate increases, although these increase regimes may or may not cover all of the impact.

As discussed previously, *network* risk is retained by the public authority in AP projects. In tolls and lease projects, this risk was mostly shared since public agencies are typically responsible for reimbursing a portion of revenues lost due to non-exempt facilities impacting revenue. Exceptions include I-495 (Virginia) – where *network* risk was borne by the private party, and North Tarrant Express (1-2A, Texas) – where the risk was borne by the public sector. *Payment for services* is a risk for the developer if it does not receive project revenues in a timely manner for services rendered. In tolled or lease projects, where the developers collect user fees, this risk materializes when users avoid toll payments, and the developers must handle collection enforcement themselves. In AP projects, *payment for services* becomes an appropriations risk, if the public authorities have funding shortfalls or are late. Usually, delays in payment by the public are provisioned so that they are not considered as contract breaches. Late payments were typically subject to a pre-agreed (fixed or floating) interest rate; however, this interest rate may not reflect all developer losses. Hence, private developers are not considered fully protected from these delays.

2.6.2 Comparative Analysis within Jurisdictions

During the period of this study, Florida, Texas and Virginia were the most active jurisdictions in P3 project implementation (Florida: 3 projects/\$5.82 billion; Texas: 5 projects/\$8.69 billion; Virginia: 3 projects/\$5.08 billion). Hence, the contracts within these states offer an opportunity for comparative analysis. Table 2.7 presents the deviations in risk allocation in these three states.

Table 2.7. Notable differences in risk allocation in active jurisdictions

Projec	Stat	Commercial clo close	Interest rates pre finan	Inflatior	Right of way & easements	Access additional properties	Site geology	Environmental risks	Access and adjustment to utilitie	Permits	Environmental permits	Commodity price adjustment	Revenue during construction	Usage-demand risk	Network	Operating expenses	Maintenance	Latent defects
I-595	FL	2009	?															
Miami Tunnel	FL	2009	?															
I-4	FL	2014	?															
SH-130	TX	2007										?						
I-635	TX	2009																
NTE (1-2A)	TX	2009										?						
NTE (3A-3B)	TX	2013										?						
SH-288	TX	2016		?								?						
I-495	VA	2007										?						
Elizabeth River	VA	2011																
I-95	VA	2011		?														

All three projects in Florida utilized availability payments. In these projects, more risks were retained by the Florida Department of Transportation (FDOT). I-595 and I-4 are managed-lanes roads; while Port of Miami Tunnel is a fixed-crossing. I-4, the most recent project, has risk allocations that deviate from the other two projects. Specifically, some of its endogenous risks (*right of way and easements*, *access to additional properties*, *site geology*, *commodity price adjustments*, *operating expenses*, and *maintenance*) were allocated more toward FDOT than those of I-595 and Port of Miami Tunnel. *Latent defects* – an endogenous risk – was also treated differently in the I-4 and I-595 projects. Though both projects had pre-existing assets, FDOT shifted this risk in I-4's pre-existing assets to the private party. In I-595, FDOT utilized a deductible scheme for latent defects, provided that the private developer can prove that the defects are actually "latent", which means that such defects were unknown to both parties at contract formation. In this case, the deductible amount is $2,000,000: the private party must pay the first $2,000,000 for the cost to repair any defects in pre-existing assets while any costs above this are borne by FDOT (I-595, Section 4). For some risks, I-4 had allocations different from all other 10 projects in FL, TX, and VA: it is the only project that retained *access to additional properties* by public, transferred entirely *permits* and *environmental permits* to developer, and shared *commodity price adjustment*, *operating expenses*, and *maintenance*.

In Texas, all its contracts were toll concessions, and they have shown a more consistent risk allocation than those in Florida. The most observable difference is that two related projects, North Tarrant Express (1-2A) and North Tarrant Express (3A-3B), each having the same private developer, have deviated from other projects in the allocation of *latent defects* risks: NTE (3A-3B) shared *latent defects* whereas other Texas projects allocated the risk to the private party. While three of the other four projects were also managed lands, the developer of NTE (3A-3B) had to manage a significant pre-existing assets compared to the others. Interestingly, NTE (1-2A) in 2009 was a competitive procurement between TXDOT and NTE Mobility Partners whereas NTE (3A-3B) was a sole-source negotiation between the same parties; this may have influenced the alternative allocations observed because the counterparties in each situation had different levels of bargaining power and information asymmetry.

Like those of Texas, Virginia's projects are tolled. Some notable differences in allocation are also observed among this set; *interest rates pre financial close* was shared in I-495 and I-95, but held by the public sector in Elizabeth River Tunnels. Elizabeth River Tunnels was the only project in the entire sample that originally granted the developer the right, and the risk, of collecting *revenues during construction*; this was possible given the inclusion of existing tunnels in the project's overall scope. As previously discussed, I-495 transferred *network* risks to the developer, so VDOT has no liability if facility improvements in the region impact the developer's revenues. Finally, *latent defects* risk was shared in Elizabeth River Tunnels whereas it was held by the private entities in the other two projects; this is not surprising given the pre-existing assets under the developer's control during the contract, including two existing tunnels.

2.7 Discussion

The findings from this study suggest that the approach adopted to analyze the content of P3 contracts and to determine risk allocation is sound; the confirmation of the risk allocation results with available Bond Offering Statements supports its overall validity. Not surprisingly, many risks are transferred to the private sector; this is consistent with a central tenet of P3s that risk transfer is an essential part of the Value for Money (VfM) proposition. However, risk sharing in the US market was more prevalent than that reported in the literature focused on risk allocation in Australia, the UK, China and India. This divergence could be due to differences in research approach and scope; alternatively, the federalist system in the US, where states have significant autonomy particularly in matters of infrastructure and procurement, could also explain this outcome compared particularly to the UK and China. Event mechanisms were utilized most frequently for risk sharing; hence, an event such as a change in law would trigger the relevant event mechanism, and the counterparties would follow the contractual procedure specified to handle the situation; in a number of instances, treatment of the event relied on negotiation between the counterparties to find a resolution.

Overall, the risk allocation results did not reveal specific trends by various parameters such as time, contract duration or project type. The one exception was variation by payment mechanism; here, most of the differences found were linked to the characteristics of the availability payment versus toll structure such as the retention of *usage/demand* and *network* risks by the public sector. Similarly, assessment of the risk allocation results in projects from the most active jurisdictions – Florida, Texas and Virginia – showed some consistency in allocation with certain risks but deviations from project to project even within the same jurisdiction. These findings suggest that *project context matters*. In other words, the local and specific circumstances of a project can and likely will drive risk allocation. This is reinforced if the allocation of exogenous versus endogenous risks across the project sample is examined. Table 2.8 summarizes the allocation of such risks; consistent allocation is found in three of five exogenous risks while consistent allocation is generally found in roughly half (13 of 25) of the endogenous risks. As discussed earlier, one might expect consistent treatment of exogenous risks since these are primarily influenced by macro or global factors whereas endogenous risks are influenced by project-specific issues. However, variability is seen in both sources of risk; moreover, the vast majority of the endogenous consistency is among risks that are typically transferred to the private partner. Hence, Table 8 suggests areas where baselines for allocation exist while also reflecting the impact of project context on risk allocation; these observations contribute to the literature that has examined the tension between standards and context in P3 arrangements (Dewulf et al. 2015; Kivleniece and Quelin 2012).

Table 2.8. Allocation of Exogenous vs. Endogenous Risks

Exogenous	**Allocation**	**Endogenous**	**Allocation**
• Socio-political opposition • Change in law • Force majeure	Shared	• Financing • Refinancing • Design • Performance • Availability and service • Operating expenses (one case shared) • Maintenance (one case shared) • Transfer • Residual Value	Private
• Interest rates pre financial close • Inflation	Variable	• Archaeology and fossils (one case public) • Permits (one case private) • SPV default • Termination by public authority	Shared
		• Right of way & easements • Additional properties • Site geology • Environmental risks • Access/adjustment to utilities • Environmental permits • Commodity price adjustments • Changes by public authority • Usage/demand • Network	Variable

Exogenous	Allocation	Endogenous	Allocation
		• Payment for services • Latent defects	

2.8 Conclusion

Unlike prior research in P3 risk identification and allocation, this work utilized actual P3 project contracts to study risks as allocated and provisioned. Using a systematic content analysis framework, the allocation of 31 risks in 21 US highway P3 contracts was determined. These contracts represent the entire population of US highway P3 projects from 2004 through first quarter 2016 with the exception of one project whose contract was not made available. The allocation results were internally validated through inter-rater testing, and they were externally validated using Bond Offering Statements available for 13 of the 21 projects. Hence, the investigation is unique in its approach and comprehensive scope.

The allocation results demonstrate that some risks were retained by the public sector such as *changes by the public authority*, but the preponderance of the 31 risks were either transferred to the private sector or shared. The former result is not unexpected since risk transfer is generally viewed as fundamental to the P3 value proposition; however, the prevalence of sharing in the US market is greater than that conveyed in the literature examining risk allocation in Australia, the UK, China and India. The reason for this variance is uncertain, so further comparison of risk allocation practices across national jurisdictions is an area for future research. The risk sharing arrangements uncovered ranged from deductible schemes to event mechanisms with the latter employed quite frequently. Both risk sharing and contract design have garnered significant attention in the P3 literature, so investigating connections between the risk sharing strategies found and prevailing theories of contract such as agency theory and incomplete contracts is another avenue for future research.

Parametric analysis did not reveal any dominant trends in risk allocation in the US P3 highway market. However, the payment mechanism – availability payments vs.

tolls – did impact the allocation of risks distinctive of each payment structure such as *usage/demand* and *network*. Additionally, tolled projects had more risks allocated to the private sector; neither of these outcomes is surprising. Yet, examination of risk allocation by active jurisdictions (Florida, Texas and Virginia) and source of risk (exogenous vs. endogenous) showed that project context influences risk allocation; while some consistency was found in the treatment of the 31 risks, the variation in allocation is further evidence that project-specific factors and environments will continue to challenge efforts to create uniform or standard contracts and contractual provisions.

Finally, the scope of this investigation has important practical implications. The US P3 market is still evolving and fragmented; thirty-three states and a territory have varying enabling legislation (Rall 2014), and several states such as Colorado and North Carolina have recently implemented P3 highway projects. The results provide practitioners implementing or considering the implementation of P3s a comprehensive overview of risk allocation practices and contractual language across a variety of P3 project characteristics. Consequently, they can utilize the results to inform their own decisions regarding risk allocation and contract design.

2.9 Acknowledgements

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3 Chapter 3: Contract Design in US Highway Public-Private Partnerships: Assessing the State of Practice[2]

3.1 Abstract

Public-private partnerships (PPPs) are multi-lateral transactions implemented over long time horizons; hence, they are complex arrangements that face various forms of uncertainty. These characteristics have made them a subject of research in a variety of fields. The nature of the transaction has attracted scholars who have examined them in the context of agency theory, incomplete contracts, and transaction-cost economics. The prevalence of uncertainty in PPPs is at the root of many contractual issues, such as incentive allocation, incomplete contracts, high transaction costs, and opportunism, which are innate in long-term contracts. Thus, the uncertainty management function of PPP contracts, including risk-sharing methods and actor governance, plays an integral role in resolving contractual issues. Yet, limited research has comprehensively examined these topics at the project-level. This investigation remedies this gap by examining how 21 PPP contracts in the US highways sector were structured along two avenues of investigation; the first explored the tension between public sector control versus concessionaire empowerment and the second explored whether risk sharing mechanisms were designed for ex ante treatment or ex post resolution. The findings demonstrate that public agencies utilize various approaches to monitor and control concessionaire actions rather than empowering them in PPP. This suggests that agency problems persist in PPP arrangements. Yet, this circumstance may be a consequence of the sociopolitical scrutiny of public agencies generally and PPPs specifically, so further investigation of this observation is warranted. Risk sharing strategies employed range from 'event' mechanisms to deductible schemes. Event mechanisms typically force the counterparties to negotiate a resolution once a qualifying event occurs; the

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[2] Nguyen D.A. and Garvin M.J. (2017). "Contract Design in US Highway Public-Private Partnerships: Assessing the State of Practice". Journal of Management in Engineering. In preparation.

prevalence of these mechanisms reinforces the theory that contractual parties will intentionally leave a contract incomplete. Deductible schemes require the counterparties to define thresholds that dictate which party will bear the consequences of a risk. These two examples also highlight opposite ends of the transaction cost spectrum – one foregoes ex ante costs but anticipates ex post while the other does just the opposite. However, additional research of risk sharing practices is needed to better understand the intent of the counterparties and to determine the effectiveness of risk sharing strategies.

Key words: Public-private partnerships, Risks, Risk Allocation, Contract, Sharing, Mechanisms

3.2 Introduction

Infrastructure public-private partnerships (PPP) are an outgrowth of the contemporary movement in government to alter the public service delivery paradigm. Risks and contracts are central to these arrangements. In fact, the PPP paradigm is founded, rather significantly, on the concept of risk allocation through contracts. The transfer of risk, through the contractual framework, often is the basis for the decision to deliver public services by a PPP arrangement and movement of assets off the public sector balance sheet. Contracts serve as the vehicle for tangibly distributing benefits and risks in PPPs, typically for the better part of 30 years or more. Ideally, the contractual framework is structured to balance the interests of the public and private sectors to promote reasonable outcomes for both parties. Yet, uncertainty with time and the limitations of contracts challenge the efficacy of PPP arrangements since unpredictable, incalculable events are inevitable.

Undoubtedly, contract design has received significant attention. In particular, scholars have focused on three related theories: agency theory, incomplete contracts and transaction cost economics. Agency theorists have examined how to structure contracts despite the well-known principal-agent problem (Coase 1988; Hölmstrom 1979) while incomplete contract theorists recognize the limitations of contracts in complex, long-term transactions and have indicated that ex post surplus distribution is best handled through: (a) counterparty renegotiation or (b) assignment of residual or ownership rights to incentivize the contracting parties towards productive investment (Crocker and Masten 1991; Hart 1995; Hart and Moore 1988). Transaction cost economics has taken a slightly different perspective; it views contracting as an exercise to identify governance structures that minimize transaction costs in light of issues such as asset specificity, bounded rationality and opportunism (Williamson 1979, 1996).

Within this context, researchers have examined contract-related issues in PPPs. One theme of investigation has focused on risk identification and allocation (Akintoye et al. 1998; Bing et al. 2005; Chou and Pramudawardhani 2015; Chung et al. 2010); this work has pinpointed perspectives of various risks and which risks are retained by the public sector, transferred to the private sector or shared. Another theme has more specifically explored contract design through the lens of contract economics. For instance, Grout and Stevens (2003) examined broadly the different arrangements for the delivery of public services. A significant part of their assessment was the increasing role of the private sector. Their study struck at the root of a major issue with PPPs (or any private provision of public services):

> *A major problem with any framework to deliver public services is that those delivering the service can have far better information than the government agency. This disparity allows them to pursue goals that may not fully coincide with society's objectives. The old fashioned 'model' of simply creating a public-sector agency that would be expected selflessly to pursue the required objective is no longer accepted without question. It is essential to design activities to elicit correct information from 'agents' responsible for delivery, and to put in place structures so that the incentives facing the agents coincide with society's objectives. Of course, this is far from easy (pp. 216-17).*

Similarly, Hart (2003) explored the boundaries between public service provision by either a public or private organization; he compared a bundled approach using a single contract with a private party for facility construction and service provision with a "conventional" approach using separate contracts with private parties for facility construction and service provision. Among Hart's conclusions was bundling promoted advantageous investments overall as long as service requirements were adequately specified. Work in the area of the second theme has suggested various strategies for coping with agency and incompleteness problems within contractual frameworks generally and within PPPs specifically, and it is this avenue of research that underpins this investigation.

Consequently, the intent of this research is to examine contracting practice to determine *how* PPP contractual frameworks are structured. It builds from a companion investigation that determined how risks were allocated and provisioned in 21 highway PPP project contracts in the US (Nguyen et al. 2017). One of the study's lines of inquiry examines *the tension between strategies for aligning principal-agent interests*. On the one hand, agency theory suggests that one strategy for alignment of principal-agent interests is through monitoring of agent actions by the principal. On the other hand, incomplete contract theory indicates that ownership, specifically the assignment of residual rights, influences the incentives of the contracting parties and will stimulate productive levels of investment. In other words, a properly empowered agent will act in the interests of the principal. Hence, are PPP contracts structured to monitor and control or empower a concessionaire? A second line of inquiry further examines the prevalence of risk-sharing mechanisms uncovered in the companion investigation (Nguyen et. al. 2017). Through additional examination of risk-sharing structures, *the propensity to specify ex ante treatments versus ex post resolution can be gauged*; this also provides an indication of the timing of transaction costs. Thus, do PPP risk sharing mechanisms rely on ex post solutions, suggesting that such mechanisms are intentionally left incomplete?

To address these questions, theories of contract are first reviewed. This is followed by a review of research that has investigated contractual strategies to address issues of incompleteness, information asymmetry, opportunism, and transaction costs. The majority of this research is normative in nature, which provides the motivation for the present study to explore how PPP contracts are structured. Consequently, the balance of the paper describes the study's methodology, findings and conclusions.

3.3 Theories of Contract

Contracts in PPPs are associated with three fundamental theories: agency theory, incomplete contracts, and transaction cost economics (Chung and Hensher 2016). These theories can affect contract design through the formation and enforcement regimes they advocate. Each is briefly reviewed.

3.3.1 Agency theory

Agency theory refers to the relationship between a principal and an agent. Sappington (1991) described the circumstance as simply as: when it is too complicated or too costly for the "principal" to do a job itself, it must hire a competent "agent" to perform the task. The major issue that arises is how to motivate (or give incentive) to the agent so that the agent will perform the task as the principal desires; matters are complicated if the task is encounters difficulties and uncertainty (Sappington 1991), involves asymmetric information (Hölmstrom 1979), and the parties have different risk preferences (Allen and Lueck 1995).

Agency theory has been used in many areas, such as accounting, economics, finance, political science, organization behavior, and sociology (Eisenhardt 1989). Agency theory is quite useful in describing risk sharing and incentive problems in contracts (Eisenhardt 1989; Shavell 1979).

Different risk preferences can affect how risk sharing/incentives are structured in a contract. A popular assumption is that the buyer (principal) is usually risk neutral and the seller (agent) is usually risk averse; however, empirical evidence has shown that the agent is sometimes risk neutral (Allen and Lueck 1995). For those two different risk preferences of the agent, Shavell (1979) suggested proper incentive schemes (i.e. how the principal pays a fee to the agent for its services):

(a) If the agent is risk neutral, then *fee* should equal *outcome* minus the *principal's share* (the principal's share is a constant). In this case, the agent's effort has no value in determining the fee. This case can be aligned with outcome-based contract, according to Eisenhardt (1989).

(b) If the agent is risk averse, then *fee* should depend on some extent on the *outcome*, but never leaves the agent paying all risk. In this case, the agent's effort has some value, given that the principal knows the effort. This case can be categorized as behavior-based contract, according to Eisenhardt (1989).

Grout and Stevens (2003) addressed principal-agent issues in their assessment of public service delivery; they defined a public service as any service provided for a large number of citizens where the potential for market failure justifies government involvement through production, finance or regulation. As they contend:

> *A major problem with any framework to deliver public services is that those delivering the service can have far better information than the government agency. This disparity allows them to pursue goals that may not fully coincide with society's objectives. The old fashioned 'model' of simply creating a public-sector agency that would be expected selflessly to pursue the required objective is no longer accepted without question. It is essential to design activities to elicit correct information from 'agents' responsible for delivery, and to put in place structures so that the incentives facing the agents coincide with society's objectives. Of course, this is far from easy (pp. 216-17).*

Their perspective explains, in part, the trend toward private participation while offering insights regarding the challenges of public service provision in general.[3] In the simplest terms, the organization responsible for public service provision, whether public or private, cannot suffer from the classic agency problem. Whereas, Rangan et al. (2006) more simply point out that the public sector (as principal) enters into a transaction with the private sector (as agent) because the private entity has specialized resources and cost advantages.

3.3.2 Transaction cost economics

The firm, contracts, and transaction cost economics (TCE) are three closely connected concepts in the field of economics. Coase (1937) attributed one of the reasons for a firm to exist is that there are costs of using the price mechanism (the entrepreneur will choose to produce a good/service or to acquire that good/service from somewhere else, depending on which method has the lower price). The costs include: costs for discovering the relevant prices, costs of negotiating contracts, and costs for concluding a contract. These costs are reduced, though not eliminated, if there is a firm. Coase coined the term "transaction costs" (but did not define the term) and started the foundation of transaction cost theory. One noticeable characteristic of transaction costs is that the bigger a firm becomes, its internal marginal costs for organizing transactions will grow. At a point where its internal transaction costs are equal to the costs if the firm decides to conduct the transactions in the open market, it is no longer efficient for the firm to get bigger. An analogy from PPPs is that when the government cannot bear large transaction costs as if it builds the project itself, it seeks out for more outside services from the private sector.

After decades, Coase's idea of TCE still had no root academically (Coase 1988). This changed when Williamson (1979) treated transaction costs systematically to deal with problems arising from firm and contract – the ideology of transaction cost

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[3] Certainly, the general desire to move assets of the public sector's balance sheet has and continues to be a driving factor in private provision as well.

economics adopts a contractual approach to the study of economic organization. Williamson (1996) defined transaction costs as “the ex-ante costs of drafting, negotiating, and safeguarding an agreement and, more especially, the ex post costs of maladaptation and adjustment that arise when contract execution is misaligned as a result of gaps, errors, omissions, and unanticipated disturbances; the costs of running the economic system.” This definition not only described components of transaction costs but also delineated their causes. In determining dimensions of TCEs, Williamson (1996) characterized three factors: (i) the frequency of transactions, (ii) the degree and type of uncertainty of transactions, and (iii) the asset specificity of transactions. The last factor assesses “how is the transaction transferrable without sacrificing productive value” and was rated by Williamson as most important among the three factors.

Williamson paid particular attention to bounded rationality and opportunism – behavior assumptions – when considering the cost of a transaction, because “they serve to delimit the study of contract to the feasible subset” (Williamson 1996). Speaking of behavior assumptions, Williamson (1996) wrote:

> Transaction cost economics pairs the assumption of bounded rationality with a self-interest-seeking assumption that makes allowance for guile. Specifically, economic agents are permitted to disclose information in a selective and distorted manner. Calculated efforts to mislead, disguise, obfuscate, and confuse are thus admitted. This self-interest-seeking attribute is variously described as opportunism, moral hazard, and agency.”

In the context of PPPs, Ho et al. (2015) categorized three types of opportunism that increase project transaction costs: (1) principal-principal problem – where the controlling principal exploits passive stakeholders; (2) firm hold-up problem – renegotiation induced by the concessionaire; and (3) government-led hold-up problem – when the bargain balance shifts to the government and it induces renegotiations (e.g. to decrease tolls or raise taxes). These opportunism problems in PPPs are somewhat unique compared with those in other types of governance.

3.3.3 Incomplete Contracts

In a costless world where transaction costs are zero and parties can write complete contracts, contracts would not need to be modified or updated since everything would be anticipated and planned for in advance, or there would be no cost for engagement of a third party (e.g. a court) to resolve problems. In reality, however, transaction costs are pervasive and substantial, so long-term contracts are always incomplete (Hart 1988). Hart defined an incomplete contract briefly as one that "contains gaps or missing provisions". For an incomplete contract, events will occur that make it desirable for the parties to depart from what was specified in the contract: they may want to revise the contract; they may disagree about the meaning of the contract; and lastly, disputes may occur so parties will need to bring in a third party to determine a solution (Hart 1988).

These high costs are caused by: unforeseen contingencies (describable and indescribable); cost of writing contracts; cost of enforcing contracts, and renegotiation cost (Anderlini and Felli 1999; Maskin 2002; Tirole 1999). Ayres and Gertner (1989) also listed asymmetric information distributed between parties as an additional factor influencing transaction costs. Given that transaction costs are undeniable, and reasonable contractual parties cannot design a contract that precisely predicts all contingencies in the future, some mechanisms have been investigated to make contracts "less" incomplete.

First, Hart (among others) focused on the notion of property rights theory (Grossman and Hart 1986; Hart 2009, 1988). The idea of property rights theory, simply put, is that for events that happen in an incomplete part of a contract, the party which has the residual right on the asset (of the transaction) reserves the decision right. Hart (1995) simplified this idea by an example: company A is renting equipment from company B through a contract (so B owns the equipment). If the contract is silent on the maintenance requirements of the equipment, then A must ask for B's permission before any changes are made in the equipment's parts.

Second, parties can rely on norms to cover the incomplete part of the contract (Anderlini and Felli 1999; Ayres and Gertner 1989; Maskin 2002). Norms has two forms: default rules and immutable rules. Default rules govern unless the parties contract around them while immutable rules always govern even if the parties attempt to contract around them (Ayres and Gertner 1989). The advantage of using norms is that it requires minimal complexity costs to write and implement (Anderlini and Felli 1999).

Following the third approach, parties may rely on renegotiation as the mechanism for revising the terms of trade as they each receive information about benefits and costs over time (Hart and Moore 1988). Renegotiation has been the most common approach to deal with incompleteness of long-term contracts (Roberts 2014).

Finally, Crocker and Masten (1991) and Crocker and Reynolds (1993) suggested that contracting parties may elect to leave a contract intentionally incomplete since they "face a trade-off between the costs of drafting a more complete document and the losses associated with incomplete agreements." (p. 145). Essentially, their work indicated that the level of incompleteness in practice was a function of the magnitude of these respective costs. Transaction attributes such as technological uncertainty or remote contract performance periods increased ex ante drafting costs, so less exhaustive frameworks were preferable.

3.3.4 Summary of major issues in long-term contracts

The contract theories just reviewed are linked, and they provide a potential basis to address various issues. Figure 3.1 summarizes the major issues associated with long-term contracts where uncertainty plays a central role in other contract issues.

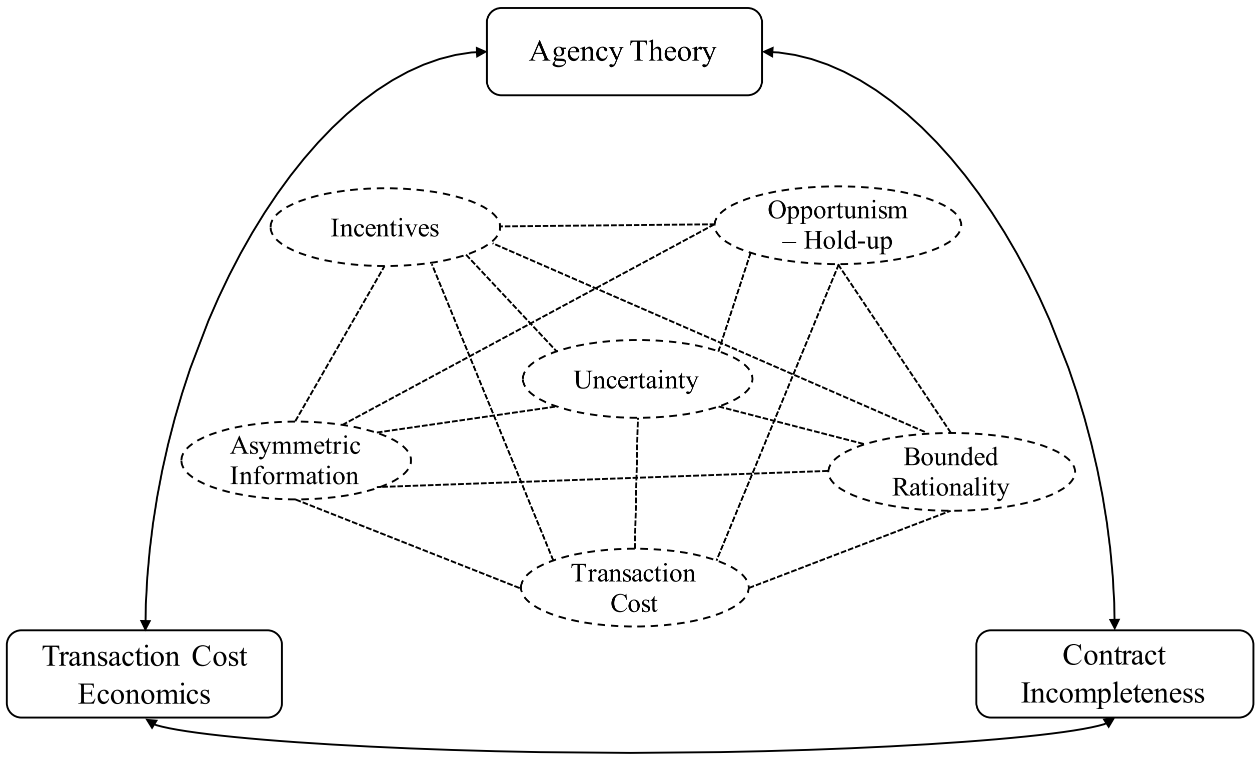

Figure 3.1. Contract theories and major issues of long-term contracts

3.4 Bundling and PPPs

A distinguishing characteristic of a PPP – as opposed to other forms of private participation such as privatization – is the bundling of asset creation and service provision into a single long-term contract between the public and private sectors (Bennett and Iossa 2006; Grout and Stevens 2003; Engel et al. 2008). "Bundling" is the nature of PPPs (Flinders 2005), and it has several potential advantages. Theoretically, it gives a concessionaire an incentive to produce innovative designs, build the project on time and on budget, and ensure and sustain the quality of construction since a concessionaire has responsibility for the long-term performance of assets that significantly influence its future revenues (Iossa and Martimort 2015; Siemiatycki and Friedman 2012). Bundling also transfers more risk to a private concessionaire, and will enhance a government's ability to access market and operational information (Iossa and Martimort 2015). Consequently, a project's value-for-money increases since a private concessionaire will lower operation and maintenance costs (Bing et al. 2005) and maximize its operational efficiency to provide the best whole-of-life outcome (Chung et al. 2010).

However, bundling also has disadvantages. First, the approach also gives a concessionaire an incentive to decrease the quality of the project assets – underinvestment – which contradicts arguments above regarding incentives to ensure project asset quality. Hart (2003) explained this possibility; bundling leads a firm to internalize the cost of operating the facility; however, a firm cannot be perfectly monitored, so it could then choose to cut costs and lower service quality (corner-cutting) without any resulting liability. In practice, Chung et al. (2010) observed that many consortia do not intend to hold on to the assets for too long; therefore, they will minimize operational efforts to reduce costs. Aside from underinvestment and corner-cutting, another disadvantage is the possibility that a government may act opportunistically by not respecting the terms in long-term contracts (Valero 2015). Opportunistic behaviors may include premature contract termination, appropriation, changes in law, or actions that negatively affect the business environment (e.g., changes in tax). Hence, the private sector may experience the hold-up problem.

3.5 Potential Remedies for Contractual Issues in PPPs

As the preceding sections indicate, contractual frameworks have received attention generally and in the context of PPPs. Not surprisingly, scholars have examined long-term contractual issues in PPPs, exploring possible solutions to such challenges. Three distinct strategies are subsequently considered: (1) ownership, control rights and bundling; (2) information revelation; and (3) renegotiation.

3.5.1 Ownership, Control Rights and Bundling

One thread has emphasized the importance of concessionaire (agent) ownership and control rights as well as bundling. The length and terms of PPP contracts effectively, if not legally, grant a concessionaire ownership, or control rights.[4] Hart (2003) provided evidence that both residual control rights and bundling can counter *incomplete contract* and *asymmetric information* issues since the party who "owns" the asset retains the right to make decisions, and it consequently has sufficient incentive to invest productively. Iossa and Mortimort (2015) subsequently provided additional support for the assignment of ownership rights to a concessionaire to incentivize beneficial investments.

3.5.2 Information Revelation

A common contractual strategy to mitigate *asymmetric information* and *opportunism* is counterparty information revelation. From a programmatic perspective, Dewatripont and Legros (2005) suggested that public agencies should be compelled to provide demonstrable evidence of the measures taken to architect projects to anticipate future economic shocks as a means to avoid inefficiencies in the choice of contracts. At the project-level, Ho et al. (2015) argued that hold-up problems for both a government and a concessionaire could be minimized through information revelation as well as having appropriate specification of tariff/toll regimes and appropriation provisions. Similarly, Valero (2015) indicated that government opportunism can be mitigated through contractual commitments such as those defined in appropriation and tariff control provisions. Iossa and Mortimort (2015) also emphasized information revelation to combat asymmetric information; further, they argued that contractual structures that cause inefficient firms to run a loss should be in place. Pragmatically, information revelation equates to contract administration and monitoring of a concessionaire by a public agency.

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[4] Here, the important distinction is the degree of control that the private party has over the asset and its related services as opposed to asset ownership in the strictest sense.

3.5.3 Renegotiation

Another avenue has stressed renegotiation as a scheme to handle *incomplete contracts* and *transaction costs*. Here, the rationale follows the logic established by Athias and Saussier (2007) described three contract strategies: one termed a 'flexible contract' where the parties plan to renegotiate once uncertainty unfolds; one termed a 'rigid contract with renegotiations' where the parties cannot commit not to renegotiate but attempt to prevent renegotiation; and one termed a 'rigid contract' where the parties commit not to renegotiate. Their work indicated that contractual designs that balance flexible and rigid features will minimize transaction costs.

3.6 Point of Departure

Notwithstanding the value of the research that has examined PPP contractual design and issues, the vast majority of this literature is theoretical and normative, focusing on what contracting parties ought to do. A much smaller body of literature has examined how PPP parties contract in practice and whether their actions align or depart with prevailing theory. For example, Iossa et al. (2007) recommended principles for several contractual areas, such as risk allocation, payment mechanism, flexibility and renegotiation, and refinancing from actual PPP contracts. In addition, Foster (2013) investigated how standard PPP contractual frameworks in Australia, India, South Africa, and the United Kingdom structured contract variation (or changes) provisions, such as variations caused by changes in law, changes by government, and contract termination by government.

Chung and Hensher (2015) reviewed several contractual risk management mechanisms in a case study of the M4 highway PPP in Australia. The contractual areas included changes by government, handback, sovereign risk, and technological risk as well as some incentives schemes associated with these areas. The authors traced contract enforcement throughout this project's concession period and connected successes and challenges of the contract management process with how the mechanisms were designed. A strength of their work was that it followed the contract enforcement process from concession start to finish to assess risk mechanism effectiveness. However, the research investigated only a few areas in a single case study, so this limits generalization of the research observations. Clearly, an opportunity to more comprehensively explore how PPP contractual frameworks are structured exists to determine the nexus of theory and practice.

3.7 Methodology

3.7.1 Areas of Inquiry

Building from a companion investigation that determined how risks were allocated and provisioned in 21 highway PPP project contracts in the US (Nguyen et al. 2017), this research investigates contracting practice to determine how PPP contractual frameworks are structured. Through the lens of contract theories and proposed solutions for known transactional problems, two specific avenues of inquiry were followed:

- The first avenue explored *the tension between strategies for aligning principal-agent interests*. Agency theory and research suggest that a strategy for alignment of principal-agent interests is through monitoring of agent actions by the principal. Alternatively, incomplete contract theory and research indicate that ownership, specifically the assignment of residual rights, influences the incentives of the contracting parties and will promote productive levels of investment. In other words, a properly empowered concessionaire will act in the interests of the principal. Hence, are PPP contracts structured to monitor and control or empower a concessionaire?
- The second avenue examines risk-sharing mechanisms uncovered in Nguyen et. al. (2017), which found risks were shared frequently through various mechanisms. These risk-sharing structures were further examined to gauge *the propensity to specify ex ante treatments versus ex post resolution*; this also provides an indication of the timing of transaction costs. This examination is based on the premise that uncertainty drives risk-sharing overall, and its severity pushes contracting parties towards reduced ex ante

specification. Consequently, do PPP risk sharing mechanisms rely on ex post solutions, suggesting that such mechanisms are intentionally left incomplete?

3.7.2 Contract Analysis Approach

The companion investigation employed a content analysis framework to examine PPP contract documents in order to identify provisions associated with 31 risks across 21 highway PPP projects in the US; subsequently, a determination of whether each risk was retained by the public sector, transferred to the private sector or shared between the parties was made and validated (Nguyen et al. 2017). Table 3.1 depicts the contracts investigated.

Table 3.1. Highway PPPs in the US (Nguyen et al. 2017)

Project	**Jurisdiction**	**Commercial Close**	**Value ($mil)**
Chicago Skyway	Chicago	2004	$1,800
Indiana Toll Road	Indiana	2006	$4,600
CO NW Parkway	Colorado	2007	$600
I-495 Capital Beltway Express	Virginia	2007	$2,068
SH 130: Segments 5 & 6	Texas	2007	$1,380
I-595 Express Lanes	Florida	2009	$1,760
Port of Miami Tunnel	Florida	2009	$651
North Tarrant Express (1 & 2A)	Texas	2009	$2,000
I-635 LBJ Managed Lanes	Texas	2009	$2,600
PR-22 & PR-5	Puerto Rico	2011	$1,136
Elizabeth River Tunnels	Virginia	2011	$2,100
Presidio Parkway (Phase II)	California	2011	$362
I-95 Express Lanes	Virginia	2011	$922.6
East End Crossing	Indiana	2012	$763
North Tarrant Express (3A & 3B)	Texas	2013	$1,350
US 36 Managed Lanes - Phase 2	Colorado	2013	$175
I-4 Ultimate Improvements	Florida	2014	$2,323
I-77 HOT	North Carolina	2014	$655
Rapid Bridge Replacement Program	Pennsylvania	2015	$1,119
Southern Ohio Veterans Memorial Highway	Ohio	2015	$819
SH 288 Toll Lanes	Texas	2016	$425

Select contract provisions from the 21 project contracts were identified for the first avenue of inquiry – are PPP contracts structured to monitor and control or empower a concessionaire? Table 3.2 depicts the contractual provisions identified for assessment and the rationale for their selection. The select provisions from within each contract were then analyzed to determine where the locus of control resided; keywords such as: approve, report, submit, sole discretion, shall.

Table 3.2. Contract provisions and rationale for selection

Contract Provisions	Rationale for Examination
Project management plan	• Indication of the service and quality requirements of a concessionaire • Indication of enforcement measures associated with concessionaire commitments • Auditing burden could present information asymmetry issue or dispute potential
Performance measurement	• Advantages of bundling depend on effectiveness of specification and focus on outcomes • Specification structure logically introduces controls or incentives • Auditing burden could present information asymmetry issue or dispute potential
Changes by government or concessionaire	• Dictates government's and concessionaire's decision making rights • May provides levels of control over opportunism
Competing facilities or proximate work	• Dictates government's decision making rights • Flexibility afforded government could incentivize certain public or private sector actions
Refinancing	• Dictates controls or incentives to sustain concessionaire commitment • Government may impose controls over concessionaire to preclude activity detrimental to main purpose of the project
Transfer	• Dictates controls or incentives to sustain concessionaire commitment • Government may impose controls over concessionaire to preclude activity detrimental to main purpose of the project
Handback/Residual value	• Specification structure logically introduces controls or incentives • Significant, claimable residual value (or perhaps remuneration) may incentivize innovative investments or practices

Contract Provisions	Rationale for Examination
	• Auditing burden could present information asymmetry issues or dispute potential

For the second avenue of inquiry, the content of the risk sharing provisions identified in Nguyen et. al. (2017) was analyzed based on selected rules of coding to determine the characteristics and features of the risk sharing provisions (Krippendorff 1980; Weber 1990). A classification scheme was adopted to categorize the sharing provisions while the level of specification provided an indication of ex ante drafting effort. The level of completeness of each mechanism reflects the effort required of the contractual parties to implement the mechanism when its corresponding risk occurs. Such efforts correspond to the level of specification of the mechanism. A more specific mechanism, one with high specification, requires more ex ante effort – hence ex ante transaction costs – and vice versa. Therefore, the specification level of a mechanism indicates its completeness. A qualitative assessment of contractual provisions where the risk sharing mechanisms were employed was conducted to determine whether it had a high, medium or low level of specification. The specification level was surmised based on two characteristics of a provision: (1) its procedures and (2) its definitiveness. Most provisions establish procedures for treatment of a contractual situation or event; however, a provision may not be definitive in its treatment; in other words, the provision is conclusive regarding its treatment. A definitive provision has established ex ante how a risk or contractual event will be handled; whereas, a provision that is procedural has established how the contracting parties will interact regarding the risk or event, but it is not conclusive – its resolution will occur ex post.

3.8 Research Findings

3.8.1 Public control versus concessionaire empowerment

3.8.1.1 Monitoring the private sector's actions to safeguard project performance

In the analyzed contracts, monitoring was used extensively. Monitoring, as observed, included: defining a lifecycle management approach, defining a performance measurement system, defining government's rights to oversee a project, and defining mechanisms for non-compliant performance.

Defining lifecycle management approach

In nearly all of the contracts, the lifecycle management approach was defined in a document called the "Project Management Plan" – PMP – (or similarly in some projects such as the "Project Management Standards" in Northwest Colorado Parkway). A PMP is created by a private concessionaire and submitted to the government in the procurement process. After selection of the preferred bidder, the public agency and the concessionaire negotiate the PMP – along with other contract elements - so that the final PMP reflects the parties' desires for overall project management; example contractual language follows (emphasis added):

> *Project Management Plan means the document, including approved changes, additions and revisions, prepared by Developer and approved by the Department describing Quality Assurance, Quality Control and other activities necessary to manage the development, design, construction, operation and maintenance of the Project, containing the Department-approved component parts, plans and documentation described in, and prepared in accordance with the Project Scope. (Project Portsmouth Bypass, Exhibit 1-56).*

PMPs typically consisted of multiple elements: Design Quality Management plan, Construction Quality Management plan, Operating and Maintenance (routine maintenance) plan, and Maintenance (major maintenance) Management plan; these items govern such project activities throughout the contract term.

Defining a performance measurement system

Measuring project performance was meticulously defined in the contracts. Contracts typically utilized a "Noncompliance Point System"; representative contract language follows:

> *The Non-Compliance Points Table attached as Exhibit W sets forth a table for the identification of certain Concessionaire acts, omissions, breaches or failures to perform its obligations under this Agreement (each such omission, breach or failure, a "Performance Shortfall") that may result in the assessment by the Department of Non-Compliance Points. The Non-Compliance Points system is used by the Department to measure the Concessionaire's performance levels. The accumulation of Non-Compliance Points by the Concessionaire may trigger the remedies set forth or referenced in this Article 11 and in Article 19. (Elizabeth River Tunnels, Section 11.01).*

Noncompliance Point Systems projected detailed scenarios where the private sector might breach the contract's standards. They assigned "performance points" – often on a 365-day rolling period – to these scenarios, depending on the severity of the breach. For example, Exhibit T in the I-495 contract stipulated the following: "The Concessionaire fails to include identified material defects in the next Life Cycle Maintenance Plan and/or the Operations and Maintenance Plan" within 14 days will be assigned 5 noncompliance points." However, parties recognize that the Noncompliance Point System is not exhaustive and can be updated:

> *The Non-Compliance Points Table contains a representational, but not exhaustive, list of Performance Shortfalls possible under this Agreement. Accordingly, subject to Section 11.01(e), the Department may from time to time add any entry to such table describing a Performance Shortfall under this Agreement that was not previously included in such table, establishing the Non-Compliance Points applicable to such Performance Shortfall and setting a cure period after consultation with the Concessionaire. (Elizabeth River Tunnels, Section 11.01).*

Defining government oversight rights

The contracts often stipulated that the government has the right to oversee all the project elements (e.g. design, books and records, quality procedures, audit reviews) and has access to the project assets at all times. Governments can designate a person (or persons) – called independent engineers – to oversee projects on their behalf. Example contract language follows:

> *IFA shall have the right at all times to conduct Oversight, to the extent necessary or advisable, including as provided in the Technical Provisions, (a) to comply with FHWA, U.S. Army Corps of Engineers, U.S. Coast Guard or other applicable federal agency requirements, (b) to verify Developer's compliance with the PPA Documents and Project Management Plan and (c) otherwise to comply with other applicable Law... (East End Crossing, Section 3.4)*

Governments can also typically request reports on project information, even confidential information, from concessionaires; they can also request any type of technical test on project assets.

Defining mechanisms for non-compliant performance

Contracts also defined methods for handling non-compliant performance (or breaches of performance). When no breaches occur, the parties are usually in "quiet enjoyment" (I-95). In cases of noncompliance, government response is typically dictated by non-compliance frequency during a defined period. For instance, three different types of actions were defined in I-495 contract (Table 3.3).

Table 3.3. Trigger levels of the government on noncompliance points (Exhibit T – I-495 Contract)

Total cumulative number of uncured points	Total cumulative number of cured and uncured points	Implications
30	135	Increased Monitoring by the Department
45	200	Remediation Plan to be submitted to the Department
68	245	VDOT may exercise its rights [under Section 17.01 of the Agreement]

If the consequence of non-compliance exceeds the higher trigger points, the breach may be considered liquidated damage. Contracts often stipulate penalties for different types of liquidated damages. For instance, late final acceptance in project I-95 was defined as: "the Department will be entitled to assess $5,000 as liquidated damages for each Day that Final Acceptance of the Project remains to be achieved following the expiration of the Final Acceptance Deadline, and the Concessionaire will cause any related liquidated damages payable by the Design-Build Contractor under the Design-Build Contract." (Section 8.10).

3.8.1.2 Ownership and control rights in the contracts

As described, various contractual provisions identify how ownership and control rights are distributed in the contracts including changes by government or concessionaire, competing facilities or proximate work, refinancing, transfer, and handback/residual value.

Changes by government or concessionaire

Changes in project scope, assets, and services is an area showing asymmetry in the control of the government and the concessionaire; the government has significant rights to make or request changes to the project as indicated in this representative provision in IH-635.

> *The Department may, at any time and from time to time during the Work Period, <u>authorize and/or require changes</u> (i) in the Work as set forth in the Scope Document pursuant to a Change Order or (ii) in the terms and conditions of the Technical Requirements (including changes in the standards applicable to the Work); (Project IH-635, Section 7.12)*

Additionally, certain contracts restricted the concessionaire's ability to exploit ancillary opportunities arising from project development; the following provision from I-77 is indicative of such constraints.

> *"NCDOT <u>reserves to itself, and Developer hereby relinquishes, all right and opportunity</u> to develop and pursue entrepreneurial, commercial and business activities that are ancillary or collateral to (a) the use, enjoyment and operation of the Project and Project Right of Way as provided in this Agreement and (b) the collection, use and enjoyment of Toll Revenues as provided in this Agreement ("Business Opportunities")." (Project I-77, Section 11.2).*

The private sector can typically request changes or deviations if such are deemed to enhance the project. However, these deviations are limited and must be approved by the government. Changes by the government that incur costs may even be subject to a deductible amount for the concessionaire: "NCDOT Change means any of the following events that increases Developer's costs or adversely impacts Toll Revenues or both, by <u>more than $10,000</u>" (I-77, Section 14.1). If changes result in savings, then the saved amount is either deposited into a change account (for future changes) or divided between the government and the concessionaire.

Competing facilities or proximate work

Competing facilities are transportation facilities developed or enhanced in the future by government in the same geographical area of the project and their operation can affect project revenues. For concessionaires, competing facilities may be one of the most impacting risks, hence their desire for some protection from this uncertainty. Nonetheless, governments reserved all rights to conduct any future investments, regardless of their potential impacts to current projects; in certain cases, these future investments are those that exist in short or long-term transportation plans, but in some instances no restrictions applied – as described in this provision from I-77:

> *NCDOT will have the unfettered right in its sole discretion, at any time and without liability, regardless of impacts on Toll Revenues, to finance, develop, approve, expand, improve, modify, upgrade, add capacity to, reconstruct, rehabilitate, restore, renew and replace any existing and new transportation or other facilities (including, without limitation, free roads, connecting roads, service roads, turnpikes, managed lanes, HOT/HOV lanes, light rail, freight rail, bus lanes, bridges, tunnels, ferry service, etc.). Such right extends to facilities both within the Airspace and outside the Project Right of Way, whether identified or not identified in transportation plans, and whether adjacent to, nearby or otherwise located as to affect the Project, its operation and maintenance (including the costs and expenses thereof), its vehicular traffic and/or its revenues. (Project I-77, Section 11.3).*

Competing facilities are subject to some relief or compensation mechanisms (e.g. relief events, compensation events), but determination of the remedy is typically subject to negotiation; hence, the recoup of any loss in revenues remains uncertain.

Refinancing

During the project term, the concessionaire may seek to change the project's financial structure, to take advantage of changed conditions that generate financial benefits. However, such actions might not align with the purpose and objectives of the project, so governments usually impose controls over refinancing. Most used mechanisms imposed by government on these actions including: (i) lock-up periods where refinancing is impossible, (ii) approval from the government prior to any refinancing, and (iii) split of gains from refinancing between the two parties. The following provision from I-595 is illustrative of such controls:

> *"Other than an Exempt Refinancing and a Rescue Refinancing, no Refinancing is permitted prior to the Substantial Completion Date, except to the extent Concessionaire demonstrates to FDOT's reasonable satisfaction that (a) the Committed Investment will continue to meet or exceed the minimum amount described in Section 14.2. 1, and (b) the Refinancing will produce Refinancing Gain in which FDOT will be entitled to a portion in accordance with this section" (Project I-595, Section 16.4.3).*

Transfer

Transfer – or change in asset ownership or control – was defined broadly in the contracts as indicated in this representative provision: "any assignment, sale, financing, grant of security interest, transfer of interest or other transaction of any type or description, including by or through voting securities, asset transfer, contract, change in management or management powers, merger, acquisition, succession, dissolution, liquidation or otherwise, that results, directly or indirectly, in a change in possession of the power to direct or control or cause the direction or control of the management of Developer or a material aspect of its business." (Project SH-288, Appendix 1)

Since transferring ownership of the project to other investors may diminish commitment of the private sector to the project, this action is strictly limited in the analyzed contracts. Once again, the governments retained all the rights to transfer and give assignment of the projects to other entities; whereas, the private sectors had no right to transfer the projects without the governments' consent, as illustrated in this example from SH-288.

> *Developer shall not voluntarily or involuntarily sell, assign, convey, transfer, pledge, mortgage or otherwise encumber the Developer's Interest or any portion thereof without TxDOT's prior approval (Project SH-288, Section 33.1).*

Alternatively, TxDOT retained the right of transfer with minimal constraint:

> *TxDOT may assign all or any portion of its rights, title and interests in and to the CDA Documents, Payment and Performance Bonds, guarantees, letters of credit and other security for payment or performance, (a) without Developer's consent, to any other Person that succeeds to the governmental powers and authority of TxDOT, and (b) to others with the prior consent of Developer. TxDOT also may assign, without Developer's consent, all or any portion of its rights, title and interests in and to revenue streams from Developer under the CDA Documents, together with Payment and Performance Bonds, guarantees, letters of credit and other security for payment of such revenue streams and TxDOT's rights to enforce payment of such revenue streams other than rights to terminate this Agreement and the Lease, to any trustee, credit enhancer or swap counterparty with respect to bonds or other indebtedness issued by TxDOT or a related entity or instrumentality as security for repayment of the bonds or other indebtedness." (Project SH-288, Section 33.4).*

Granted, the likelihood that TxDOT would transfer its rights is low, but the authority to do so exists.

Handback/Residual value

Unlike privatization, returning the project to the government is a nature of PPPs. The residual value and handback process is clearly an area of governmental concern based on handback provisions reviewed. This is clear in how contracts.

> *Upon the Termination Date, Developer shall transfer the Project, including any Upgrades, to the Department, at no charge to the Department, in the condition and meeting all of the requirements set forth in Section 5 of Division II ("Handback Requirements")." (Project Presidio Parkway, Section 5.9)*

The contracts generally employed a scheme – the Project Handback Requirement Reserve Account – to guarantee the residual value of the project. Concessionaires had to establish and deposit funding into this account within a period (typically 5 years or less) before contract termination. The amount of the deposit was at least equal to the funding needed – as determined by an independent consultant during investigation of asset conditions – to renew project assets to the agreed standards in the Project Handback Requirements; the following provision is representative of reserve account requirements.

> *Beginning four full Fiscal Years before the expected end of the Term, Developer shall establish a reserve account (the "Handback Requirements Reserve Account") exclusively available for the uses set forth in Section 5.10.3. Developer shall provide to the Department the details regarding the account, including the name, address and contact information for the depository institution and the account number. The Department shall have a first priority perfected security interest in the Handback Requirements Reserve Account, and*

the right to receive directly from the depository institution monthly account statements. (Project Presidio Parkway, Section 5.10).

Once handback is complete and all renewal work is finished, concessionaires are typically entitled to the residual in the Handback Reserve account.

3.8.2 Risk sharing mechanisms: ex ante or ex post treatment

Fifteen unique mechanisms were identified in the contracts. For some risks, only single mechanisms were used. For example, 'network' risk in project IH-635 was treated with *compensation events*. However, for most of risks, multiple mechanisms were used together. For example, in provisions related to 'change in law' risk in the same project, *compensation events*, *relief events*, and *negotiation* were used in tandem for this risk. Table 3.4 presents these sharing mechanisms in the order of their frequency of usage.

Table 3.4. Descriptions of risk sharing mechanisms in US highway PPP contracts

(A) Mechanism	**(B) Description**	**(C) Risks that use the most**
Relief event (used 128 times out of 552 times a sharing mechanism was identified)	Events with negative impacts on the projects (e.g. losses in time, money) but cannot be avoided or reduced by reasonable efforts of the private party. The private party is excused from contract non-conforming penalties. It can then be compensated with extended time (most of the times) or some other forms, including monetary compensations. Not all events with causes listed in Relief event are considered relief events but only the consequences left after absorbed by insurance. In case of relief events with financial compensation, a "Relief events Allowance account" often exists which is deposited by the public party. This account pays for extra work and delay costs as it is most prioritized for. In	Socio-political opposition, change in law, risks that can cause delay and loss in construction (e.g. right of way, site geology, archaeology and fossils), risks that are caused by the public sector (e.g. permits, changes by the public authority, network, latent defects of existing assets), and risks caused by natural disasters

(A) Mechanism	(B) Description	(C) Risks that use the most
	case of extension of time, the private party will file a document explaining the delays caused by a relief event; if the public party agrees, it will extend the term of the project (construction phase or operation phase). If disputes occur, parties will follow dispute resolution procedures as designed in the contract.	
Compensation event (69/552)	Events that are not caused by the concessionaire and that have negative impact on the concessionaire and are in special situations that the government must financially compensate the concessionaire. Situations that most likely lead to compensation include faults by the state or federal governments and changes made by governments.	Risks that are caused by the public sector (e.g. some qualifying change in law, delay caused by the government, changes by the government, revenue payment, network, latent defects of existing assets, termination for convenience)
Delay event (54/552)	Delay events usually apply to the same events as Relief events and are treated similarly. Delay events and Relief events were mutually exclusive in the project contracts analyzed.	Used for the same risks as Relief event
External reference (43/552)	Risks whose impacts are calculated based on some external factors at the time those risks occur or at other times as agreed by parties. An example is that the Consumer Price Index (CPI) – an external factor – that is considered to calculate impact by inflation. Another example is "Fair market value" of the project which is used as a base value for parties to negotiate when the project has to terminate early.	Inflation, Interest rates before financial close, SPV default, Termination by the government
Force majeure event (41/552)	Events that have unpredictable causes in both time and consequences but occur from outside of the project	Socio-political opposition, Natural disasters such as

(A) Mechanism	(B) Description	(C) Risks that use the most
	system. Causes may be from civil or nature. Consequences vary from delays, losses in revenues, or catastrophic for the project assets. Force majeure events are usually insured through obligations. However, some causes have high policy premium and some are even uninsurable. Contracts re-quire the private party to buy minimum insurance plans, which may include plans to protect the projects from natural disasters such as storms and earth-quakes. Uninsurable force majeure risks may include disasters by human such as wars and terrorisms. Once the risks happen and the consequences are too great for the insurance plans to cover, the contracts usually treat these events as Relief or Delay events (presented below) and negotiations likely follow.	earthquakes or named storms, Terrorisms, Floods
Further interpretation (38/552)	Some risks need to be broken down for the parties to determine appropriate mechanisms. For example, when a latent defect is detected, parties must investigate the cause and the time it might have occurred before deciding how the loss will be treated. Another example is environmental risks: parties must know that the risk is or is not pre-existing.	Used mostly with change in law and environmental risks since the cause of these risks determine subsequent actions of parties. For instance, not all changes in law become subject to compensation; only a few, including discriminatory changes in law that affect a small group of the private sectors, will qualify.
Negotiation (36/552)	Using this mechanisms, the parties state that they will negotiate on the outcomes of the risks. This does not necessarily lead to an amendment of the contract. This mechanism is distinguished from renegotiation	Used mostly with SPV default and termination by the government.

(A) Mechanism	(B) Description	(C) Risks that use the most
	whose the product is an amendment of the contract.	
Extension (24/552)	In some Relief/Delay events when the contract explicitly states that the term of the contract will be extended so that the losses of the concessionaire will be re-covered.	Used with permits, site geology, socio-political opposition risks
Deductible (23/552)	Specified amount of loss must be borne by a party before applying other sharing mechanisms	Force majeure, changes by the government, environmental risks (pre-existing), right of way and easement risks
Proration (21/552)	Parties share the losses (or gains) on pro rata basis.	Changes by the government, right of way and easement, and interest rates before financial close
Extra work costs and delay costs (21/552)	The costs that surpass estimated costs due to causes related to public party or relevant governments or nature of the project and are provisioned or agreed by parties to apply compensation mechanisms.	Force majeure, changes by the government, environmental risks (pre-existing)
Insurance (21/552)	The mechanisms that the two parties use to transfer part of the risks to a third party and the risks are usually large in consequence and have the causes of high uncertainty. Private party is (most of the times) obligated to buy insurance plans. Particular plans with minimum deductibles are required for particular assets in both construction and operation phases. If the insurance requirements are not met due to high premiums or lacks in market supply (uninsurable) then further tasks (e.g. consulting insurance experts) will be taken by parties to	Force majeure

(A) Mechanism	(B) Description	(C) Risks that use the most
	prepare for the risks. Projects in different areas have different requirements on insurance. For example, projects closed to oceans have higher insurance requirements on storms; some projects have higher insurance requirements on earthquakes. Residual losses after insurance coverage will then be treated by other sharing mechanisms as agreed in the contracts.	
Cost adjustment (18/552)	Provisions in the contracts usually depend on estimated costs of work (e.g. in base case model). When real costs change significantly (determined by parties' agreement), costs that are basis of other calculations are adjusted correspondingly.	Inflation, payment for services in AP projects
Relief event for the government (12/552)	Similar description as Relief event for the concessionaire, but in this case, the government is the party who has extended time (e.g. for making payments) and is exempt from non-conforming penalties.	Payment for services in AP projects, existing latent defects
Maximum reimbursement (3/552)	A compensation or sharing mechanism is conducted until some agreed values are reached.	Used rarely with some risks such as network, payment for services

Column A in Table 3.4 shows fifteen mechanisms; these mechanisms were identified 552 times in the 21 contracts. Examples of actual contract provisions are presented in the Appendix. As explained, mechanisms were often used in tandem, and Table 3.5 depicts how often a mechanism was used with another mechanism.

Table 3.5. Correlations between pairs of risk sharing mechanisms

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
(1) Relief event		33	0	1	25	27	3	15	13	12	13	14	0	0	0
(2) Compensation event	33		14	0	4	23	3	0	1	3	2	4	0	0	1
(3) Delay event	0	14		0	14	7	0	7	1	1	7	2	0	0	0
(4) External reference	1	0	0		0	0	32	0	0	0	0	0	7	0	0
(5) Force majeure event	25	4	14	0		0	0	5	6	3	21	3	0	0	0
(6) Require further interpretation	27	23	7	0	0		0	0	2	3	0	3	0	0	0
(7) Negotiation	3	3	0	32	0	0		1	0	0	0	0	0	0	0
(8) Extension	15	0	7	0	5	0	1		0	1	0	0	0	0	0
(9) Deductible	13	1	1	0	6	2	0	0		8	0	0	0	1	0
(10) Prorated	12	3	1	0	3	3	0	1	8		1	0	0	0	0
(11) Insurance	13	2	7	0	21	0	0	0	0	1		3	0	0	0
(12) Extra Work Costs & Delay Costs	14	4	2	0	3	3	0	0	0	0	3		0	1	0
(13) Cost adjustment	0	0	0	7	0	0	0	0	0	0	0	0		3	0
(14) Relief event for the government	0	0	0	0	0	0	0	0	1	0	0	1	3		0
(15) Maximum reimbursement	0	1	0	0	0	0	0	0	0	0	0	0	0	0	

Multiple mechanisms can be used to share a certain risk. For instance, row 5 shows that there were 25 cases where risks were treated with *force majeure event* and *relief event* at the same time; however, there were only 4 cases where risks were treated with *force majeure event* and *compensation event* in tandem.

In the analyzed contracts, mechanisms were classified into three groups of specification: high, medium, and low.

Highly specific mechanisms include *deductible*, *insurance*, and *maximum reimbursement*. In a *deductible* provision, the deductible amount – which requires ex ante effort – and the party who first bears it is set and is definitive. Therefore, once the risk happens, the parties will not likely need to spend too much effort to determine each party's required tasks or loss. For instance, the Elizabeth River Tunnels contract utilized a deductible to handle latent defects as provisioned in Section 8.11: *"(A) the Concessionaire will be solely responsible for the Net Cost Impact for performing Excess Rehabilitation Work up to $5 million in the aggregate ("Excess Rehabilitation Work Deductible"); and (B) the Department will be solely responsible for the Net Cost Impact for performing Excess Rehabilitation Work in excess of the Excess Rehabilitation Work Deductible but less than or equal to $20 million…"*; this provision is indicative of the deductible schemes found in the contract set, and it is conclusive regarding who bears the cost of excess rehabilitation work.

An *insurance* provision in a contract often stipulates the assets, the deductible amount, and the maximum coverage that the private developer must purchase. Government must expend effort (or rely on standard provisions or consultant advice) to stipulate insurance requirements because each project is located in a different area and has its own characteristics that affect its vulnerability to different kinds of threats (e.g. natural disasters). The following provision from Colorado Northwest Parkway dictates the government's requirements:: *"The Concessionaire shall obtain All Risk Property Insurance at full replacement cost, covering all loss, damage or destruction to the Parkway, including improvements and betterments; provided, however, that the limits of such coverage may be based on a probable maximum loss analysis, subject to the Authority's Approval of such probable maximum loss analysis by an independent third party that is reasonably acceptable to the Authority, which Approval shall be provided prior to Closing…"* (Section 13.1). In these requirements, the private party even must obtain approval from the government before it purchases the insurance plan; the provision is procedural, but it is definitive since coverage amount and scope are set. The ex post effort of the parties to seek compensation of insured assets, on the other hand, only requires that the insured follow the policy requirements with the government expending little to no effort.

Mechanisms with low levels of ex ante specification include the "event" mechanisms and negotiation. "Event" mechanisms (i.e. relief, delay, compensation, force majeure events) require minimum ex ante efforts but potentially large ex post efforts by the parties. The ex ante effort is low since the uncertainty associated with the risk is high, so the parties cannot specify all the necessary parameters during contract formation. For situations categorized as "event" mechanisms, parties will base their decisions on how the risks actually occur. The Portsmouth Bypass contract – Section 15 – stipulated a representative procedure for relief, which is long and complex but is summarized as follows:

- The concessionaire must: identify "time impact analysis", prove that the event affected the project's critical path, prove that the event could not be avoided by reasonable efforts, and provide evidence of the causes of the event.

- The government then reviews the information and decides how to grant relief.

- If the concessionaire agrees with the government's decision, then the decision is followed; if the concessionaire disagrees with the government, then the provision indicates:

"If the Parties cannot agree on the extent of any delay incurred or relief from Developer's obligations under this Agreement, or the Department disagrees that a Relief Event has occurred (or as to its consequences), or that Developer is entitled to relief under this Article 15, the Parties shall resolve the matter in accordance with the Dispute Resolution Procedures." (Portsmouth Bypass, Section 15.3).

The relief provision has a number of stipulations, but these are procedural rather than categorical; hence, the parties will expend considerable effort ex post to remedy the situation.

Negotiation is another process associated with high ex post transaction costs in the literature. By choosing negotiation, parties again structure an unspecific provision as represented in this provision from I-595: *"If and only if FDOT, in its sole discretion, is interested in the proposed Business Opportunity, FDOT and Concessionaire shall thereafter negotiate cooperatively and in good faith to formulate a structure, terms and conditions and written agreement(s) for such Business Opportunity and its use and development,"* (Project I-595, Section 21.2). Here, the parties will expend effort ex post and are more exposed to other kinds of uncertainty – uncertainty associated to human behaviors and opportunism. This is why "good faith" – a general but weak commitment – is usually stated in *negotiation* provisions.

The remaining mechanisms – *proration*, *external reference*, *further interpretation*, *cost adjustment*, *extra work costs and delay costs*, and *extension* – fall into the medium category since these mechanisms require both ex ante and ex post effort, but less than that of the other two groups. Compared to the highly specific mechanisms, more effort is necessary if risks are realized. A representative *proration* provision follows: *"The Parties shall negotiate in good faith to determine the Refinancing Gain. FDOT will receive a payment equal to 50% of any of Refinancing Gains received in connection with any Refinancing other than an Exempt Refinancing"* (Project I-4, Section 16.4.3). In this provision, parties must define the ratio (50%) beforehand, i.e. the definitive portion, as well as expend additional effort to determine the refinancing gain once refinancing occurs, i.e. the procedural portion, which will add some ex post transaction costs to the process. Another example provision, the *further interpretation* mechanism, also illustrates the timing of transaction costs:

"Discovery of (i) subsurface or latent physical conditions at the actual boring holes identified in the geotechnical reports included in the Reference Information Documents that differ materially from the subsurface conditions indicated in such geotechnical reports at such boring holes, excluding any such conditions known to Developer prior to the Proposal Due Date, or (ii) physical conditions within the Project Right of Way of an unusual nature, differing materially from those ordinarily encountered in the area and generally recognized as inherent in the type of work pro-vided for in the Agreement, excluding any such conditions known to Developer prior to the Proposal Due Date or that would become known to Developer by undertaking reasonable investigation prior to the Proposal Due Date…" (Project IH-635, Exhibit 1, page 53). This means that the loss due to actual site geology conditions will be compensated by the government if they "differ materially" from known conditions; similarly, it is procedural and somewhat definitive since baselines for judgments of material difference – the Reference Information Documents and those ordinarily encountered. Though this interpretation seems simpler than negotiation, agreement on "differ materially" may or may not be easy for the parties.

As a result, three groups of mechanisms can be depicted schematically by degree of completeness and timing of transaction costs (Figure 3.2), where provisions in the high group are in the upper left quadrant, the medium group are at the intersection of the two axes, and the low group is in the lower right quadrant. Each provision is sized according to its frequency of use in the contract set.

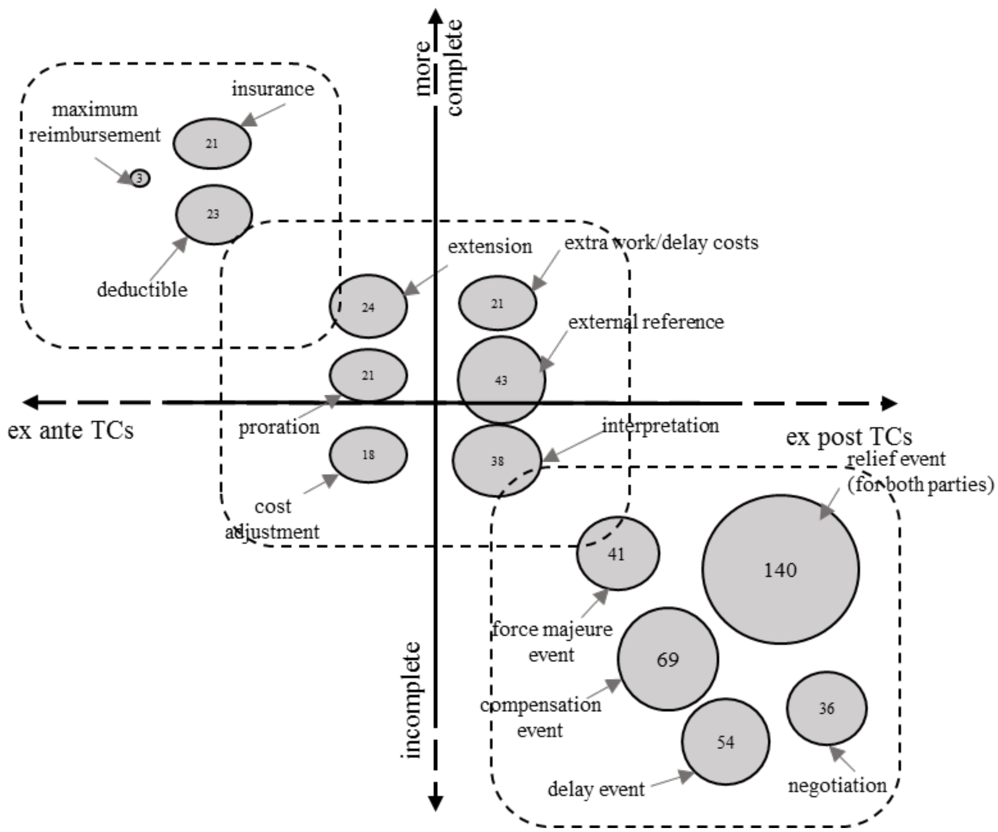

Figure 3.2. Classification of risk sharing mechanisms

Each mechanism is positioned within the group for illustrative convenience; it does not indicate its location along the two continuums. Some differences in the level of specification between mechanisms in the various contracts would shift a mechanism's location along each continuum, but it would still remain within its quadrant.

3.9 Discussion

3.9.1 Public control versus concessionaire empowerment

The literature explains that information revelation (monitoring) can mitigate asymmetric behavior and opportunism in long-term (and consequently incomplete) contracts while ownership or assignment of residual rights can mitigate such concerns in long-term contracts. While a concessionaire may not legally "own" PPP project assets, the duration and scope of such contracts theoretically provides them significant rights over project assets. The evidence gathered from actual contracts examined provisions related to actions such as project management, performance, refinancing, transfer and handback. These provisions clearly demonstrated that information revelation or governmental monitoring is pervasive in US highway PPPs; indeed, most contractual language reviewed either forces the concessionaire to reveal as much information as possible or places safeguards to ensure performance and proper management/investment or to mitigate opportunistic behavior and information asymmetries. This assignment, according to the theory of property rights (Grossman and Hart 1986; Hart and Moore 1988), contributes to determine the outcomes of situations where the contracts are incomplete by granting the governments the rights to decide.

The dominance of the government's control rights over private autonomy suggests that the principal-agent problem persists in the context of PPPs; consequently, these transactions have not that far from traditional delivery methods where aligning principal and agent interests is a central issue. The government is generally granted rights to not only oversee the projects but also to decide on or approve of important matters. Consequently, agents are driven via contractual obligations to act in a principal's interests.

Possible explanations for these observations are several. A public agency finds itself in a complicated position in a PPP; it is a concessionaire's contractual counterparty, but it is also a regulator, representing broader sociopolitical interests (Kivleniece and Quelin 2012). Hence, it is potentially prone to act conservatively in these transactions. This is also likely a consequence of the extensive public accountability standards in place for public procurement and the general and PPP-specific scrutiny that these transactions receive. Rufin and Rivera-Santos (2012) indicate that these circumstances make public authorities and managers more risk averse. Another potential reason why governments may impose heavy monitoring and control requirements is that the typical term of a highway PPP is usually 35 to 50 years;

certainly, this longevity is greater than typical, but as Chung (2009) points out this may still only be roughly 30% to 50% of infrastructure service life. This may induce the public agency to demand knowledge of asset management and condition since it get the asset back with perhaps half of overall service life remaining.

3.9.2 Risk sharing mechanisms: ex ante or ex post treatment

The findings related to the structure of risk sharing mechanisms suggest that when this strategy is employed it tends to rely on event mechanisms more often than not; these are less complete than other mechanisms such as deductible schemes or insurance. Figure 3.3 depicts the frequency of the mechanisms used in the analyzed contracts; the prevalence of the event mechanisms is clear. These were categorized into the low group with respect to ex ante specification. While procedurally complex, they are not very definitive. This suggests that contract designers do leave contracts incomplete as suggested in the literature (Crocker and Reynolds 1993; Iossa and Martimort 2012; Rausser and Stevens 2009). The presence of mechanisms ranging from more complete to less complete is also aligned with recommendations by Athias and Saussier (2007) to balance rigid (non-negotiable) with flexible (negotiable) contractual structures.

However, the strength of these findings is limited by the qualitative assessment approach employed to assess the mechanisms as well as the tendency of contract designers to use these mechanisms in tandem – in other words, a less complete mechanism such as a relief event can be used in conjunction with a more complete mechanism like a deductible. This combination would shift this specific treatment in the quadrant space presented previously toward the middle, i.e. medium completeness and both ex ante and ex post transaction costs; the research did not assess these combinations due to the number of permutations found in the contracts.

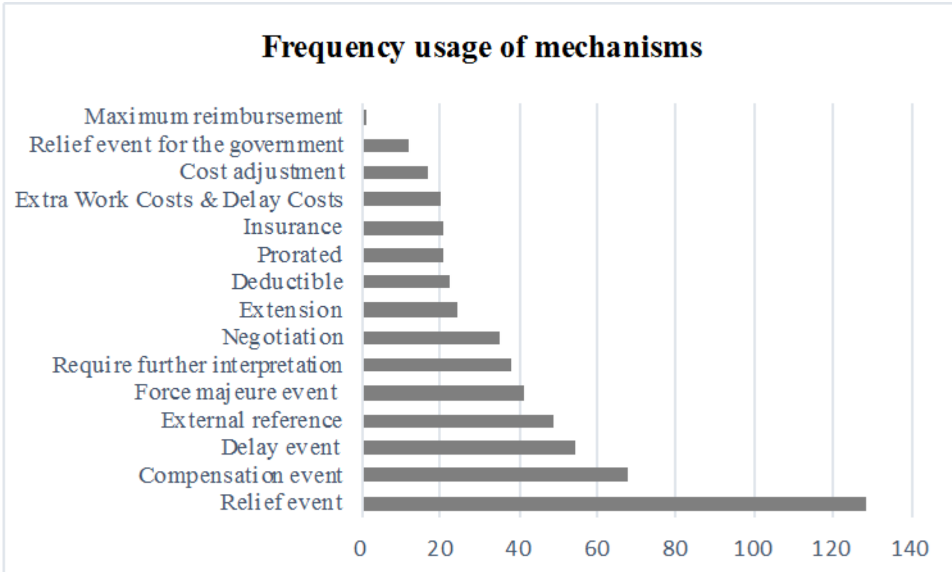

Figure 3.3. Usage frequency of risk sharing mechanisms

3.10 Conclusion

As long-term contracts, PPPs potentially face many issues such as contract incompleteness, high transaction costs, and incentive problems. Yet, these procurements are also challenged by the overarching emphasis on preserving the public interests in infrastructure procurement and service provision. Building off a companion investigation that identified risks and risk allocation in 21 US highway PPP projects, this research examined how highway PPP contracts are structured to determine what choices governments make with respect to control rights, contract formation and enforcement. One avenue explored whether governments elect to monitor and control PPP projects or empower concessionaires. A second avenue examined whether risk sharing mechanisms employed are structured to specify ex ante treatments or to rely on ex post resolutions in such mechanisms.

Findings related to the control versus empowerment question were quite clear. Governments relied extensively on provisions for monitoring and controlling concessionaires, so concessionaires must reveal information as deemed necessary and many of their decision rights are subject to approval or constraints. Project quality assurance is conducted through a common vehicle – the non-compliance performance system. Some quality incentives were based the measures of this non-compliance system. Governments also retained many ownership or control rights over projects throughout their contract duration. For example, in order to change the scope, make deviations, or transfer rights, concessionaires must seek governments' approval before proceeding. Governments also reserve the rights to change projects' scope, other business investment opportunities, and project transfer. Further, governments stipulate processes and approvals for refinancing and project handback to ensure concessionaires remain committed to a project's purpose and invest adequately in asset quality and sustainment. The dominant role of governments in overseeing project decisions in US highway PPPs places the locus of control in their hands rather than in the hands of their private partners.

Findings related to the ex ante or ex post treatment were less conclusive. Fifteen risk sharing mechanisms were identified in a companion investigation and were further investigated; these mechanisms ranged from *deductible* to *negotiation* and *event mechanisms*. Based on the content of the contractual provisions, each mechanism was qualitatively assessed and categorized by its level of completeness and timing of transaction costs; mechanisms such as *relief events* were classified as incomplete with ex post transaction costs while mechanisms such as *deductible* and *insurance* were classified as more complete with ex ante transaction costs. The frequency of risk sharing mechanism use was also determined. Far and away, *event mechanisms* were the prevailing method for risk sharing in the contract set (55% of risk-sharing strategies employed an event mechanism). The prevalence of these mechanisms suggests that the parties do leave risk sharing provisions incomplete; however, the strength of this finding is limited by the assessment approach adopted as well as the risk sharing mechanisms permutations; the latter means that mechanisms were often used in tandem, which complicates the assessment process, but it does indicate the relative complexity of the risk sharing schemes adopted.

Results show that contract practices in US highway PPPs are strongly aligned with contract theories. This contributes to the body of knowledge in contract design and management in PPPs in both theory and practice. As one of the first investigations to examine how contracts are structured and what contract formation and enforcement choices PPP practitioners make, this research can serve as the basis for future research including: (i) complementary research in different international markets and market sectors and (ii) tracking the performance of the contract mechanisms, as the US highway PPPs evolve throughout project lifecycles, hence providing empirical assessment of contract mechanisms' efficiency.

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4 Chapter 4: Beyond Standard Revenue Guarantees in PPPs: Enhancing Revenue Risk Sharing with Exotic Options[5]

4.1 Abstract

Revenue risk has received significant attention in infrastructure Public-Private Partnerships (PPPs). In theory and practice, revenue guarantees have been a popular mechanism to mitigate this risk. Real option theory is often utilized either to structure such arrangements or to value projects with guarantees. Similarly, some regions have employed minimum revenue guarantees within PPP arrangements to provide concessionaires with downside revenue risk protection. Most research and practice has treated guarantees as standard put and call options, which potentially limits revenue risk mitigation alternatives. The utilization of exotic options, however, can expand the alternatives that PPP parties have to meet their risk hedging needs while also addressing different risk perspectives. A case study from a contemporary toll highway PPP in the US demonstrates that some representative exotic options such as barrier and gap options allow a wider range of risk/reward distribution among the government, the private developer/concessionaire, and lenders. Considering the interests of these three major stakeholders, exotic options can reduce a government's expected loss and improve a project's credit risk while not significantly affecting a developer's residual cash flow. The results illustrate that the introduction of exotic features into revenue risk mitigation measures can bring more confidence to contractual parties and lenders during the project commercial and financial close process and operations period.

Key words: Public-private partnerships, Risks, Risk Allocation, Real Options, Exotic Options, Monte-Carlo Simulation

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[5] Nguyen D.A., Garvin M.J., Kumar R. (2017). "Beyond Standard Revenue Guarantees in PPPs: Enhancing Revenue Risk Sharing with Exotic Options". *Journal of Construction Engineering and Management*. In preparation.

4.2 Introduction

Infrastructure Public-Private Partnership (PPP) projects have different levels of profitability. This circumstance, along with many other project features, creates multiple alternatives for governments and the private developers/concessionaires to address revenue risk. In the highways sector, governments can retain the risk for themselves in availability payment (AP) projects where the concessionaires receive scheduled payments as long as the project meets specified service "availability" standards. Alternatively, concessionaires can bear the entire revenue risk in tolled projects, where ridership and toll rates determine their annual revenues, or revenue risk can be shared between governments and developers through certain financial or contractual mechanisms.

Different strategies have been utilized to mitigate revenue risk in highway PPPs worldwide. Generally, these approaches fall into three categories. First, governments can employ subsidy programs that can provide: direct contributions to a project's funding, governmental loans or other incentives and/or credit enhancement. Subsidies as upfront funding contributions are utilized worldwide since concessionaires cannot always acquire the necessary project funding exclusively from equity investors and lenders. In the US, governmental lending includes: Transportation Infrastructure Finance and Innovation Act (TIFIA) loans that are subordinate to senior debt and Private Activity Bonds (PABs) that are tax-exempt and issued by or on behalf of state or local governments whose proceeds are used for projects with significant private involvement. In 23 design-build-finance-operate-maintain (DBFOM) projects implemented in the US highway sector through 2016, government subsidies as upfront contributions were as high as 28.0% of project costs; whereas, TIFIA loans were employed in 16 projects and PABs were issued in 12 projects (Nguyen et al. 2017).

A second approach is variable-length contracts (Engel et al. 2001; Vassallo and Gallego 2005). This method has been utilized in South America (Engel et al. 2003; Vassallo 2006) and Spain (Vassallo et al. 2012). Engel et al. (1997, 2001) helped pioneer this approach where during a PPP procurement, each concessionaire bids a present value of the revenue (PVR) it expects to gain from the entire project operation. The bidder that has the least present value of the revenue (LPVR) wins the bid if all of its other bidding requirements are met. During the project operation phase, actual revenues are recorded and audited. Once the aggregate PVR reaches LPVR, the contract terminates. This leaves contract duration unknown at the outset. Nombela and de Rus (2004) suggested least present value of net revenue (LPVNR) instead of LPVR by also considering operation and maintenance costs. Variable contract duration has the advantage, among others, that the arrangement does not introduce a liability onto a government's balance sheet. However, Nombela and de Rus (2004) and Guasch (2004) reported that the variable contract duration method tends to induce more renegotiations, therefore higher transaction costs, compared with fixed-term contracts. Furthermore, the fact that a concessionaire bids for the least net present value but can still hope for renegotiations along the way can trigger the contract hold-up problem that the governments often want to avoid (Hart 2009).

A third approach to mitigating revenue risk is the revenue guarantee (Brandao and Saraiva 2008; Carbonara et al. 2014). A guarantee is "the creation of a fund of liquid assets that can be rapidly mobilized in the event that a contingent liability is realized" (Delmon 2009); revenue guarantees within PPP projects, therefore, typically require a governmental fund to support concessionaires when actual revenue falls below the guarantee threshold. Utilization of revenue guarantees in developed country PPP markets (such as Australia, the US and the UK) is not common, but such guarantees are more common in developing countries such as Chile, Colombia, the Dominican Republic, and Malaysia (Li et al. 2005) but questions about efficiency of revenue guarantees are prominent in both developed and developing regions (Irwin 2007).

Literature has addressed government provided revenue guarantees in various ways. One thread of research has focused on valuing projects given particular guarantee structures (e.g. Brandao and Saraiva 2008; Chiara et al. 2007; Takashima et al. 2010) while another has examined the relationship between different guarantee structures such as payment amounts and timing of exercise rights with other relevant project variables such as IRR (e.g. Carbonara et al. 2014; Kokkaew and Chiara 2013; Wibowo et al. 2012). For both research avenues, real option theory has been used extensively, where revenue guarantees are structured as standard put options and the underwriter is the government and the holder is the concessionaire. Some research has also suggested standard call options to model other guarantee structures such as a collar (Shan et al. 2010) where the private concessionaire holds a put option and the government holds a call option; this allows the government to capture revenues to offset the effect of the put option.

To date, standard put and call option-like structures have been dominant in the literature examining revenue guarantees. These structures have some advantages; they are relatively straightforward, so parties to a project will likely understand how to set them up and, if the parties desire, to value them. Both set up and valuation would generally follow well-known real option techniques. However, these structures also have potential drawbacks. First, standard put and call options provide their underwriters and holders with only a few payoff scenarios. For example, a put option structure with a cap has the payoff for the holder: $P = \max\{(0, X - S, Cap)\}$ where P = payoff, X = put option strike price/value, S = price/value of the underlying asset, and Cap = put option cap. Within the put option's price/value range (cap), the put option's payoff only depends on X and S; in other words, the structure has only one degree of freedom – S, given X was determined when the structure was set up. This characteristic, in the context of revenue risk sharing in PPPs, means that the government and the concessionaire have limited ways to design a guarantee to fit their particular conditions and needs. Second, the purpose of revenue guarantees is to have the government bear some of the downside risk; thus, revenue guarantees are only useful when projects are experiencing revenue shortages to pay debts (Irwin 2007). For the concessionaire, this recourse can come from its counterparty or from a project's reserve accounts that depend on periodic operating conditions and performance. The latter relates to path-dependence – a concept that "history matters"

(David 2000) – and unfortunately, cannot be integrated in current revenue guarantee structures that are based on standard options only.

The two drawbacks of guarantee structures with standard put and call options can only be mitigated if structures are designed to improve standard options where only the real time price/value of the underlying assets matters. Fortunately, exotic options, which are another class of options found in both literature and practice, can potentially enhance guarantee structures. Exotic options can generate many payoff scenarios and take into consideration not only real time price/value of the underlying assets but also many more variables such as how price/value evolves, which increases the degrees of freedom when designing an option's structure. Consequently, this research focuses on enhancing revenue guarantee structures in the context of highway PPPs by exploring the utilization of exotic options.

The structure of this paper is as follows. The first section is a brief review of literature about common structures of revenue guarantees. Next, the concept of path-dependent investments is introduced, which is followed by an overview of common exotic options. The methodology follows to explain how to probe pros and cons of revenue guarantees with exotic options integrated. Next part includes suggestions of desirable characteristics of novel structures of revenue guarantees based on limitations of standard options and capability of introduced exotic options. In a case study of an ongoing highway PPP with real forecasted data some candidates of revenue structures that utilize exotic options are designed along with actual scheme in the case study contract. Expected outcomes of the actual scheme and candidate structures are generated through Monte Carlo simulations. These results are then reviewed through the lens of the project's major stakeholders' interest. Discussion on the results of the case study and conclusion finish the research.

4.3 Revenue guarantees in research and practice

4.3.1 One-way-cash-flow guarantees: put option structures

This scheme is a popular strategy used to share revenue risk in highway PPPs (Ashuri et al. 2012). The guarantees are a series of cash outflows from the perspective of the government. A guarantee is typically structured as a "minimum revenue guarantee" (MRG) where the government commits that if the project revenue drops below some value, it will compensate the concessionaire for the loss (Brandao and Saraiva 2008; Cheah and Liu 2006; Chiara et al. 2007b; Cui et al. 2004). This works exactly like a put option and all variables such as the premium, the value and the time of the guarantees can be calculated with the same techniques as a typical put option. Since governments' resources for guarantees are limited, these guarantees may be structured with a cap – a maximum guarantee payable annually and cumulatively. Figure 4.1 depicts the payoff for the put option holder – the concessionaire.

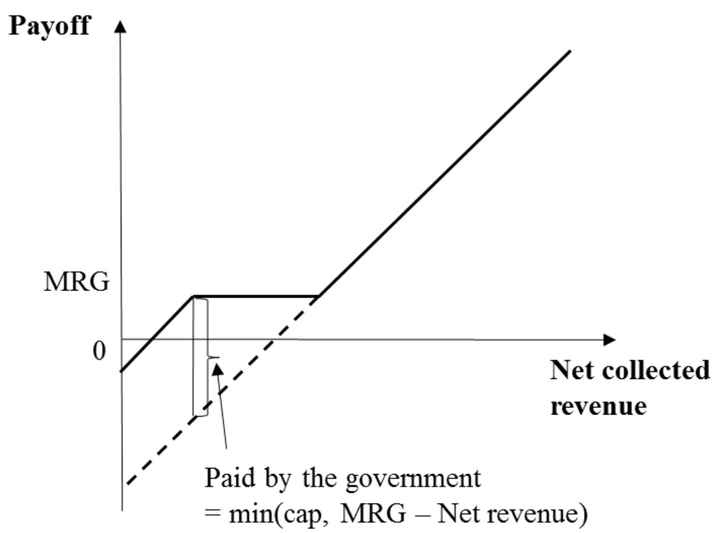

Figure 4.1. Payoff for the concessionaire

Chiara et al. (2007b) suggested revenue guarantee structures that deviated from a standard put option. The authors argued that revenue guarantees are usually exercised early in operation rather than later; hence, they proposed Bermudan options that can be exercised once on specified dates during its life, and Australian options than can be exercised M times on specified N dates [N > M] during its life as alternatives to standard European options. Guarantees with these structures can be valued using the Black-Scholes formula, binomial trees, or simulation.

Two potential problems exist with one-way-cash-flow guarantees. The first problem relates to how incentives are structured in PPP contracts. Many variables, such as economic environments and forecasting accuracy, can affect highway PPPs, causing fluctuations in operation performance during a project's contractual period. In "bad" years when annual revenues fall short, concessionaires can exercise governmental guarantees, but they are not necessarily contractually obligated to preserve surplus resources in "good" years. Consequently, this scheme places a government in a disadvantaged position. The second problem is that one-way structures may increase a project's credit risk as a result of the one-way spending. If governmental guarantee reserves are only spent but not replenished, then the reserves might be depleted quickly, putting project credit in danger. Two-way-cash-flow structures, presented subsequently, have the potential to mitigate these two problems.

4.3.2 Two-way-cash-flow guarantees: put and call option structures

In these schemes, two types of cash flows exist. For the government, lower than expected project revenue triggers a cash outflow to the concessionaire; whereas higher than expected revenue triggers a cash inflow for the concessionaire. Therefore, both downside and upside revenue risks are shared between a government and a developer.

Shan et al. (2010) considered the cash outflow as a put option and the inflow as a call option. Their research treated the two options as a collar, where the value of the put would cancel out the value of the call, so the collar would have zero-cost at the time of PPP contract formation. As a result, the concessionaire would not need to pay a premium, if requested to do so, for the put option. The authors established revenue guarantee levels (the exercise price of the put) and used the Black-Scholes formula to calculate the value of the put option; subsequently, they used this value to yield the maximum revenue threshold (the exercise price of the call option). The collar option approach, as claimed by the authors, releases parties from any upfront liability, which they are usually unwilling to commit. Figure 4.2 demonstrates the payoff of the government in the collar option case.

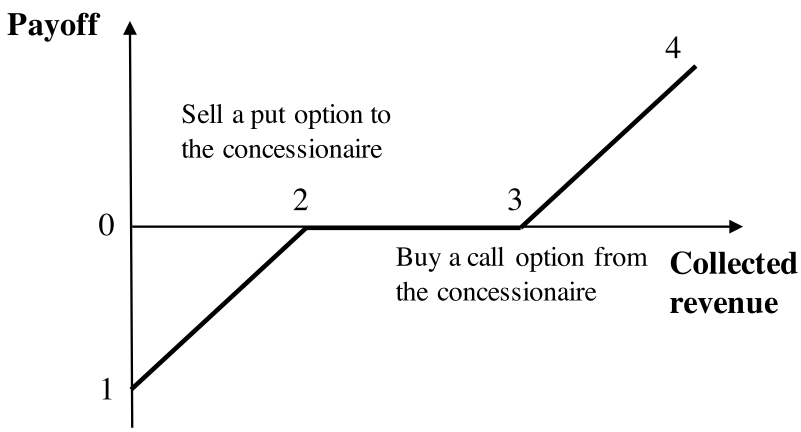

Figure 4.2. Payoff of the government in zero-cost collar option (Shan et al. 2010)

Similar to the collar option approach, Park et al. (2013) considered a maximum revenue limit (MRL) and a maximum expense limit (MEL). MEL, according to the authors, is a call option held by the concessionaire, so the concessionaire can call for the guarantees (these guarantees, however, are no different than put options held by the concessionaire as just described). MRL is a call option and is exercised when the project IRR is greater than the minimum attractive rate of return (MARR), which is specified by negotiation. In Figure 4.3, the exercise price of the put option (MEL) is determined when the total expected value of MEL exercised (A_1) equals the total expected value of MRL exercised (A_2). The most obvious difference between the combination of MEL and MRL and the collar option by Shan et al. (2010) is that the MEL & MRL does not only consider the revenue factor but it also considers the cost factor underlying asset price.

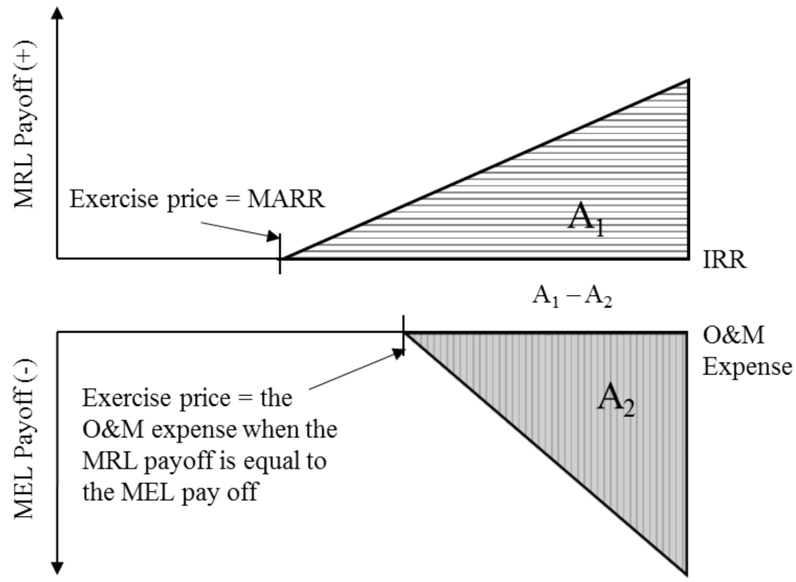

Figure 4.3. Balance of MRL and MEL payoffs (Park et al. 2013)

Since the two-way-guarantee can be set up theoretically so that the cost of the put and the call options cancel out, it releases the concessionaire from any premium liability. However, a characteristic of PPPs, particularly for tolled highways, is the ability of the government to transfer part or all of the revenue risk to the concessionaire. Using a collar system without option caps, the government is exposed to maximum loss while the concessionaire's range of risk/profit is known ex ante. Moreover, the closer the put and call exercise prices are in a collar structure, the more this structure resembles an availability payment.

4.3.3 Limitations of current revenue guarantee structures

As discussed, governmental revenue guarantees as a method for revenue risk sharing in highway PPPs have received considerable attention in the literature and been employed in practice. Such revenue guarantees are often structured as standard put options and put-and-call options. Both kinds of structures have advantages; they are relatively easy for parties to understand, implement, and value (utilizing common assumptions) thanks to the backing of real option theory. Disadvantages, however, are associated with standard option structures of guarantees. First, standard options, though they provide parties flexibility to use available resources from counterparties when necessary, limit the parties' choices of risk distribution schemes because only revenues at intervals (e.g. quarterly or yearly) are typically used to determine options' exercisability. Second, standard options typically adopt concepts from finance, so they are structured and valued under the assumption of risk neutrality (Black and Scholes 1973; Cox et al. 1979; Jackwerth 1999). Scholars, such as Akintoye and Macleod (1997), Zaghloul and Hartman (2003), and Garvin and Cheah (2004) have pointed out that this assumption is problematic in project-based environments including the construction industry, where risk preferences range from risk averse to risk neutral/seeking but with more concentration on the averse end. Indeed, underlying assumptions are one of the main reasons that real options remain underutilized (Garvin and Ford 2012; Triantis 2005). Third, standard option structures do not take into account path-dependence, which is related to the flexibility that parties have to transfer resources through time.

4.4 Desirable features of revenue risk sharing structures in PPPs

The aforementioned limitations of current revenue guarantee structures obviously affects their effectiveness for risk sharing in highway PPPs. Hence, the next generation of revenue guarantee structures should likely have the following features:

(a) More alternatives available for disbursing and reserving resources during project operations for governments and concessionaires, rather than just disbursing resources from governmental accounts;

(b) Greater flexibility for distributing losses and gains between governments and concessionaires where the distribution is based on the parties' circumstances and risk preferences, i.e. more flexible than the of risk neutrality valuation; and

(c) Ability to incorporate path-dependence and transfer resources over time.

Such features are available in other instruments that do not have the constraints of standard put and call structures. For instance, strategies for investment in path-dependent assets, including exotic options, have promise to move toward next generation revenue risk sharing models.

4.5 Exotic options: a new avenue for revenue risk sharing in PPPs

4.5.1 Path-dependent investment

As noted, governments and concessionaires in highway PPPs need not only the flexibility to call resources from other parties to support a project but also the flexibility to reserve and transfer resources over time. The latter capability can be provided by integrating a path-dependent perspective. David (2000) described a "path dependence stochastic process" as "one whose asymptotic distribution evolves as a consequence (function of) the process's own history" or in other words "history matters". Based on this definition, a standard option, where the decision to exercise or not depends only on the asset's price at maturity (European option) or at a point in time prior to maturity (American option), is not necessarily a path-dependent investment. Adner and Levinthal (2004) distinguished real options and path-dependent management strategies: real options are a "wait and see" method, while path dependence is more like "act and see". Figures 4.4 and 4.5 depict the conceptual boundaries for use of NPV and real options and real options and path-dependent investment respectively.

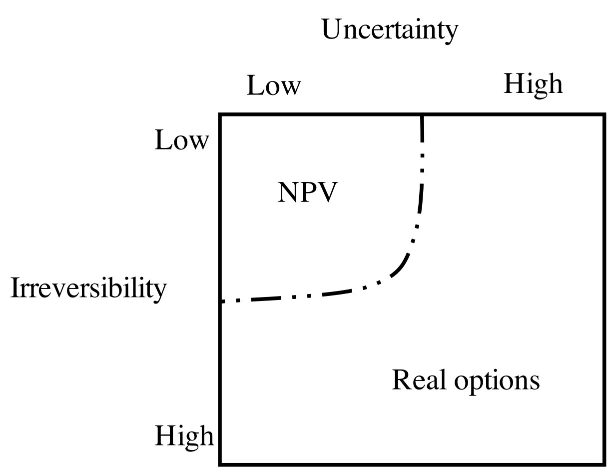

Figure 4.4. Boundaries of Applicability for Net Present Value and Real Options (Adner and Levinthal 2004)

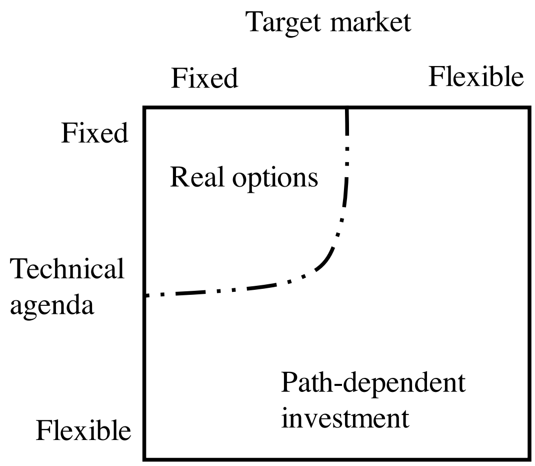

Figure 4.5. Boundaries of Applicability for Real Options and Path-Dependent Opportunities (Adner and Levinthal 2004)

Though the boundaries depicted were constructed regarding “firms” rather than “projects”, PPP arrangements are hybrids since a project enterprise or company with multiple stakeholders is formed to implement and manage the investment under the regulatory oversight (via contract) of a public agency; hence, stakeholders with different perspectives are engaged in any PPP endeavor. Moreover, Adner and Levinthal’s fundamental point was investments where managerial action and choices can influence or enhance value are more properly treated as path-dependent opportunities. Hence, real options are more applicable to specific technical assets and markets such as oil refineries whereas path-dependent processes are more applicable when the potential paths an investment may take can “wander”, managerial perspectives of the investment may differ, and sequential market and technical probing will enhance managerial choices. Consequently, the appeal of Adner and Levinthal’s arguments for path-dependent processes in the context of PPPs is linked to the range of stakeholders involved and the sequential actions they may take to adjust course or even abandon a PPP project in light of its position in their overall portfolio.

Any scheme that can be modeled as a standard real option can be modeled with a path-dependent model as well. For example, exercise of a standard European option is determined by the underlying asset price/value at maturity while one of a path-dependent option is determined by the same factor during a *period of time*. Therefore, if the *period of time* is intentionally compressed to a single unit, then the path-dependent option shifts toward the standard option – *shifting toward* but not necessarily *becoming* because other variables of the path-dependent option must be changed as well; alternatively, compressing the time period means decreasing the option's degrees of freedom by one. This ability to alter characteristics of path-dependent strategies makes them, conceptually, applicable in any project-based environment where real options are applicable. This insight inspires the consideration of exotic options, some of which have path-dependent attributes while others have additional flexible features, for utilization within PPPs. These features, perhaps, can enhance the flexibility afforded to the range of stakeholders in a PPP when developing time-dependent strategies for addressing revenue risk.

4.5.2 Exotic options

If simple put and call options are considered standard options, then exotic options are any kind of option that differs from standard options in at least one aspect (Zhang 1995). Unlike standard options, whose payoffs depend on five parameters (i.e. underlying asset price, strike price, interest rate, variance, and duration), exotic options have payoffs that are dependent on other variables. This makes exotic options more flexible but also less intuitive than standard options. Another feature of exotic options is that exotic options are often cheaper than standard options (Carr et al. 1998). The most common exotic options include Asian options, barrier options, look-back options, gap options, binary options, compound options, forward-start options, and rainbow options (Taleb 1997; Zhang 1995). Table 4.1 describes standard options and the most common exotic options.

Table 4.1. Descriptions of standard options and several common exotic options

Type	**Definition/Description**	**Parameters of designs**	**Variables impacting payoff**	**Selected literature about valuation and other topics**
Standard put and call options	A call/put option gives the holder the right to buy/sell the underlying asset by a certain date at exercise (strike) price. American options can be exercised at any time up to the expiration date (maturity); European options can be exercised only on the expiration date (Hull 2010)	- Strike price - Duration	- Asset price at considering date (American) or at maturity (European)	Black and Scholes (1973), Merton (1973), Cox et al. (1979)
Asian option	Path-dependent options where payoff depends on the average of the underlying asset price over certain time interval (Vecer 2002). For example, an Asian call option on a stock will be exercised only if the average of the stock price in a period of time is greater than its strike price.	- Strike price - Duration - Pricing interval	- Asset price at considering date - Average price over time interval	Hansen and Jorgensen (2000), Vecer (2002), Nielsen and Sandman (2003)
Barrier option	Path-dependent option and is activated (knocked in) or extinguished (knocked out) when a specified asset price, index, or rate reaches a stipulated level Broadie et al. (1997). Barrier options are path-dependent options, which means that their payoffs depend on whether their barriers are breached or not before maturity. "Knocked in" means that a barrier option, which does not exist when the option contract is formed, will come into existence when the changing value of the underlying asset crosses the barriers. For "knocked out", the option ceases to exist once the value of the underlying asset crosses a barrier. Barrier options are "up-and-in", "down-and-in", "up-and-out", and "down-and-out".	- Strike price - Duration - Barrier(s)	- Asset price at considering date - History price over time interval (break in/out or not)	Ritchken (1995), Carr (1995), Carr and Chou (1997), Geman and Yor (1996)
Bermudan option	An American-style option with a restricted set of possible exercise dates (Schweizer 2002). Bermudan options therefore can be considered a hybrid of American options (which can be exercised at any time) and European options (which can be exercised only one time at maturity).	- Strike price - Duration - Exercisable dates	- Asset price at intervals	Schweizer (2002), Whitley (2009), Boyle et al. (2013)
Binary option	An option whose payoff is a fixed amount or nothing (Stulz 1996)	- Strike price - Duration - Fixed payoff	- Asset price at considering date	Stulz (1996), Thavaneswaran et al. (2013)

Type	Definition/Description	Parameters of designs	Variables impacting payoff	Selected literature about valuation and other topics
Compound option	Path-dependence options whose underlying asset are options (but not stocks as in standard options) (Geske 1979)	- Strike price for options - Duration for options - Strike price for underlying asset - Duration for underlying asset	- History price to determine if options are in place - Asset price at considering dates	Geske (1977, 1979), Selby and Hodges (1987), Ghosh and Troutt (2012)
Forward-start option	Options whose effective starting time is sometime in the future after the contract is signed rather than starting at present (Zhang 1995)	- Strike price - Duration - Future start date	- Asset price at considering date	Hobson and Neuberger (2012), Lorenzo (2016)
Gap option	An option whose payoff is the difference between an asset's value and a pre-specified level (Zhang 1995)	- Strike price - Duration - Formula of payoff depends on variables	- Asset price at considering date	Andersen and Andreasen (2000), Kou (2002), Tankov (2008)
Look-back option	Path dependent contingent claims whose payoffs depend on the maximum or minimum of an underlying asset's value over a certain period of time (Conze and Viswanathan 1991)	- Strike price - Duration - Pricing interval	- Asset price over time interval	Hobson (1998), Petrella and Kou (2004)
Rainbow option	Options whose payoff depends on more than one underlying asset price (Alexander and Venkatramanan 2012)	- Strike price for each asset - Duration	- Price of each asset at considering date	Alexander and Venkatramanan (2012)

By altering some parameters, exotic options can behave exactly like standard options. For example, if the time interval of an Asian call option is set to zero, then it becomes a standard call option. Another example is a call barrier option that becomes a standard call if (i) the call barrier's up-and-in barrier is set equal to its strike price and (ii) its up-and-out barrier is set to infinity.

Table 1 also presents relevant literature on exotic options, with research topics mainly about option structures and valuation methods. Like standard options, exotic options can be valued by analytical methods (e.g. Black-Scholes model), binomial trees, and Monte Carlo simulations. The usage of analytical approach to value options, just like for standard options, often requires careful consideration of assumptions; when in doubt, practitioners can always use Monte Carlo simulation (Boyle 1977; Boyle et al. 1997) to probe the sensitivity or pricing efficiency of the models (Grant et al. 1997).

4.6 Methodology

Limitations of standard options as structures of revenue guarantees and potential flexibility provided by exotic options lead to an interesting research question: can exotic options improve revenue risk sharing in PPP projects from the perspective of three key stakeholders: governments, developers, and lenders? The approach adopted to answer this research question is underpinned and enhanced by: (1) the presence of a revenue guarantee structured as a put option within an actual PPP project, the I-77 Express Lanes (I-77) in the metropolitan area of Charlotte, NC, and (2) the availability of data and information about the I-77 project.

Accordingly, the methodology adopted follows: (1) identification and description of financial metrics of interest to governments, developers and lenders; (2) explanation and structuring of the revenue guarantee found in the I-77 project; (3) modification of the revenue guarantee in the I-77 project to include exotic option features to create alternative risk sharing structures and scenarios; (4) development of a stochastic model using the I-77 project data to simulate operational cash flows and to quantify the financial metrics of interest; (5) creation of simulation scenarios; and (6) assessment and discussion of the simulation outcomes to determine whether the exotic option risk sharing structures have comparative advantages.

4.6.1 Financial metrics of interest to the key stakeholders

The effectiveness of a PPP risk sharing agreement affects not only the interests of a government and a concessionaire but also that of a project's lenders. Once a revenue guarantee is in place, a government is acting as a guarantor and has assumed a liability, either a contingent or actual one depending on regional accounting standards. Consequently, its fundamental interest is minimizing its potential financial exposure in a period and/or cumulatively throughout a project's life due to exercised guarantees. Hence, *public loss* and its variance are reasonable indicators of government interests in a revenue guarantee arrangement.

A concessionaire is naturally interested in the cash flows that it can collect to recoup its investment. Since a concessionaire receives cash flows remaining after all other costs and liabilities are paid, *residual cash flows* and its variance are realistic indicators of concessionaire interests (generally) under a revenue guarantee structure. Unlike a concessionaire, whose residual cash flows are variable, lenders of a project receive fixed payments as long as a project can meet debt requirements. The debt service coverage ratio (DSCR) is often used to examine the health of a project's operational revenues. Annual DSCR equals the cash flow available for debt service divided by the debt service scheduled. Higher DSCRs suggest a project has greater capacity to pay its debt service; consequently, such projects get higher credit ratings. If DSCR is less than 1.0, then other resources must be exploited to support paying debt service. If the resources are not sufficient and alternative solutions such as equity infusions or refinancing are unsuccessful, then a project defaults. Therefore, DSCR and its variance is considered representative of lenders' interests.

In any given year i, each metric is generally defined as:

$$APL_i = \sum_{j=1}^{i} EX_j \qquad (4.1)$$

$$CFR_i = CFD_i - D_i \qquad (4.2)$$

$$DSCR_i = CFD_i/D_i \qquad (4.3)$$

Where:

APL – Aggregate Public Loss; EX – Guarantee payment exercised; CFR – Cash flow residual; CFD – Net Cash flow available for debt service; D – scheduled debt service; DSCR – Debt service coverage ratio.

4.6.2 Revenue guarantee in I-77 project

The I-77 Express Lanes (I-77) PPP project in the metropolitan area of Charlotte, NC is a 26-mile managed lanes project, with a total project cost of $636 million and contract duration of 50 years from substantial completion. The North Carolina Department of Transportation (NCDOT) led planning and procurement and reached commercial close with its selected concessionaire, I-77 Mobility Partners led by Cintra, in June 2014; financial close was subsequently achieved in May 2015, and the project is currently under construction with expected operations to begin in late 2018. The financial structure for the project includes:

- State public funding: $94.7 million (14.9%)
- Debt from federal government – TIFIA loan: $189 million (29.7%) with period 2023 – 2053
- Debt from PABs: $100 million (15.7%) with period 2018 – 2054
- Equity (real equity and short-term bank loans): $248 million (39.0%)
- Other sources: $4.1 million (0.7%)

The project included a revenue guarantee to share revenue risk through a contractual arrangement called the "Developer Ratio Adjustment Mechanism" (DRAM). The DRAM provisioned that, in a given year during the DRAM period from substantial completion until final maturity of the TIFIA loan, if the next year's projected annual TIFIA Total Debt Service Coverage Ratio (TIFIA DSCR) is below 1.0, then the project company is entitled to request that NCDOT make payments sufficient to cover the expected debt service shortfall (DRAM payment). The DRAM payments are, however, subject to restrictions: (1) in any year, the DRAM payment cannot exceed $12 million, and (2) during the DRAM period, the aggregate payments cannot exceed $75 million.

The DRAM is structured like a put option or multiple put options (one every year in the DRAM period) with annual caps of $12 million and an aggregate cap of $75 million. Specifically, the parameters of this put option are: underwriter – NCDOT; holder – I-77 Mobility Partners; exercise price – the shortage in cash flow for debt (up to $12 million); current price – the next year's net cash flow that makes DSCR equal 1.0; and duration – 1 year. Two features distinguish the DRAM from a simple put option: (i) the maximum aggregate exercised value of all the put options is $75 million and (ii) exercise of the option depends on *projected* net cash flow in the following year not on the actual audited net cash flow in the current year. Figure 4.6 depicts theoretical payoff of the DRAM for each party where "guarantee payable" is set at $12 million.

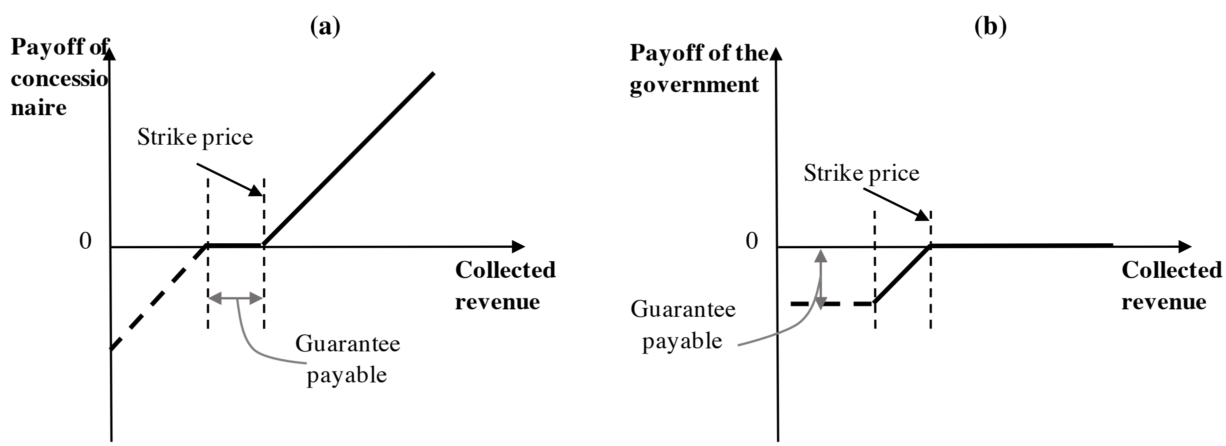

Figure 4.6. Payoffs of (a) the concessionaire and (b) the government in the DRAM scenario

4.6.3 Modification of the I-77 revenue guarantee using exotic options

The implementation of the DRAM in the I-77 project provides a unique opportunity to restructure it to explore the potential benefits of exotic features to government, concessionaires and lenders. Two exotic structures were selected based on their potential to provide previously described desirable features for revenue risk sharing: (1) a barrier option and (2) a combination of a put option and a gap call option.

4.6.3.1 The barrier put option

A barrier option is one of the most common exotic options; like other path-dependent options such as Asian and look back options, it allows the parties to integrate the project's historical business performance into the risk sharing structure; therefore, it can potentially satisfy feature (c), particularly the transfer of resources over time. Since this option structure is stricter than a standard put option because it is more difficult for the concessionaire to exercise the guarantee, an additional resource such as a reserve account must also be provisioned. This has the potential to fulfil desirable feature (a) since more alternatives are available during operations.

In order for the guarantee to be exercised, two conditions must be met. First, in a prior period (such as a previous year), the concessionaire must use its own reserves to cover any debt service shortfalls. This serves as a down-and-in barrier for the put option that will expire in one (or more) year(s). Second, if the put option is in place at its maturity, collected revenue during the current year must fail to reach the agreed amount (asset price is lower than strike price). In a particular year, the parties can find themselves in one of two circumstances: (a) put option not triggered and (b) put option triggered. In the non-triggered put option case, the concessionaire must use its debt reserve to cover the shortage in required revenue. In the triggered put option case, the concessionaire can exercise the put option if the revenue falls short of debt service requirement. Figures 4.7 (a) and (b) correspondingly demonstrate payoffs to the government and the concessionaire.

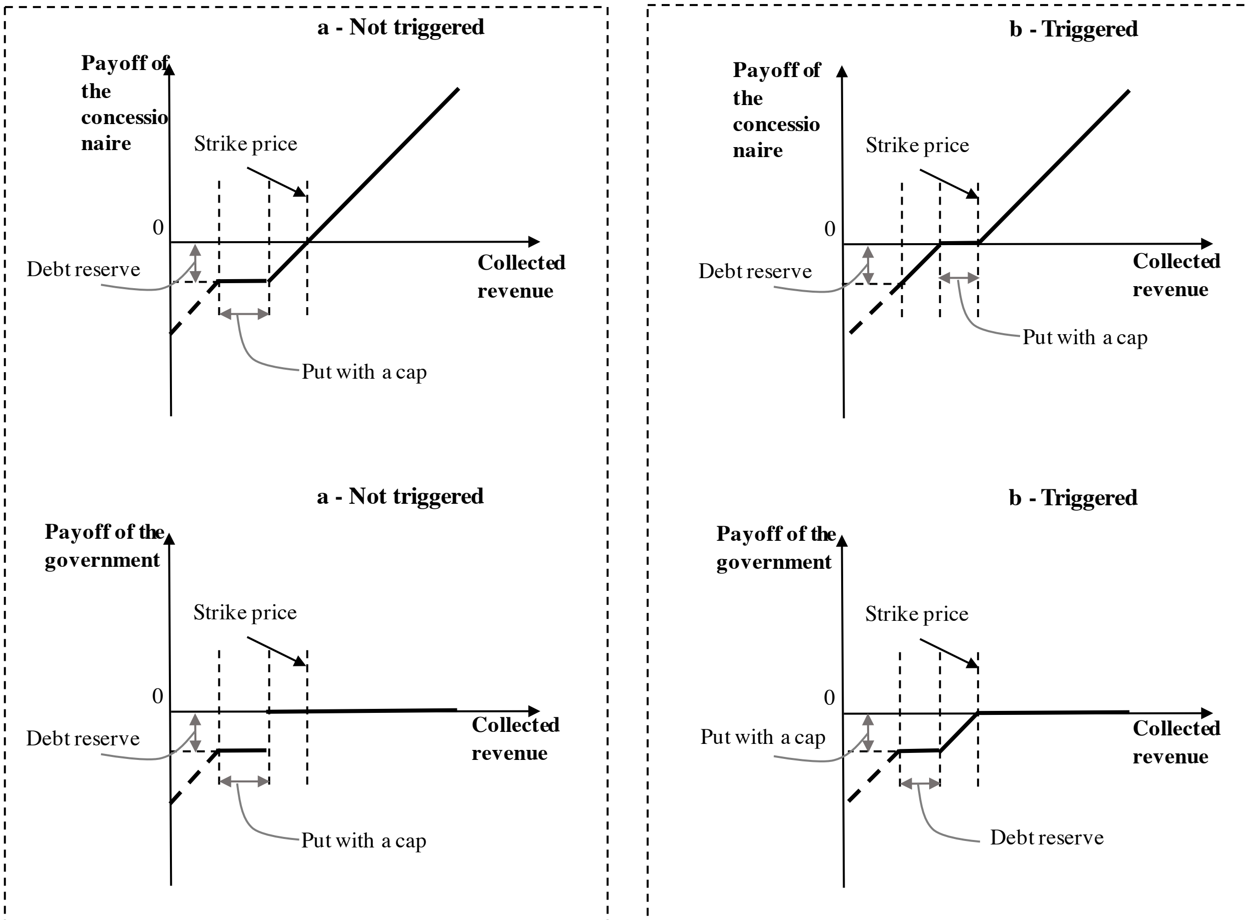

Figure 4.7. Payoff of the barrier put model in (a) not triggered and (b) triggered cases

4.6.3.2 The put option and the gap call option combination

A gap option can alter the payoffs of the two parties so that parties can adjust the sharing balance to reflect their risk preferences; therefore, it can fulfill desirable feature (b) by accounting for risk attitudes; moreover, the gap call option here is held by the government, allowing the government to claim some upside benefit from the project – this satisfies desirable feature (a). This model has two components. The first component is a standard put option guarantee to share downside revenue risk. The second option is a gap call (whose holder is the government) to split upside gains in revenue. This model is different from the standard put and call collar structure since the gap call allows the government and the concessionaire to choose the proportion split between the two parties rather than giving the government all (not just part) of the revenue gain. Figure 4.8 represents payoffs of the two contractual parties.

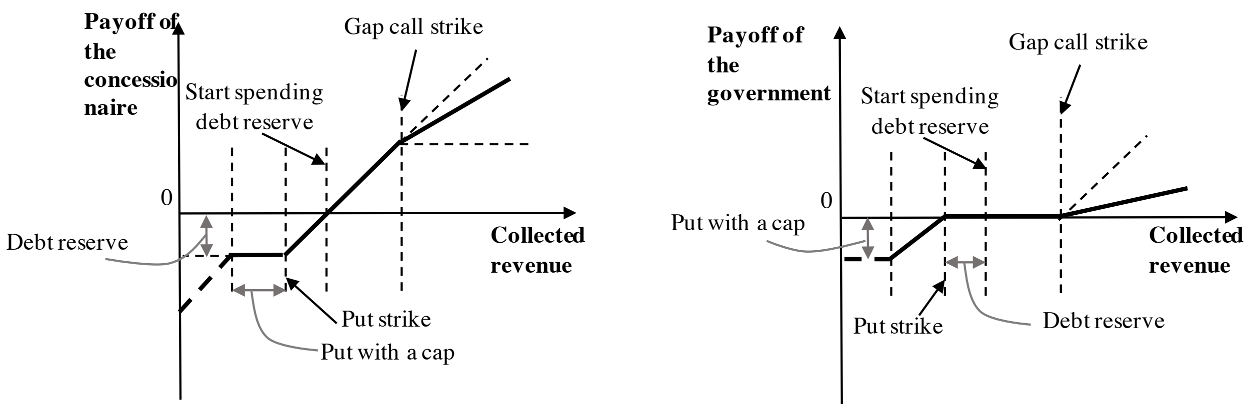

Figure 4.8. Payoffs in the put option and gap call option combination

Clearly, these two exotic models are merely representatives of the exotic option class. Other exotic features can become candidates for revenue guarantee structures as well. For example, a guarantee can be set up so that it is only exercisable if the average revenue of the project in the past n years is below a threshold (strike price) – this feature is an Asian option style.

4.7 Stochastic model of operating period using I-77 data

4.7.1 Available project data

As noted, I-77 information and data was available to support the analyses performed. Specifically, data from the project feasibility study created by a consulting agency and from the project's Bond Offering Statement created by the Citigroup and Goldman Sachs Co. – the bonds co-underwriters – was used to forecast operating period cash flows. Table 4.2 depicts a sampling of the data extracted from these sources.

Table 4.2. Project I-77 operation phase base case projection

	A	B	C	D	E	F	G	H
Year	**Revenues**	**Operating & Maintenance Expenses**	**Major Maintenance Expenses**	**Depositing/Withdrawing from Major Maintenance Account**	**Debt Service for Bonds**	**Mandatory Debt Service for TIFIA**	**Scheduled Debt Service for TIFIA**	**DSCR for both Bonds and TIFIA**
2018	4,390,500	1,065,094	-	-	416,667	-	-	7.98
2019	26,045,000	15,880,853	347,908	347,908	5,000,000	-	-	2.03
…	…	…	…	…	…	…	…	…
2022	34,928,000	17,060,932	436,120	436,120	5,000,000	-	-	3.57
2023	36,995,000	17,644,665	634,329	634,329	5,000,000	676,902	6,234,062	1.62
…	…	…	…	…	…	…	…	…
2053	109,368,000	42,944,586	3,795,698	(5,967,062)	20,070,000	6,655,723	-	2.12
2054	111,944,000	44,081,130	1,480,728	17,946,361	10,034,750	-	-	8.40
2055	114,521,000	45,246,523	1,036,450	-	-	-	-	N/A

Column A – Revenues

Column B – Operating and maintenance expenses

Column C – Major maintenance expenses

Column D – Deposits or withdrawals from Major Maintenance reserve account

Column H – Debt Service Coverage Ratio = H = (A – B – C + D) / (E + F + G)

Figure 4.9 depicts the forecast by the bonds co-underwriters.

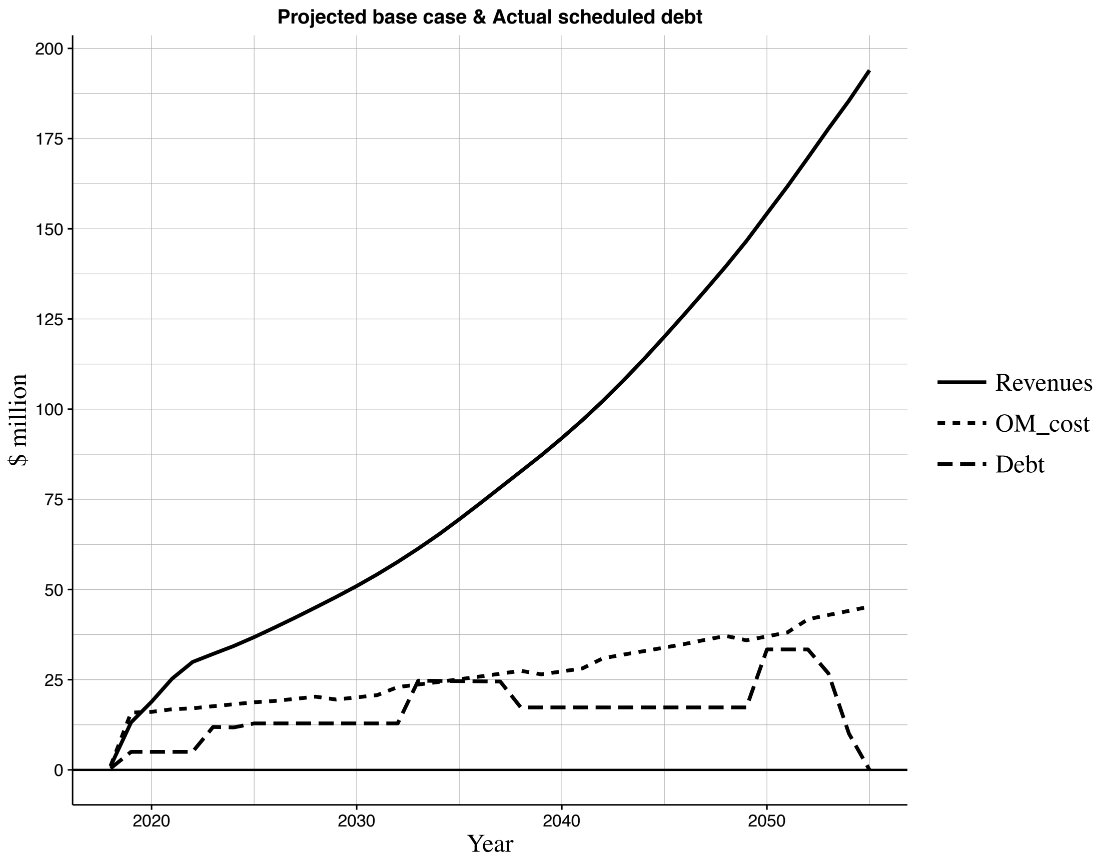

Figure 4.9. I-77 operation base case projection by lenders

Fluctuations in debt service payments were due to various maturity dates of the bond series. During the debt service period, the base case forecasts that revenue of the project develops following a clear trend after the ramp-up phase; revenue is projected to increase at 6% (2021 – 2024), 5% (2025 – 2030), 4% (2031 – 2038), 3% (2039 – 2051), and 2% (2052 – 2055).

4.7.2 Project operating accounts flow order

In the I-77 project, fourteen accounts were established for the project company such as:

- Proceeds Account
- Debt Service Payment Account

- Senior Debt Service Reserve Account
- TIFIA Debt Service Reserve Account
- DRAM Contributions Account
- Major Maintenance Reserve Account

For every project of this nature, cash flows must follow a defined order to fulfill financing responsible priority. Figure 4.10 depicts the flows of fund that were defined in I-77. This flow of fund and the established accounts may be considered resources for different features of risk sharing mechanisms.

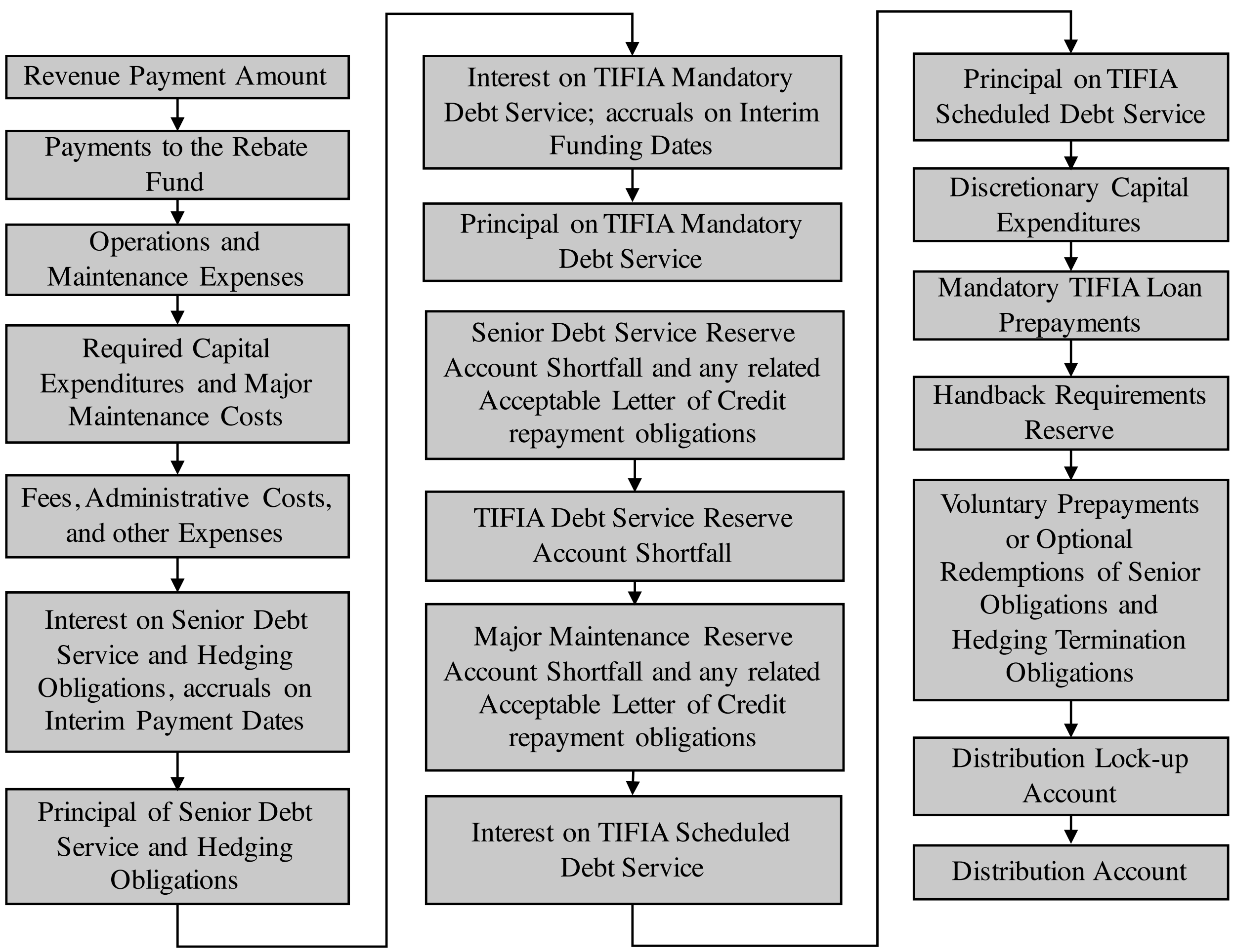

Figure 4.10. Flows of fund in I-77 (Tax-exempt Private Activity Revenue Bonds – Series 2015, page 132)

4.7.3 Modeling assumptions

Table 4.3 briefly presents inputs and assumptions in the stochastic model.

Table 4.3. Modeling input and assumptions

Input factor	Selection/Assumption	Justification	Note
Projected revenues and costs	Base case projection by project lenders	The lenders' projection is more conservative than the feasibility study's projection: "the long term growth assumptions [of the feasibility study] were optimistic] and should be reviewed" (Tax-exempt Private Activity Revenue Bonds – Series 2015, page 162)	Two sources of projections available for this project: the feasibility study and the lender's projection.
Cash flow discount rate	r = 6%	Using the weighted average capital cost estimation	Total private equity from the project company is $248 million, in which the ratio of bank loans and equity from investors was not revealed. Therefore this project's WACC was assumed.
Revenues' distribution, O & M distribution	A time series normal distribution with standard deviation sd1 = 0.3 (ramp-up) and sd2 = 0.15 (settled operation). Standard deviation of O & M cost is sd3 = 0.1		Literature did not focus much on how to select standard deviations for revenues for simulation; thus these values are assumed. However, Flyvbjerg et al. (2006) reported that settled operation phase tends to be more predictable than ramp up phase; therefore sd1 > sd2.
Tax effects	Not considered	This case considers comparison within different scenarios, therefore tax effects can be ignored	Taxes have effects on investors due to different tax brackets that a year revenue can fall in. These matter more in calculating internal rate of return than in this A/B testing
Inflation	Not considered	Since (i) this case considers comparison within different scenarios and (ii) throughout the project lifetime, the base case features US dollars in 2018, inflation can be ignored for the study's purpose	In fact, inflation can be integrated in the cash flow discount rate if necessary.
Number of trials	n = 1,000; 5,000; 10,000	Different number of trials to capture changes in simulated results	

4.7.4 Modeling project operational period

The model constructed features two time-series of the revenues and the O&M costs. Net cash flow for debt service (CFD) – a time-series itself – is obtained by subtracting the two time-series:

$$\text{CFD} = \text{Revenue} - \text{O\&M cost} \qquad (4.4)$$

Geometric Brownian Motion (GBM) has been used commonly in literature to build stochastic models of revenues in infrastructure projects (Carbonara et al. 2014; Chiara et al. 2007b; Iyer and Sagheer 2011; Mattar and Cheah 2006; Menassa et al. 2010; Takashima et al. 2010). If S_t is the revenue in year t, then the differential equation of S_t shows:

$$dS_t = \mu S_t d_t + \sigma S_t dW_t \qquad (4.5)$$

Where: μ is a constant, representing a deterministic trend; σ is a constant, representing volatility; and W_t is a standard Brownian motion and dW_t is a standard Wiener process ($dW_t = \varepsilon\sqrt{dt}$; $\varepsilon = N(0,1)$)

In equation (5), the first element expresses the development of the project revenue when the project evolves while the second element expresses "noise" or volatility given by exogenous causes. The deterministic trend of the project revenue can use projection of the lenders as noted (e.g. 6% in 2021 – 2024, 5% in 2025 – 2030, 4% in 2031 – 2038) while volatility σ can be assumed. To obtain a more comprehensive assessment of the noise element in equation (5), we can break it down to:

$$\sigma S_t dW_t = \sigma_1 S_t dW1_t + \sigma_2 S_t dW2_t \qquad (4.6)$$

Where: $\sigma_1 S_t dW1_t$ is a stochastic process that presents "local" impact (endogenous risk of the project – similar to non-systematic risk in financial market) and $\sigma_2 S_t dW2_t$ presents "global" impact (exogenous risk of the project – similar to systematic risk in financial market). "Local" means risks that distinguish I-77 from other highways; whereas "global" means external risks that affects revenues of all highways in the area.

However, available data do not allow to break the volatility down as in (6) and for the shake of simplicity, $\sigma S_t dW_t$ represents both "local" and "global" factors with σ equals 0.3 in ramp-up phase and 0.15 in settled operation phase as argue in Table 4.3.

Similar approach is applied to calculate O&M cost since the lenders also projected its trend. The difference is that its volatility is unchanged in both ramp-up and settled operation phases.

4.8 Simulation scenarios

Four scenarios were created to assess the alternative risk-sharing structures. For each scenario, a Monte Carlo simulation was conducted on R Studio Integrated Development Environment (IDE) to generate results on the metrics of interest - public loss, residual cash flows, and DSCR. All key variables were considered in the form of (1) expected values and variances, as risk-neutral individuals would prefer and (2) value-at-risk, as risk-averse individuals' would likely prefer since risk-averse individuals care more about what they can lose rather than what they can earn (Tom et al. 2007).

4.8.1 Scenario 1: No guarantee

This scenario is one where the government does not provide any guarantee to the concessionaire to support debt service payments. It provides an indication of the project's viability based on the forecasted data.

The variables that represent different stakeholders' interests are calculated as:

$$CFR_i = CFD_i - D_i \qquad (4.7)$$

$$DSCR_i = CFD_i/D_i \qquad (4.8)$$

Where:

CFD – Net Cash flow available for debt service; D – scheduled debt; CFR – Cash flow residual (for investors); DSCR – Debt service coverage ratio

4.8.2 Scenario 2: DRAM

This scenario follows the actual agreement in the contract introduced earlier. This scenario is the baseline for comparing the modified guarantee structures.

The stakeholders' interest variables in this scenario are calculated as:

$$CFR_i = CFD_i + DRAM\_X_i - D_i \qquad (4.9)$$

$$DSCR_i = CFD_i / D_i \qquad (4.10)$$

$$APL_i = \sum_{j=1}^{i} DRAM\_X_j \qquad (4.11)$$

Where: DRAM_X – exercised DRAM; APL_i – the cumulative exercised of the DRAM in year i (the public's loss).

4.8.3 Scenario 3: Barrier put (with cap) option

This scenario modifies the revenue guarantee to incorporate a barrier option as previously described; note a TIFIA reserve account already exists and is operated by the I-77 concessionaire of I-77, so the TIFIA account is a means for the concessionaire to store surplus revenue and transfer the resources through time.

The down-and-in put option is designed with parameters as in Table 4.4.

Table 4.4. Scenario 3 - barrier put option's parameters

Parameters	Value	Note
Type of option	Barrier down-and-in put	
Option's writer	Public (NCDOT)	
Option's holder	The project company	
Underlying asset (S)	Revenues	
Barrier	X	X = $ 5,000,000 in the simulation
Strike price (K)	Revenue that makes DSCR = 1.0	
Option duration	n years	n = 1 year in the simulation

Note that actual restrictions from public budget, such as maximum yearly exercisable ($12 million) and maximum aggregate guarantee ($75 million), are still kept.

In years where the revenue has a surplus, the concessionaire must replenish the reserve account with the surplus revenue before distributing to investors; this does not conflict with the actual flow of funds order.

The stakeholders' interests in year i are calculated as:

In year i:

$$CFR_i = CFD_i - D_i - DEP_i \qquad (4.12)$$

$$DSCR_i = (CFD_i + EX_i + W_i - DEP_i) / D_i \qquad (4.13)$$

$$APL_i = \sum_{j=1}^{i} EX_j \qquad (4.14)$$

In the last year of debt service (year n), the project company is entitled to any balance in the TIFIA reserve account:

$$CFR_n = CFD_n - D_n + A_n \qquad (4.15)$$

Where: W_i – withdrawal from the TIFIA Account (equals 0 if the put option is exercised under $12 million); DEP_i – deposit to the TIFIA Account (equals 0 if there is no surplus or maximum TIFIA requirement is reached); A_i – current balance of the TIFIA Account.

4.8.4 Scenario 4: Put option (with cap) + a gap call

This scenario modifies the revenue guarantee to introduce a put with a cap and a gap call as previously described; for the gap call structure, the government's proportion of revenue gains split between it and the concessionaire is determined as follows:

$$\text{Payoff of the government} = y^*(\text{Revenue} - \text{Strike price}) \qquad (4.16)$$

Where y is the percentage for the government's share that would be negotiated by the parties. In the simulation, y is varied to explore how it affects the objectives of the different parties.

If NCDOT wants to expose itself to more risk in trading for more potential rewards, it can do so by raising maximum yearly exercisable and/or maximum aggregate guarantee to treat the downside of revenue risk. In trading for that, on the upside, the two parties must split profits, if the profits meet some requirement. A gap call is proposed in Table 4.5:

Table 4.5. Scenario 4 - gap call's parameters

Parameters	Value	Note
Type of option	Gap call	
Option's writer	The project company	
Option's holder	Public (NCDOT)	
Underlying asset (S)	Revenues	
Strike price (K)	Revenue that makes DSCR = x	x is subject to parties' estimation and negotiation
Payoff	S' – K	
Gap (S')	S' = y*(S – K)	y is subject to parties' estimation and negotiation
Option duration	1 years	Less than 1 year after audited operating data are available

For the regular put: variables are computed similar to the DRAM case but with increased maximum yearly and aggregate exercisable.

For the gap call:

$$\textit{if} \text{ (there is surplus) } \textit{then} \ \{EX\_gap_i = \max\{0, y^*(CFDi - x^*Di)\}\} \quad (4.17)$$

$$CFR_i = CFD_i - EX\_gap_i \quad (4.18)$$

$$APL_i = \sum_{j=1}^{i} EX\_put_j - \sum_{j=1}^{i} EX\_gap_j \quad (4.19)$$

Where: EX_gap – exercisable of the gap call option; EX_put – exercisable of the put option.

Please see Appendix 4 for detailed pseudo codes of each scenario.

4.9 Results

4.9.1 The lenders' interest – Debt Service Coverage Ratio

Figure 4.11 depicts 90% confidence of DSCR during the committed debt service period. The higher the DSCR is the less credit risk the lenders face. For bond holders, high DSCR will enhance the bonds' liquidity. The "No guarantee" scenario yielded the most dangerous expected outcome for DSCR: from the project commencement in 2018 to 2028, there are periods that DSCR can vary less than 1.0. Moreover, the ramp-up phase (2018 – 2021), the project is in financial trouble because even the mean of DSCR goes less than 1.0: the project may default or at least needs refinancing. Or the other three scenarios perform much better except for small areas of DSCR possibility of the DRAM and the "barrier put" in the ramp-up phase go below 1.0. The "put and gap call" yielded the safest project credit expectation.

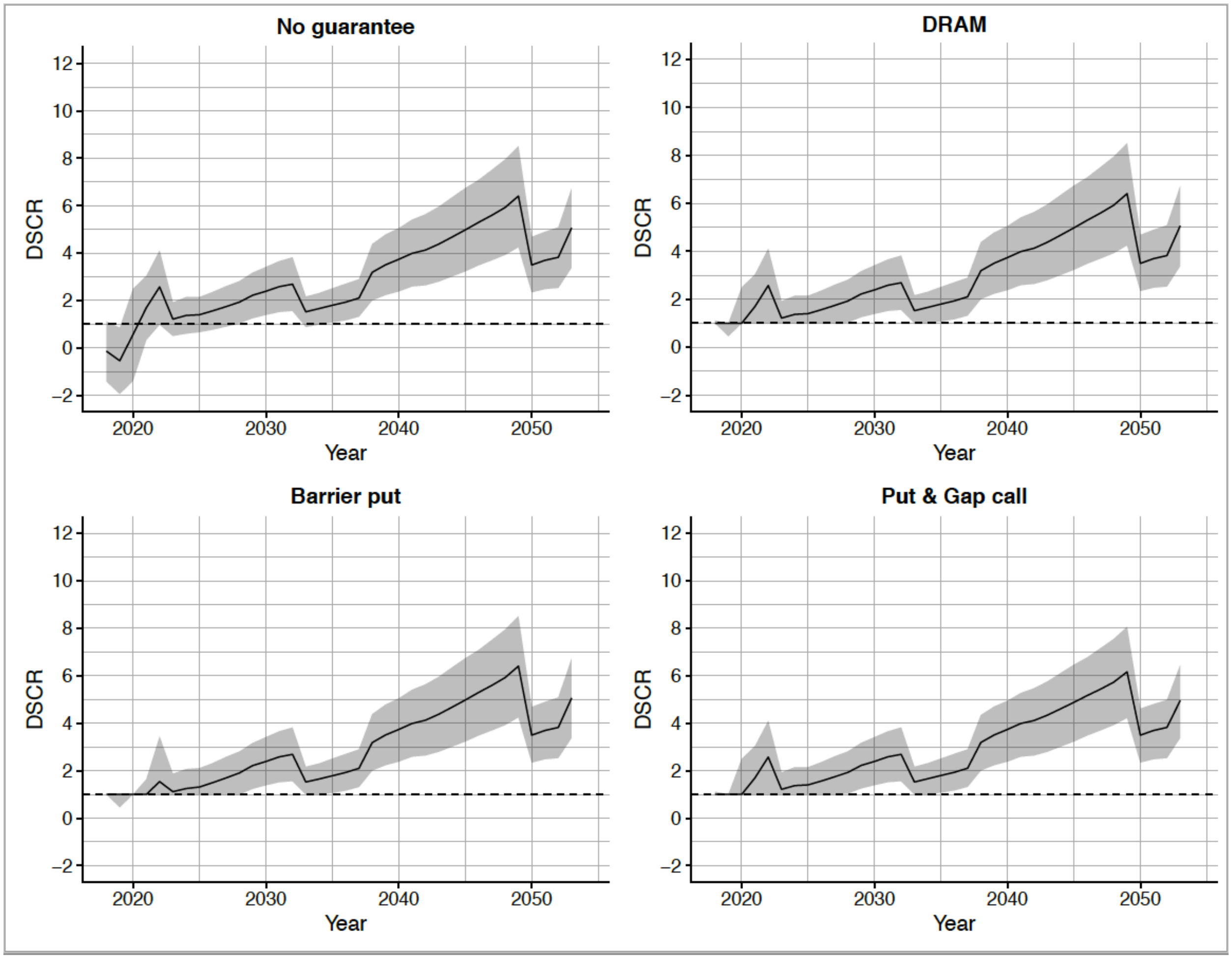

Figure 4.11. 90% confidence of DSCR in different scenarios

Figure 4.12 delineates 95% value-at-risk of the DSCR. In this figure, the "no guarantee" scheme shows its disadvantage in DSCR performance clearer.

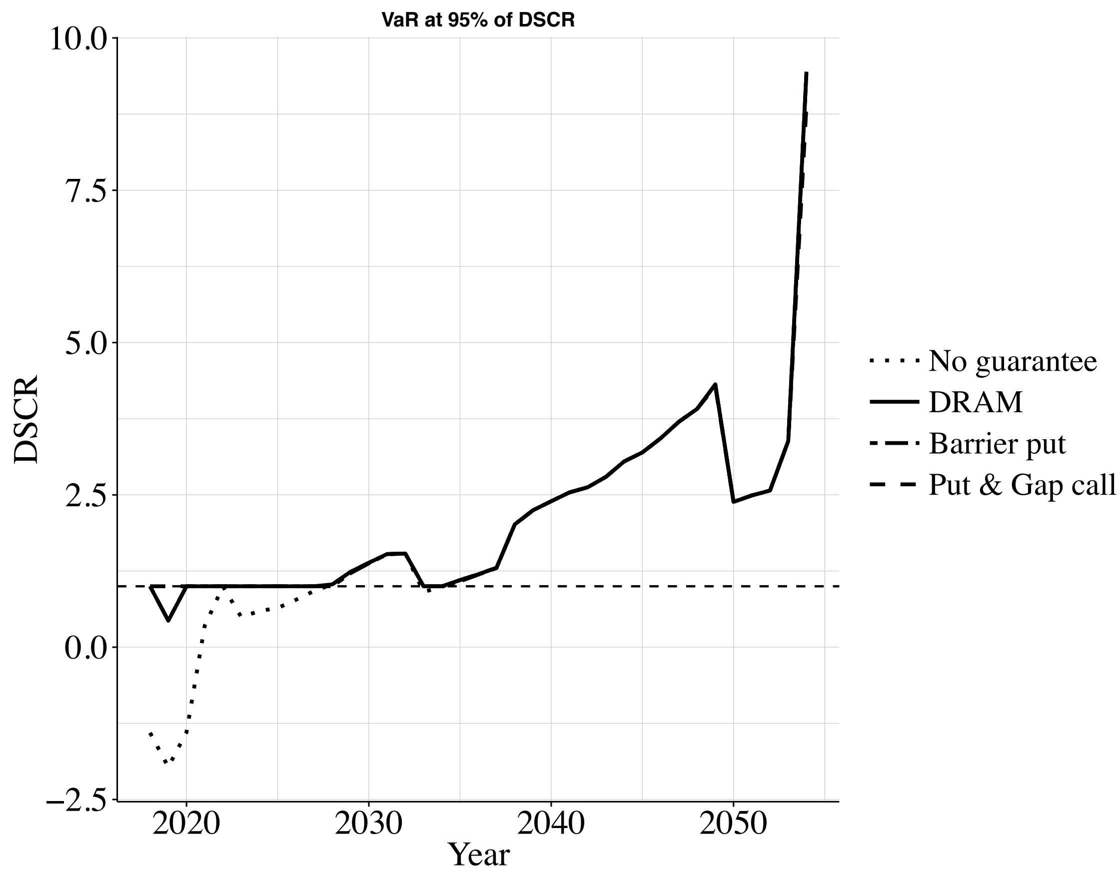

Figure 4.12. Value-at-risk at 95% of DSCR (95% confident that DSCR will be greater than the shown values)

4.9.2 The government's interest – Public's loss

At time intervals, aggregate public's losses are total cash out flow from NCDOT budget from the beginning of operation to those dates. Figure 4.13 depicts 90% confident of public's loss in three guarantee scenarios while Figure 4.14 shows value at risk at 95% of this variable.

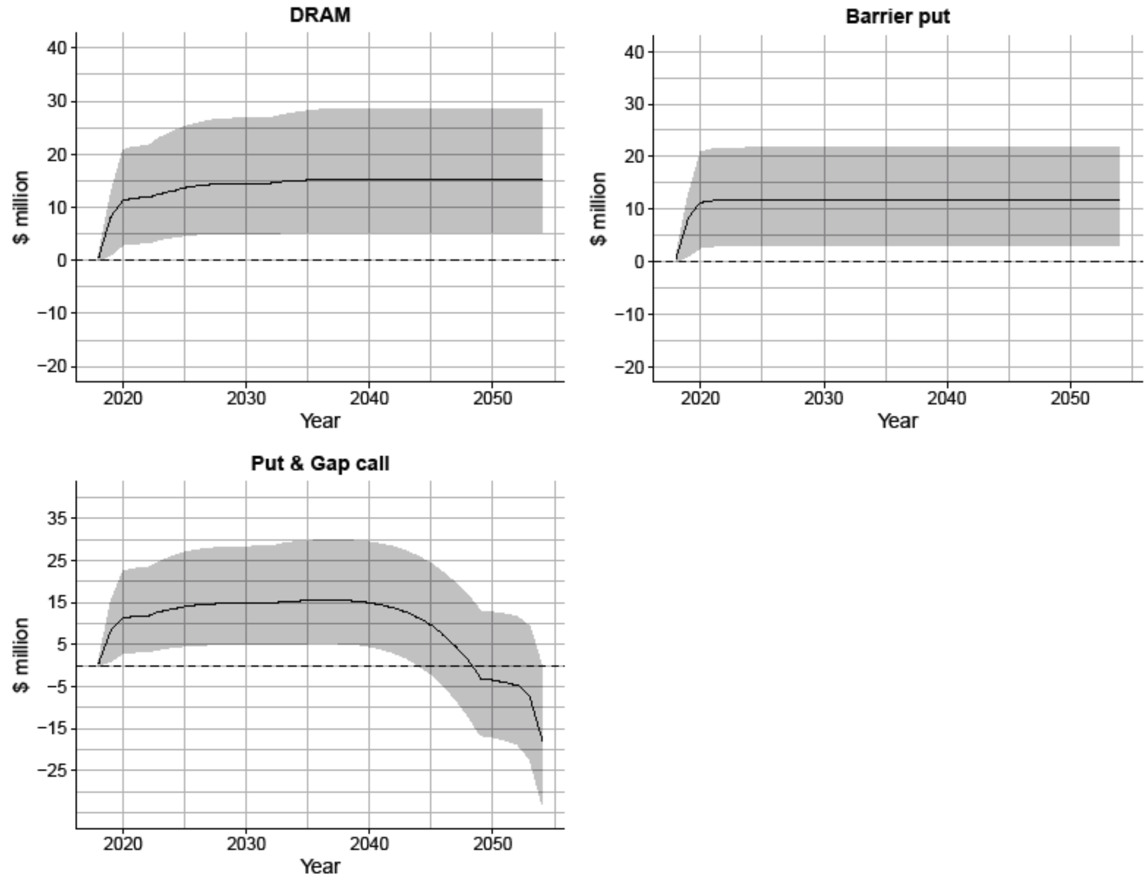

Figure 4.13. 90% confidence of public's loss in different scenarios

In Figure 4.13, DRAM has the expected public loss about $15 million and its 90% confidence variance ranges from $5 – 28 million. The "barrier put" performs better in the perspective of the government: it expects to lose only $12 million in total and the scenario's outcome is more predictable too ($3 – 22 million). The "put and gap call" scenario seems to expose the government to more risk when it slightly raises the public's loss at peak. However, this scenario allows the aggregate loss of the government to reduce by letting the government collect some revenues so that at the end of the debt service period, the government is 95 percent confident that its loss will be less than 0 (Figure 4.14).

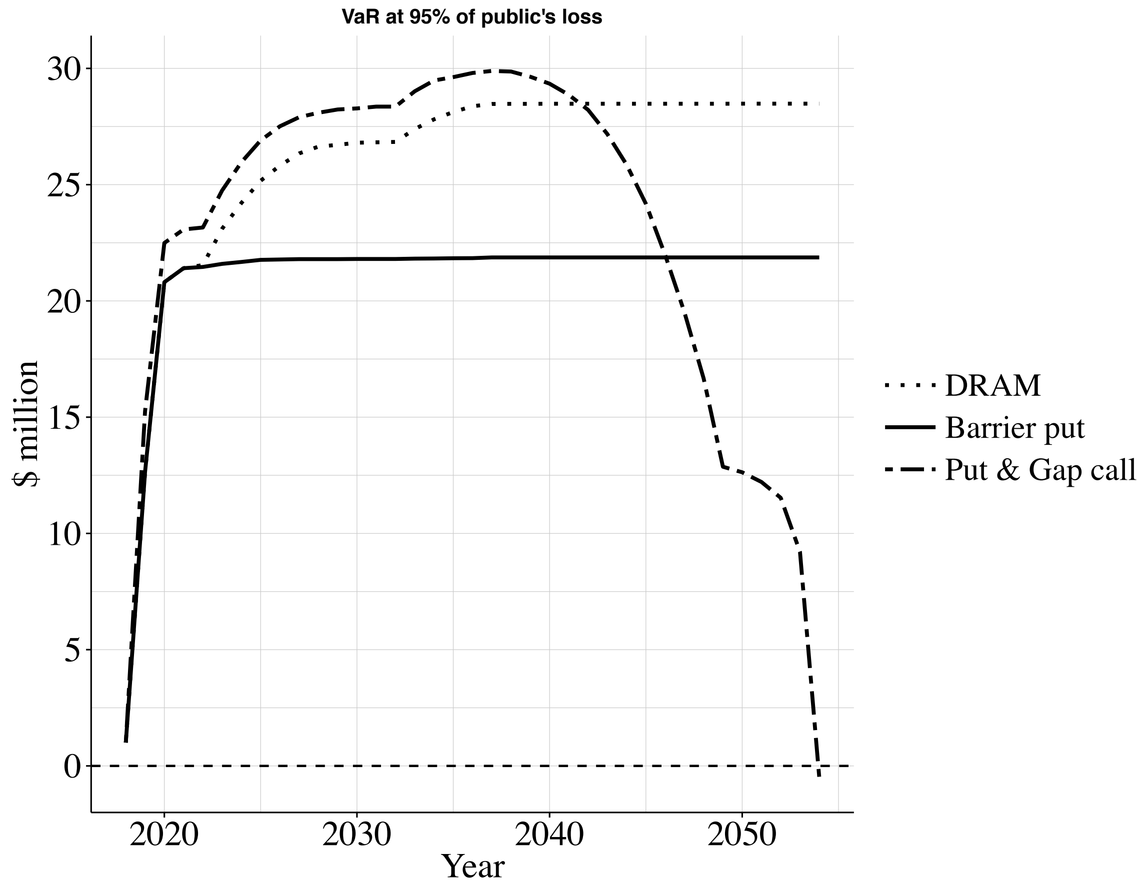

Figure 4.14. Value-at-risk at 95% of public's loss (95% confident that public's loss will be smaller than the shown values)

4.9.3 The concessionaire's interest – Residual cash flows for distribution

While interests of the lenders and the public authority are the DSCRs and the aggregate exercised values, respectively, the interests of the private equity investors are the project time value of cash flows. Figure 4.15 depicts 90% confidence level of time value cash flows and Figure 4.16 shows value at risk at 95% of time value cash flows.

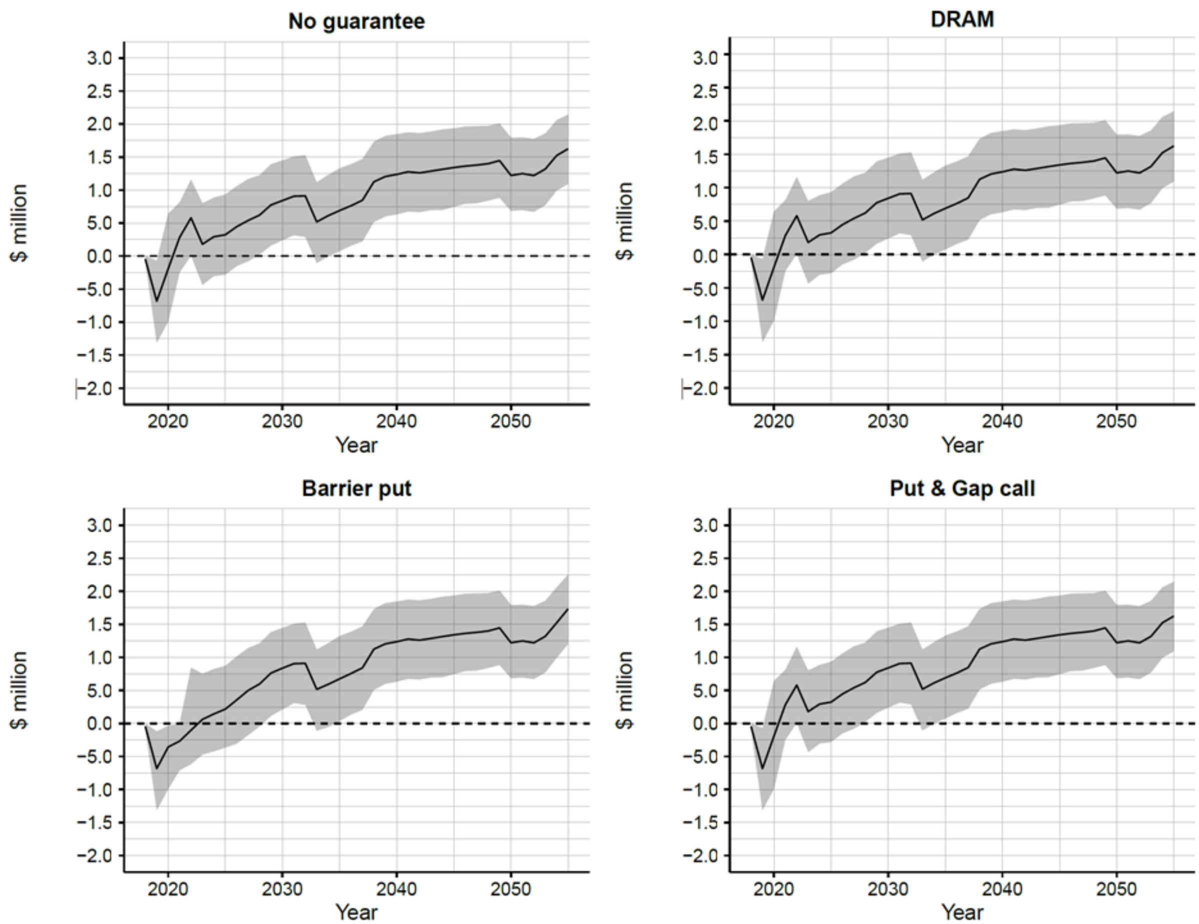

Figure 4.15. 90% confidence of cash flow in different scenarios

Figures 4.15 and 4.16 do not show too much difference in long-term expectation of the private residual cashflow; except in “barrier put” scenario, the private investors would have to wait longer to receive their dividends. The “barrier put” and the “put and gap call” are different from the DRAM in which the two exotic approaches both require the concessionaire to extract some revenues to replenish the TIFIA account. The concessionaire will be compensated at the end of the debt service period by claiming the residual amount left in the TIFIA account. However, due to time value factor (in this case the wacc equals 6%), the present value of the residual of the TIFIA account is diminished, hence the loss of the concessionaire if compared to the DRAM.

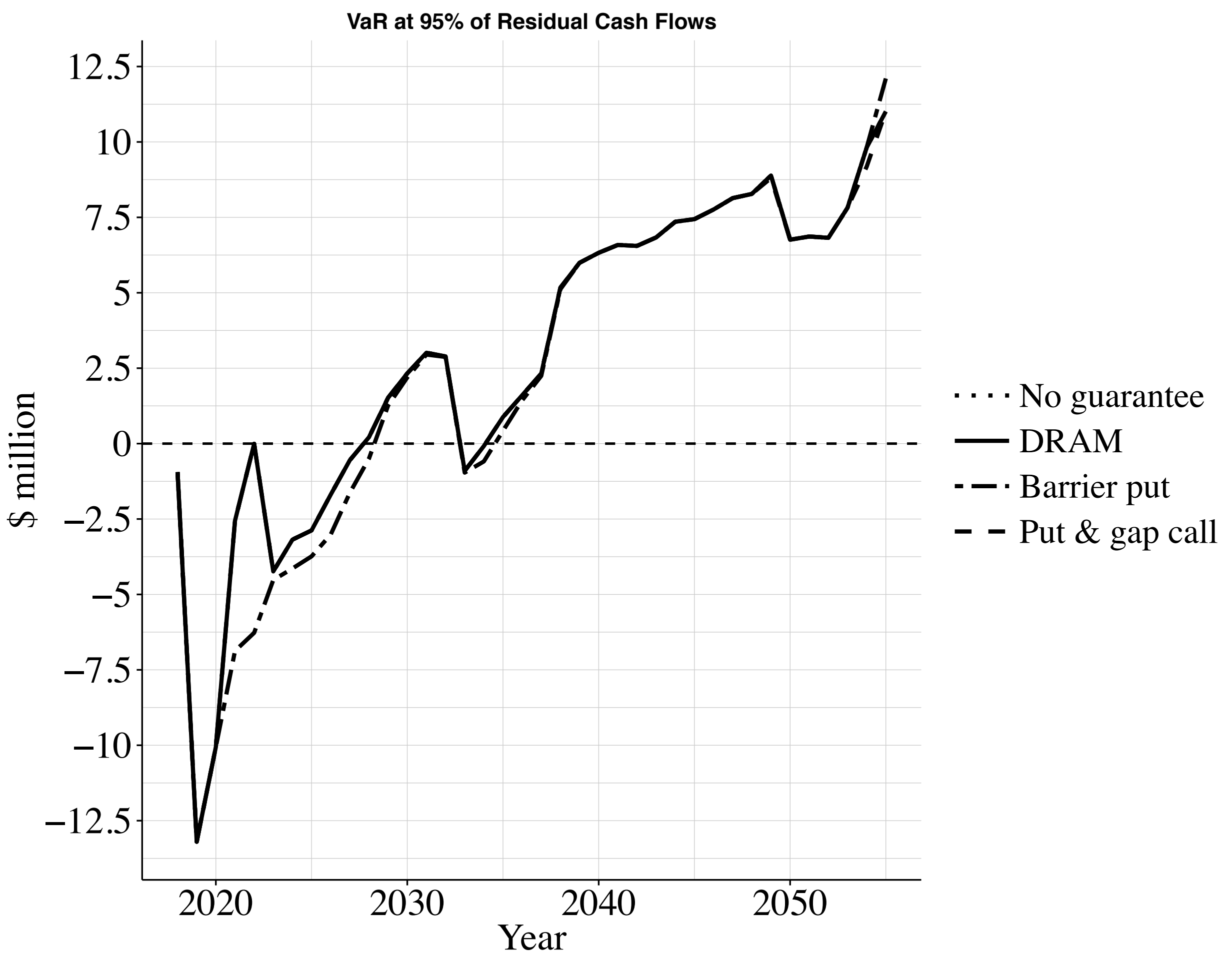

Figure 4.16. Value-at-risk at 95% of cash flow for distribution (95% confident that equity investors will receive cash flow greater than the shown value)

4.10 Discussion

Scenarios 1 and 2 (S1 and S2) simulated results for a no guarantee situation and the DRAM in the I-77 project respectively while Scenarios 3 and 4 (S3 and S4) simulated modifications to the I-77 guarantee structure with a barrier option and put plus gap call options respectively. In general, S3 and S4 with adjustable option parameters are flexible enough to shift the revenue risk balance between the government and the private concessionaire. Figure 4.17 depicts this idea and illustrates how to adjust the parameters so that the sharing structures will shift according to each parties' desires and risk preference. To the left end of the axis means that the government bears more risk (and corresponding rewards) and vice versa for the private toward the right end.

For instance, a risk averse entity would use value at risk values and rank scenarios S4 > S2 > S3 in terms of risk exposure for the government; whereas, an entity with a risk neutral attitude would likely use expected values and rank scenarios S2 > S3 > S4 for the same purpose.

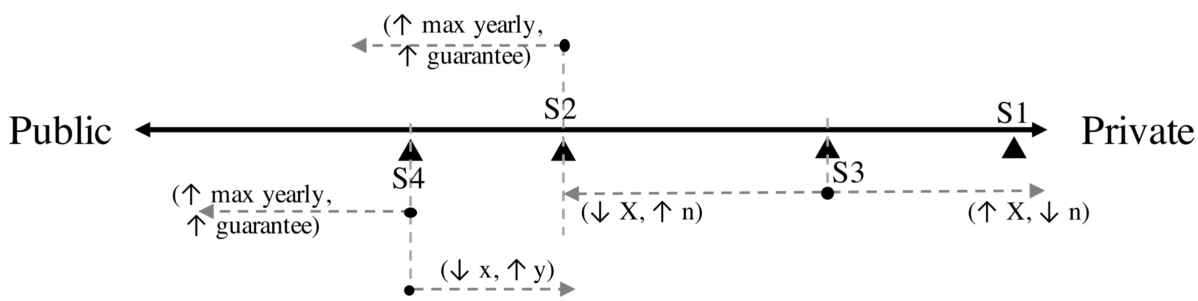

Figure 4.17. Relative positions of scenarios on risk continuum and how they can be adjusted

Compared with S2 (DRAM), S3 (barrier) and S4 (put-gap call) have shown that they can enhance benefits for the government (the public's losses are reduced) while not significantly compromising the interests of the lenders (DSCR are kept stable) and the private investors (residual cash flows are not significantly reduced). This is seemingly unreasonable since the revenue risk situation here is no more than a zero-sum game. However, the augmented values that come from the new structures employing exotic options are clear since in S3, the TIFIA reserve account was actually in place but unused in provisioning the guarantee. Therefore, the problem is not only one of how to modify the risk-reward balance in a zero-sum game but also with how to use resources better. Another potential benefit can be realized when considering the TIFIA reserve account in the contract is that the transparency of the project operating business may be enhanced. For S4 to be used, the public party needs to shift its risk behavior from "risk averse" toward "risk neutral" to accept higher value at risk.

Although the simulation focused on revenue risk and utilized only two types of exotic options, it shows the potential applicability of exotic options in PPPs. First, not only can exotic real options be applied in all situations that are applicable to standard real options but exotic options are more flexible than standard real options. Once resources available for parties are fixed, standard real options only provide limited choices of expected outcomes for the parties; whereas changing parameters of exotic options provide parties with greater range of expected outcomes (see Figure 4.17). Second, these exotic option candidates on revenue risk promise a new line of various risk sharing mechanisms to match different hedging needs of parties such as barrier options and Asian options for revenue risk, binary options as rewards for availability and service performance, and barrier options for force majeure and latent defect risks. Finally, the added flexibility from exotics options does not come without cost. For instance, compared to the DRAM provision, the barrier put option requires usage of the TIFIA reserve account in the contract. This, however, provides parties an opportunity to review resources available to them in managing the project, possibly contributing to better use of these resources and enhancing the project's transparency.

4.11 Conclusion

Revenue guarantee has been a popular approach for the governments to share revenue risk with the concessionaires in highway PPPs around the world. To date, a majority of revenue guarantee structures in practice and in research have considered standard put and/or call options. Despite their popularity, these standard option approaches have disadvantages such as their disregard of parties' risk preferences and inability to incorporate path dependence. By addressing the limitations of standard options as means to structure revenue guarantees revealed desirable features that future revenue guarantees could have. Consequently, this research introduces a potential direction in using real option theory in sharing highway revenue risk via exotic options. Exotic options can increase the risk sharing degrees of freedom and take into account path dependent features of a transaction, thereby enhancing the guarantee structure flexibility and potentially satisfying desirable features of the next generation of revenue guarantees and better supporting major stakeholders' interest.

The I-77 project, a current highway PPP project in the US, provided the opportunity to explore the applicability of exotic options as a means to modify revenue guarantee structures. In the project, a put-option-like guarantee delineated as a DRAM was utilized. Based on actual data, two alternative revenue risk sharing candidates were proposed: a barrier put option and a combination of a put option and a gap call option. Simulations were conducted using the project's data. Key measures representing the interests of the government (public loss), concessionaires (residual cash flows), and lenders (DSCR) were analyzed and compared to assess the applicability of exotic option candidates over the actual put option agreement. Compared to the standard option approach, the exotic option approaches enhance the project's credit by stabilizing its DSCR and give the government and the concessionaire a wider range of options to select their desired risk sharing balance.

Governments, concessionaires, contract designers, and project managers focused on project-based investments may see benefits from this research in several aspects. First, a tranche of relatively innovative tools is introduced to enrich these practitioners' arsenal to deal with abundant risk in infrastructure PPPs. Appropriately designed, these exotic real options can be more flexible than standard real options in creating revenue risk sharing models. Second, this research opens an avenue for risk management research with these rather novel exotic approaches, not only for revenue risk but also for other important risks that highway PPPs' parties have to face.

As a primary effort in literature toward using exotic options in project-based investments, this study has some limitations that can be addressed in future research. First, this research only aimed to introduce exotic options by showing a non-exhaustive sample that includes barrier and gap options. Many other types of exotic options also have potential in structuring PPP risk sharing arrangements. Second, this research does not examine analytic valuations of these exotic options. Future research can examine this topic to make contract parties more confident about actual usage of these approaches if they are able to calculate the analytic values of revenue risk guarantees. Future research can also investigate the usage of exotic option techniques in a broader scope, including routine-like situations in project management that requires no contractualized formation.

4.12 Acknowledgements

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5 Chapter 5: Summary, Contributions and Future Research

5.1 Summary of Findings

My research was designed to address contract issues that are primarily a consequence of bundling through three distinct but related studies: risk allocation in PPP highway contracts, state of practice in PPP contract design, and incorporation of new revenue risk sharing features in PPP contracts.

The first and the second studies both investigated critical aspects of 21 US highway PPP contracts to determine risk allocation, assess contract designs, and evaluate risk sharing mechanisms; the findings indicate public and private parties' selection of contractual strategies to govern PPPs. Figure 5.1 illustrates findings from Study 1.

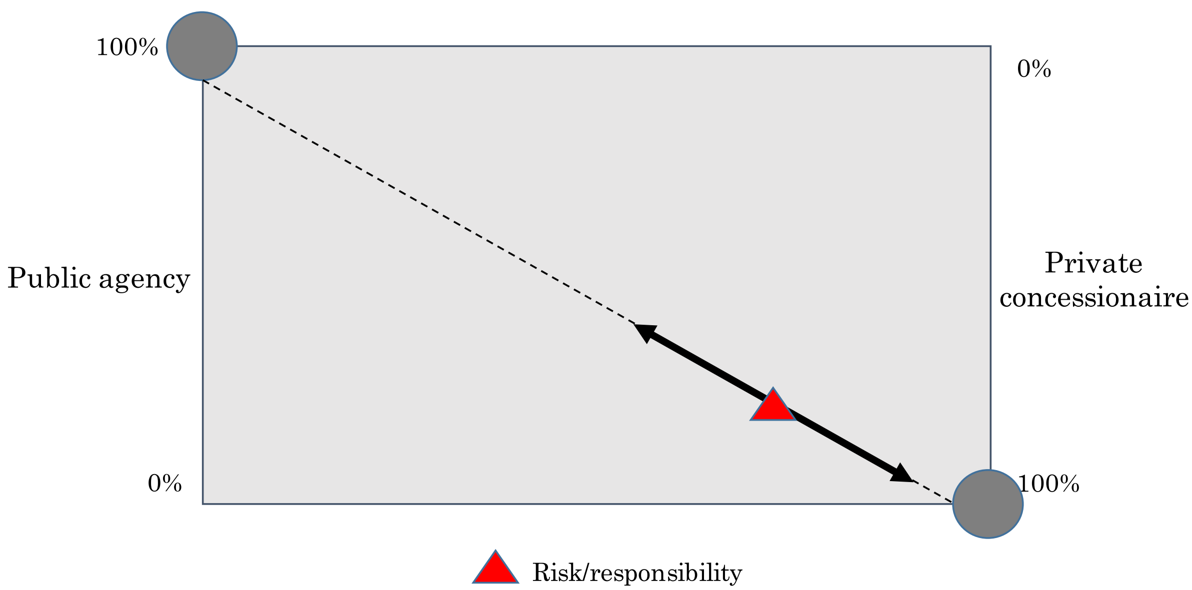

Figure 5.1. Illustration of Study 1's results: Risk allocation

The position of the "risk/responsibility" icon in Figure 5.1 shows that most risks were transferred to the private sector or shared; interestingly, more risks were shared in the US market compared to similar studies in other markets such as Australia and the United Kingdom. Consequently, the prevalence of risk sharing introduces variance in the risk allocation.

Study 2 found that contract designs were geared toward public agency oversight and control rather than concessionaire empowerment (the study's first avenue of inquiry), resulting in the position of the "decision rights" icon closer to the public agency; in other words, the expected influence of bundling on the distribution of risk and ownership/decision rights was not observed (see Figure 1.2); these are depicted in Figure 5.2.

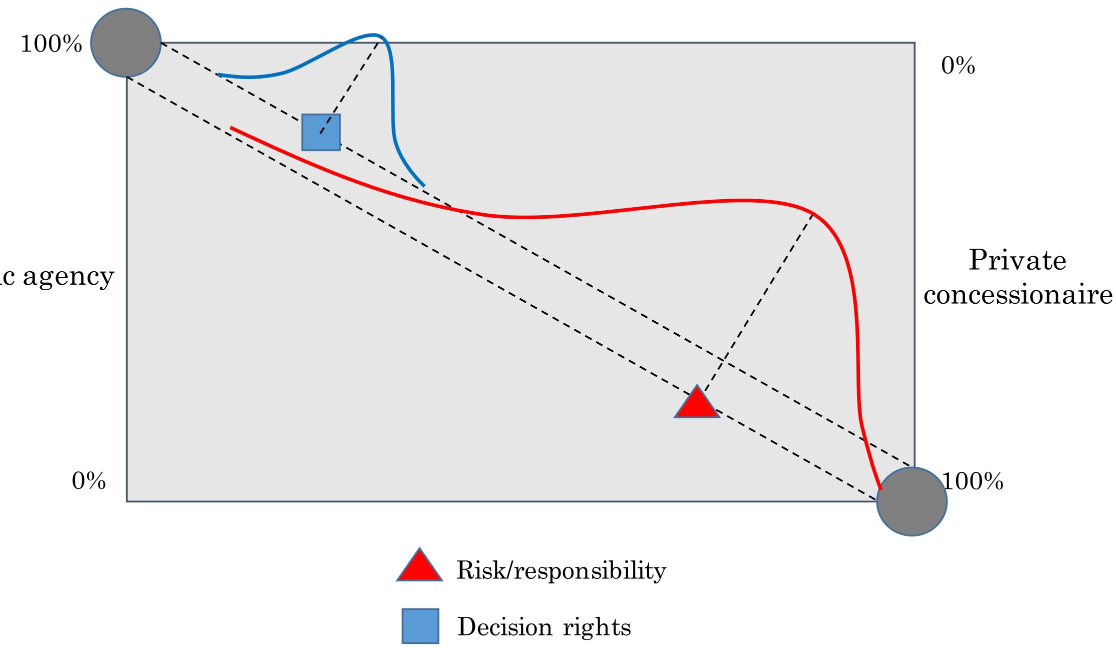

Figure 5.2. Illustration of Study 2's results: distribution of decision rights and risk/responsibility

Public agencies have yet to move toward this perspective; the agency problem persists, and governments preferred to maintain the majority of the decision rights, despite the fact that most lifecycle risks were assumed by concessionaires. Contracts were not identical, so some variance in practice exists. Study 2 also found that risk sharing provisions make substantial use of event mechanisms, and these mechanisms rely on ex post determination (the study's second avenue of inquiry). Consequently, contract designers tend to leave these aspects of a contract incomplete intentionally. Hence, uncertainty and incomplete contracts that relied on ex post resolution suggest an extensive spread in risk allocation, which is depicted notionally in Figure 5.2; in other words, which party ultimately bears many risks is unknown ex ante due to the open-ended nature of many risk sharing mechanisms.

The final study investigated whether alternative option structures could improve more typical revenue guarantee structures that employ standard put and call options. It capitalized on the presence of a revenue guarantee, called a DRAM, in the I-77 PPP project in metropolitan Charlotte, NC. Exotic option structures – a barrier put and a put and a gap call – were introduced to assess whether they provided comparative advantages over standard structures. Data from the I-77 project was used for the quantitative analysis performed. Figure 5.3 schematically demonstrates the distribution of outcomes offered by the various scenarios analyzed.

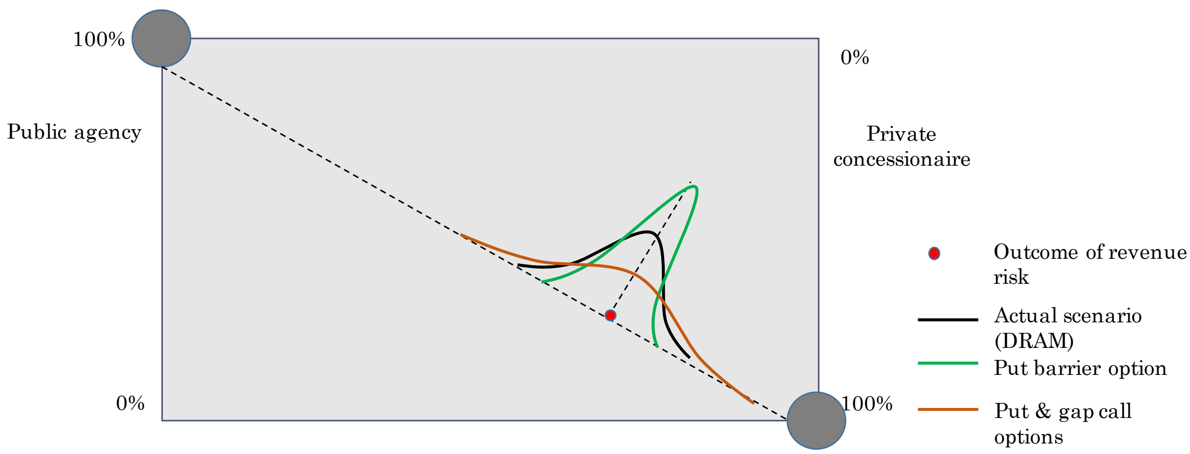

Figure 5.3. Variance of risk in revenue guarantee scenarios in Study 3

Findings of Study 3 indicated that the exotic structures had advantages over the standard option scheme in satisfying the PPP stakeholders' interests. Moreover, exotic features offered a variety of choices of revenue guarantee structures that may be better tailored to different needs and risk preferences of the government and the private concessionaire. Risk preferences will dictate which structure is preferred; for instance, a risk-averse public agency will prefer the put barrier option over the DRAM.

5.2 Contributions and Implications for Practice

My dissertation focused on PPP contracts; contracts are central in project-based industries and even more significant in PPPs where a contract is the foundation of a long-term relationship between public and private entities that have partnered for the provision of infrastructure services. The contract establishes the nature of the relationship and should balance the interests of the parties. Consequently, the contributions of the research and the implications for practice are derived from the source of the data and how contracts were formed to address the objectives of PPP project stakeholders – particularly, public procuring agencies and private concessionaires.

5.2.1 Data set and content analysis framework

Despite the centrality of contracts in PPPs, very little research in this realm has used them directly as a source of data. Perhaps, this is due to the challenges of collecting data of this type and at a considerable scale, so this work had to first address these issues. A content analysis framework was developed which, (i) employed a risk matrix and rubric for the collection, coding and analysis of textual data within complex contractual provisions and (ii) validated its results both internally and externally. The framework supported the extraction of data from 21 US highway PPP contracts (i.e. the contract data set). The breadth of the contract data set is unique in the PPP community, and it served as the basis of all three studies in this dissertation. In addition, the analysis framework is validated and replicable; consequently, as new PPP contracts in the US highways sector reach financial close, the data set can be expanded using the framework. Moreover, it can be used to study other jurisdictions and market sectors. Hence, both the data set and the analysis framework are important contributions.

5.2.2 Contractual risk allocation

Given their long-term nature, risks are prominent in PPPs, so their allocation and management are crucial to PPP success and the benefits that the contractual parties will accrue over the duration of the arrangement; this well-documented in the literature. Further, the risk allocation agreed in a contract is a key determinant of the nature of the counterparty relationship. Despite this, past research has relied on a limited number of case interviews or practitioner surveys to examine risk allocation in international jurisdictions such as the UK (Bing et al. 2005; Ke et al. 2010), Australia (Hodge 2004; Quiggin 2004; Chung et al. 2010), China (Chan et al. 2010b; Ke et al. 2010) and India (Kalidindi and Thomas 2003). Ng and Loosemoore (2007) and Chung and Hensher (2015) did examine actual contracts in their work; however, both works examined a single contract within a case study.

Utilizing the developed content analysis framework, the first study of my dissertation determined the risk allocation for 31 risks in the contract data set; hence, the scope of the investigation is distinctive. The results confirmed that lifecycle risks such as design, financing, operations, maintenance, and residual value were transferred to concessionaires; this is not surprising since bundling of asset development and service provision tasks and risks is characteristic of PPPs. However, risk sharing in the US highway PPP market is more prevalent than that found in international jurisdictions (Bing et al. 2005; Chan et al. 2010; Kalidindi and Thomas 2003; Chung and Hensher 2015); while the reason behind this is uncertain, the federalist system may account for this finding. Further, the risk sharing mechanisms used are diverse and complex, ranging from deductible to proration to event mechanisms; while existing literature such as Chung and Hensher (2016) has broadly examined PPP risk sharing, i.e. parsing of risks among contractual parties, this work classified project-level risk sharing by the mechanisms utilized. Finally, while consistency of allocation across the contract data set was found for some risks, project context matters; variance was found in risk allocation for similar projects in the same era and jurisdiction. So, local and specific circumstances of a project can and likely will drive risk allocation – particularly for endogenous risks. This reinforces existing literature that has examined the tension between standards and context in PPPs (Dewulf et al. 2015; Kivleniece and Quelin 2012).

These findings have some important practical implications. First, policy-makers and practitioners should be cautious of adopting past PPP contractual practices in current or future projects. Each project's context may dictate how a risk is allocated and provisioned; while this is applicable to any project, the potential lock-in effect is amplified in PPPs due to their duration. Second, the prevalence of "event mechanisms" suggests that a number of PPP risks are difficult to perceive and quantify, so contractual parties should assess the value of ex ante specification versus ex post resolution; this is easier said than done, but if the conditional treatment of a risk mounts, then it is more likely that ex post resolution will be preferred. Finally, the findings are mixed with respect to the efficacy of standard contractual provisions; consistency was found for a non-trivial number of risks, but variance was high for others. Efforts to create such standards can focus on areas of commonality while perhaps offering alternative means for handling more project-specific risks/issues.

5.2.3 Contractual design and practice

The second study further explored two key findings in the first study through the lens of contract theories. First, the transfer of lifecycle risks, which is a consequence of bundling in PPPs, places significant long-term tasks and risks in the hands of concessionaires – essentially, they are responsible for a project's lifecycle performance; consequently, one line of inquiry investigated how contractual frameworks in the contract data set aligned principal-agent interests. Second, the prevalence of risk sharing opened up another line of inquiry; whether risk sharing mechanisms in the contract data set rely on ex ante specification or ex post resolution. Similar investigations in the current literature are either theoretical and normative (Hart 2003; Iossa and Martimort 2015; Ho et al. 2015) or have investigated a limited set of specific contractual provisions or individual cases (Iossa et. al. 2007; Foster 2013; Chung and Hensher 2015).

Along the first line of inquiry, the findings demonstrated that contract design in the data set emphasized government monitoring and control, which aligns with recommendations from agency theorists as a means to mitigate information asymmetry and opportunism; while concessionaires may have responsibility for lifecycle performance, they are not granted the decision rights or empowerment that incomplete contract theory would suggest is necessary. Bundling, from the public agency's perspective, does not create the incentives for the private sector to sustain its commitments throughout the project lifecycle. These findings provide evidence that validates the theoretical work of PPP researchers such as Ho et al. (2015) and Iossa and Mortimort (2015). Given the scrutiny that PPPs receive (Rufin and Rivera-Santos 2012) and the intricacy of acting as a contractual counterparty and sociopolitical regulator (Kivleniece and Quelin 2012), the apparent risk-averse behavior of public agencies in this context is not surprising. Zaghloul and Hartman (2003) also suggested that such intensive monitoring requirements represent mistrust of the private sector by government.

The second line of inquiry indicated that risk sharing mechanisms relied more on ex post resolution strategies rather than ex ante design, so incompleteness in this context is intentional; hence, these findings align with theoretical recommendations from incomplete contract theory (Crocker and Reynolds 1993; Iossa and Martimort 2012; Rausser and Stevens 2009). However, the risk sharing mechanisms were distributed between ex ante specification and ex post resolution. Prior work by Athias and Saussier (2007) indicated that PPP contracts should balance rigid and flexible forms, so risk sharing practices in the contract data set tend to follow this formula. Whether the contracts are "balanced" or not remains unanswered.

The second study focused on uncovering the state of practice, but what are the findings' implications? Foremost, if current designs continue, both public and private parties can expect high ex post transaction costs. Contract enforcement regimes and resolution of events will increase costs for both parties. Unless the scrutiny of PPPs abates, it is very unlikely that public agencies will move toward concessionaire empowerment. Consequently, one area of attention is the Project Management Plan (PMP) put in place; these are the basis of information revelation and monitoring lifecycle performance. Clearly, their efficiency and effectiveness will dictate the overall auditing burden and their adaptability. Better measures of performance would help as would consideration of new incentive structures – where could incentives be designed to replace monitoring functions? Certainly, the rise of interest in relational forms of governance is a consequence of the state of practice – relational norms can supplement regulative standards to promote better outcomes (Henisz et al. 2012). Beyond this, both parties might consider how to increase the shadow of the future on the current relationship; however, this is not easily done in the PPP market. Examples of repeat PPP relationships exist in Texas: NTE 1-2A (2009) and NTE 3A-3B (2013) and in Virginia: I-495 (2007) and I-95 (2012); in each case, both projects were a continuous business cooperation between the same public agency and private parties. However, other concerns arise – legitimacy, competition, etc. – in such circumstances. Perhaps, contingent opportunities well short of "another project" such as ancillary development rights or right-of-way utilization could be sufficient.

5.2.4 Revenue risk sharing

Capitalizing on the presence of a revenue guarantee in the I-77 project in the contract data set, the final study introduced a tranche of relatively new tools, exotic options, to cope with revenue risk – one of the most significant risks in PPPs. Current literature on revenue guarantees utilizes primarily standard put options, although Shan et al. (2010) introduced collar options while Chiara et al. (2007) proposed Bermudan options. Standard options do not take into account many project variables such as path-dependent and incentive features while Bermudan options – a member of exotic option class – only allow option holders a certain number of discrete exercise rights; this feature is attractive since it provides financial support to the project when it needs it the most; however, Bermudan options have limitations.

The existing revenue guarantee in the I-77 project was modified to incorporate two exotic structures, a barrier put and a put gap call. The results demonstrated that both exotic option structures served the interests of major PPP stakeholders better since they can reduce a government's expected loss and improve a project's credit risk while not significantly affecting a developer's residual cash flow. This work extends the application of real option theory into new territory. Moreover, the assessment framework used did not require valuation of the options. Rather, it relied on common financial metrics and fairly straightforward financial modeling; this should support challenges for diffusion to practice (Triantis 2005; Garvin and Ford 2012).

The implications of the final study for practice are several. Exotic options are flexible with more degrees of freedom, so they can be structured to: (i) consider different parties' needs in hedging risks and alternative parties' risk preferences; and (ii) integrate incentive schemes and path dependent features. Reflecting parties' needs better than current revenue guarantee structures, exotic options have the potential to improve the alignment of stakeholder interests in PPPs.

5.3 Future work

This dissertation is the start of a path for further research of partnerships between the government and the private sector for infrastructure service provision. Two avenues of future research are envisioned: (i) contractual frameworks and governance and (ii) revenue risk and payment mechanisms.

Contractual frameworks and governance

This first avenue builds from the first and the second study. One of the most obvious opportunities is to take advantage of the work done to expand the research to examine contract practices in Australia and Canada since these countries also have a federalist system similar to the US. Expanding the scope of the investigation to consider countries under unitary or centralized systems such as the United Kingdom and Spain could provide additional insights[6] – particularly if practice in federalist and unitary systems turn out to be either similar or dissimilar. Contracts in these international jurisdictions will be examined using the methodologies developed in this dissertation to investigate: risk allocation; monitoring and decision rights; and risk sharing. Comparative analyses would reveal convergence and divergence among the practices in these jurisdictions. Ultimately, the objective would be to identify where uniformity across jurisdictions exists and what alternative contractual approaches are employed, which would contribute toward identification of international "best practices." Along with actual contracts, standard contracts (or provisions) available in these jurisdictions could be examined since they tend to reflect lessons learned in each jurisdiction.

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[6] Clearly, the UK and Spain have some of the deepest contemporary experience in the world with respect to PPPs, so their inclusion would need to be carefully designed to "control" for experience and jurisdictional differences.

Notably, the first and the second studies only looked at how contractual frameworks and provisions in the US were formed but not how they were implemented. In the near future, many US highway P3 projects in data set will be several years into their operation phase. This opens an opportunity to investigate, using a longitudinal case-based approach, how key aspects in these project contracts were implemented. Case study data will reveal: (i) whether risk allocation and contract structures were followed, (ii) how monitoring/decision right frameworks were actually employed to manage the projects and interactions between the parties, and (iii) how provisions relying on ex post resolution, such as event mechanisms, were implemented. These findings would identify how contracts are administered and enforced relative to their formation. They would also lay the groundwork to quantify ex ante and ex post transaction costs and efficiency of each contract framework. In principle, similar investigations could extend to jurisdictions outside the US, but pragmatic issues might limit the extent of such investigations.

Longer term, my research could move beyond contractual structures to the broader area of project governance. The aim here would be to examine alternative governance structures that may better align interests of stakeholders in infrastructure development. The second study indicated that governments use intensive monitoring and want to control P3 projects; this is not likely the best approach to balance parties' interests because of: (i) the burden of monitoring/controlling that may increase transaction costs, (ii) the opportunity for the government to act opportunistically, and (iii) the parties are not necessarily in an environment promoting trust and relationships. In essence, the public agency is in the intricate position of acting as a contractual partner and regulator. Aside from promoting relational mechanisms (Henisz et. al. 2012), a potential alternative worth considering is decoupling these roles in the public sector; the public agency acts as the contractual partner to the concessionaire while oversight is done by another government entity. This approach would adopt features of how utilities such as gas and electricity are currently governed. Another approach is to restructure the relationship between the government and the private sector – a "co-ownership" model in which the government and the private sector combine into a single investing entity. In Vietnam, this approach is already in use: the government and the private sectors establish a limited liability company whereby the government has more than a half of the control rights of the company.

Considering my goal to obtain an academic position in Viet Nam, I can also expand my exploration of contracting and governance to examine both developed and developing regions. The first study reinforced the observation that *project context matters*, even within the same state. Therefore, the difference between developing and developed areas can impact how contracting takes place in infrastructure projects. Research that deepens understanding and compares infrastructure development environments and contract practices in both areas will reveal differences as a result of the context in developed versus developing areas. I would likely select consider regions such as China, India, and South East Asia countries versus the US, Australia, Canada, and the UK.

Revenue risk and fiscal support mechanisms

Revenue risk and payment mechanisms are topics that need continuing effort since they reflect interest alignment between the government and the private sector.

In the very near future, research could extend the investigation of revenue guarantee structures done here. As Delmon (2009) argued, revenue guarantees, despite their popularity, have issues. The third study examined a put and gap call option; in a case of revenue shortfalls, the guarantee (put) is likely exercised. The private sector, however, is not necessarily incentivized to increase project revenue or reduce O&M costs. This situation can be possibly remedied by replacing the put option with a gap put option, so the government only supports part of the loss. Combined with the gap call, this structure splits the loss and the gain between the public and private parties. However, the split ratio would also need determination, so that they reflect the needs and risk preference of each party; this latter aspect would be essential if such a structure were to be adopted.

Additional research in this avenue could take advantage of an exotic option tranche. Revenue guarantees are often structured with linkages to different project periods. For instance, the revenue guarantee may be larger in the ramp-up phase or smaller (or non-existent) after the ramp-up phase. However, current practice relies on estimates of the ramp-up phase that are likely negotiated between the parties. A common estimation is that the ramp-up phase is between 2 to 8 years with 5 years average (Wibowo and Kochendörfer 2005), or between 3 to 5 years (Flyvbjerg 2005); Shan et al. (2010) even assumed the ramp-up phase to last 10 years. In the I-77 project however, it was determined as the first 3 years of operation. An exotic option can solve this problem: option-on-option. The first option is used to determine the type of option that will be used. The first option can utilize a look-back option to determine whether the ramp-up phase has ended or continues (i.e. by measuring the range of fluctuation or the range of revenue movement during a period), then determines how the private sector is entitled to the guarantee from the government. Many types of incentives for the parties can be used for the alignment of interests. Hence the needs for further examination of exotic structures to support the purpose of building incentives.

Ultimately, proposed structures of revenue guarantees need assessment by practitioners with respect to implementation. Triantis (2005) and Garvin and Ford (2012) reported potential reasons that narrow the usage of real options in project-based environments. Many reasons relate directly to implementation, which is not often considered by academic theorists. This outreach research would collect useful input from the potential users to improve the development of real options in project-based environments.

Further research is also needed to understand the volatility of key project variables. Current research often assumes volatility. However, volatility assumptions can significantly affect calculated outcomes (e.g. simulation), reducing researchers' confidence. In the third study, the volatility in the Brownian motion was assumed as well. This research could mitigate the problem by collecting revenue data from highway projects and other sectors. The data could then be paired against macroeconomic events over time to compute volatility. Therefore, volatility could be broken down to endogenous and exogenous causes. The outcomes become a solid point-of-departure for future research that utilize simulations or forecast methods.

In longer time horizon, more attention can be paid the types of fiscal support that governments offer in infrastructure projects; this would extend beyond revenue guarantees to potentially include all types of support ranging from up-front government contributions to tax-exempt instruments like Private Activity Bonds to other credit enhancement features. Ideally, the government should select the type of support so that society's objectives as well as project stakeholders' objectives are aligned.

5.4 Reflections

When it comes to learning new things, I am always amazed by interdisciplinary topics. Fortune brought me to this dissertation area – Public-Private Partnerships in infrastructure development – a context where social aspects and engineering meet. No matter how sophisticated engineering is, its ultimate goal is to serve society. However, societal issues will determine the effectiveness of engineering. The socio-technical issues in infrastructure development causes the complexity of the topics requiring research to increase exponentially! I believe that the knowledge obtained and the challenges of an interdisciplinary dissertation will pay me high dividends over the long-term in roles that I may serve[7] in my career.

I also feel lucky because my research topic required me to utilize both qualitative and quantitative research methods, honing my research skills and enriching my arsenal to confront future inquiries.

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[7] "That I may serve" ® is the motto of Virginia Tech in English

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7 Appendix A. Supplementary Information for Chapter 2 and Chapter 3: US Highway PPPs and other Information[8]

Project	Juris-diction	Com. close/ Fin. close	Value ($mil.)	Pay. mech.	Description
Chicago Skyway	Chicago city (Illinois)	January 26, 2005/ August 2005	$1,800	Lease	The Chicago Skyway is a 7.8-mile elevated toll road connecting I-94 (Dan Ryan Expressway) in Chicago to I-90 (Indiana Toll Road) at the Indiana border. The facility includes a 3.5-mile elevated mainline structure crossing the Calumet River. Built in 1958, the Skyway was operated and maintained by the City of Chicago Department of Streets and Sanitation. In March 2004, the City of Chicago issued a request for qualifications (RFQ) from potential bidders interested in operating the facility on a long-term lease basis in March of 2004. It received 10 responses and in May 2004 invited five groups to prepare proposals. Bids were submitted in October 2004, with the long-term lease awarded to Cintra/Macquarie on October 28, 2004. Cintra/Macquarie bid $1.83 billion for the 99-year concession, 2.6 times as much as the next highest bidder, a French and Canadian group led by Vinci Concessions. Abertis Infraestructuras of Spain was the only other bidder, offering $505 million for the lease. The Skyway Concession Company, LLC (SCC) assumed operations on the Skyway on January 26, 2005. SCC is responsible for all operating and maintenance costs of the Skyway but has the right to all toll and concession revenue. This agreement between SCC and the City of Chicago was the first long term lease of an existing toll road in the United States. In June 2015, Cintra and Macquarie, seeking to make a return on their equity investment, announced their intent to sell all interest in SCC. A consortium comprising three Canadian pension funds (Calumet Concession Partners LLC) agreed to purchase the lease for $2.8 billion in November

[8] Federal Highway Administration (May 2017). *PPP highway project profiles*. Retrieved from https://www.fhwa.dot.gov/ipd/p3/project_profiles/

Project	Juris-diction	Com. close/ Fin. close	Value ($mil.)	Pay. mech.	Description
					2015. The Canadian Pension Consortium will operate and collect tolls on the Skyway for the remainder of the lease, until 2104. Funding: -Original financial structure (backed by toll receipts): + Cintra equity: $485 million + Macquarie equity: $397 million + Bank Loans: $948 million - Subsequent refinancing (backed by toll receipts): + Cintra/Macquarie equity - $510 million + Capital accretion bonds - $961 million (21-year maturity; 5.6% interest rate) + Current interest bonds - $439 million (12-year maturity) + Subordinated bank debt - $150 million (Banco Bilbao Vizcaya Argentaria and Santander Central Hispano of Spain, together with Calyon of Chicago) Notes: - First long term lease of an existing public toll road in the United States - Funded a $500 million long-term and $375 million medium-term reserve for the City of Chicago, as well as a $100 million neighborhood, human, and business infrastructure fund to be drawn down over five years.
Indiana Toll Road	Indiana	2006/ June 29, 2006	$4,600	Lease	In operation since 1956, the Indiana Toll Road (ITR) stretches 157 miles across the northernmost part of Indiana from its border with Ohio to the Illinois state line, where it provides the primary connection to the Chicago Skyway and downtown Chicago. The Indiana Toll Road links the largest cities on the Great Lakes with the Eastern Seaboard. Connections with I-65 and I-69 lead to major destinations in the South and on the Gulf Coast.

Project	Juris-diction	Com. close/ Fin. close	Value ($mil.)	Pay. mech.	Description
					After his election in 2004, Governor Mitch Daniels tasked the Indiana Finance Authority (IFA) with the responsibility of exploring the feasibility of leasing the ITR to a private entity. IFA engaged Wilbur Smith to prepare a revenue analysis and Goldman Sachs to provide financial advice. These assessments led to IFA's release of a Request for Toll Road Concessionaire Proposals on September 28, 2005. Four teams submitted proposals by the October 26 deadline. The lease concession was awarded to Indiana Toll Road Concession Company, LLC (ITRCC) comprising an even partnership between Cintra of Spain and Macquarie of Australia. ITRCC submitted the highest bid of $3.8 billion. The ITR lease transaction was contingent upon authorizing legislation known as "Major Moves," which was signed into law in late March 2006. On April 12, 2006, ITRCC and IFA executed the "Indiana Toll Road Concession and Lease Agreement" providing for a 75-year lease of the ITR. ITRCC formally assumed operational responsibility for the ITR on June 29, 2006. As part of the concession, ITRCC pledged to spend $200 million on capital improvements to the facility during the first three years of the lease and approximately $4.4 billion over the life of the concession. By leasing the facility, the state was able to retire $225 million in debt. It allocated the remainder of the lease proceeds to several funds used solely to pay for infrastructure projects throughout the state. In March 2015 IFA awarded a new $5.725 billion, 66-year lease concession to IFM Investors following the 2014 bankruptcy of ITRCC. Nearly all of the sale funds will be used to pay back creditors holding ITRCC's debt. IFM has plans to invest $260 million in capital improvements over the first five years of the concession to address deteriorating pavement, bridges, and travel plazas. <u>Funding</u>: Cintra Equity - $374 million Macquarie Equity - $374 million

Project	Juris-diction	Com. close/ Fin. close	Value ($mil.)	Pay. mech.	Description
					Senior bank debt - $3,030 million (backed by toll receipts) Notes: - First long term lease by a state of an existing public toll road in the United States. - The concession agreement establishes toll rates and possible increases and places limits on the return on investment for the concessionaire.
Colorado Northwest Parkway	Colorado	2007/ December 21, 2007	$600	Lease	The Northwest Parkway is an 8.9-mile toll road that connects E-470 in the northern Denver metropolitan area to just before U.S. 36 in Broomfield, Colorado. The Parkway is one segment of the Denver Beltway system, which includes E-470 and C-470. The Parkway comprises four lanes, 26 structures, three major interchanges, four ramp plazas, and four mainline toll plazas. The Parkway was developed by the Northwest Parkway Public Highway Authority, a joint powers authority formed in 1999 that continued earlier work by a nonprofit entity seeking to connect communities in the northwest Denver metro area to I-25 and U.S. 36, providing better access to jobs and commercial establishments. The project was locally financed with toll revenue bonds and opened in 2003, but with traffic volumes less than forecast, a decision to lease the facility to a private consortium was made, prompted initially by an unsolicited proposal received in 2006. A 99-year, long-term lease agreement with Northwest Parkway LLC to operate and maintain the toll road in exchange for the right to retain the toll proceeds was executed in August 2007. An upfront payment consisting of cash, the assumption of existing debt, and an annual administrative fee to the Authority to be paid over the life of the lease, was primarily used to defease the toll road's debt. A portion of it was placed into escrow pending a notice to proceed if issued by the end of 2018 to extend the Parkway 2.3 miles south over U.S. 36 to SH 128 in Broomfield, as well as notice to proceed to extend the Parkway 15 miles further southwest from there to SH 93 at 64th Avenue in Arvada. Release of the funds in escrow to the Authority is also possible if the two extensions are completed by the end of 2020. In both cases,

Project	Juris-diction	Com. close/ Fin. close	Value ($mil.)	Pay. mech.	Description
					the concessionaire must also contribute another $60 million to the construction of the extensions. Funding: Original construction: Toll revenue bonds - $416 million Long-term lease financing: Senior bank debt - $459 million 10-year term loan - $249 million 11-year equity bridge - $60 million 10-year liquidity facility - $150 million Equity - $266.9 million Notes: - Converted to Lease due to lower than projected toll revenues on the Parkway. - Included in the terms of the concession agreement was $40 million placed in escrow to be released to the Authority to facilitate the extension of the Parkway, if it occurs by 2020. - The concessionaire is required to share revenue with the Authority after profits exceed certain levels.
I-495	Virginia	2007/ December 20, 2007	$2,068	Tolled	The Capital Beltway High Occupancy Toll (HOT) Lanes project (officially the 495 Express Lanes) is a public-private partnership between VDOT and Capital Beltway Express, LLC (a joint venture of Fluor and Transurban) that opened in November 2012. The project limits are from the Springfield Interchange (south) to just north of the Dulles Toll Road (14 miles).

Project	**Juris-diction**	**Com. close/ Fin. close**	**Value ($mil.)**	**Pay. mech.**	**Description**
					Previously, the Capital Beltway had four lanes in each direction. Improvements included: 14 miles of two new lanes in each direction First time introduction of High Occupancy Vehicles (HOV) lanes to the Capital Beltway and reliable transit options to the Beltway and Tysons Corner, Virginia Congestion-free network for carpools, vanpools, transit and toll-paying motorists Replacement of more than $260 million of aging infrastructure, including more than 50 bridges and overpasses Construction of carpool ramps connecting I-95 with the Capital Beltway to create a seamless HOV network <u>Funding</u>: Private Activity Bonds - $589 million TIFIA Loan - $589 million Commonwealth of Virginia grant - $409 million VDOT change-order funding - $86 million Interest income - $47 million Private Equity - $348 million <u>Notes</u>: - Fully electronic toll collection using transponder technology Dynamic tolling based on real-time traffic conditions - First HOT lane implemented in the state of Virginia - Largest financing of a HOT lanes project

Project	Juris-diction	Com. close/ Fin. close	Value ($mil.)	Pay. mech.	Description
					- First time a Private Activity Bond (PAB) was used for HOT lanes in the U.S. and the first time combined with TIFIA financing
SH-130 (segments 5-6)	Texas	2007/ March 7, 2008	$1,380	Tolled	SH 130 is a four-lane, 91-mile toll road east and south of Austin designed to relieve congestion on the heavily traveled I-35, the primary north-south route through Central Texas. Segments 1-4 of SH 130 (which are part of the Central Texas Turnpike System that includes SH 45 North and Loop 1) were constructed as a separate project and opened in stages between November 2006 and April 2008. On March 22, 2007, TxDOT signed a Comprehensive Development Agreement (CDA) with the SH 130 Concession Company to design, build, finance, operate, and maintain a 40-mile extension of SH 130 (Segments 5 and 6) under a 50-year concession from the date of opening. The project opened to traffic on October 24, 2012 and service commenced on November 11, 2012. The extension follows the current US 183 alignment from north of Mustang Ridge to north of Lockhart and extends southwest to I-10 northeast of Seguin. The final maturity of the TIFIA loan is June 2047. A $35 million bank liquidity facility and contingent equity was available to meet senior and TIFIA debt service obligations in the first five years of operation but was fully drawn in the first few years of operation after toll revenues fell well short of forecasts. In addition, a 12-month debt service reserve account will be established beginning in year six of operations and will be in place through the final maturity of the TIFIA loan. Despite increasing traffic levels in 2015, SH 130 Concession Company filed for Chapter 11 bankruptcy protection in federal court in March 2016. On September 9, 2016, Cintra relinquished ownership of the facility to its creditors but will continue to operate the facility for 18 months. Funding: - Senior bank loans - $685.8 million

Project	Juris-diction	Com. close/ Fin. close	Value ($mil.)	Pay. mech.	Description
					- TIFIA loan - $430 million - Private equity - $209.8 million - Interest income - $2.3 million Notes: - First privately developed and operated open toll road facility in Texas
I-595	Florida	2009/ March 2, 2009	$1,760	AP	The I-595 corridor originally opened to traffic in 1989, coordinating the movement of high traffic volumes between the developable areas in the western parts of the Southeast Florida region with the established north-south freeway and principal roadways to the east, including I-75, Florida's Turnpike, SR 7, I-95 and US 1. However, travel demand within the corridor has increased at a pace where the long-range traffic forecasts for the current highway would be reached in the short term. The I-595 Corridor Roadway Improvements project consisted of the reconstruction and widening of the I-595 mainline and all associated improvements to frontage roads and ramps from the I-75/Sawgrass Expressway interchange to the I-595/I-95 interchange, for a total project length of approximately 10.5 miles. The project passes through, or lies immediately adjacent to, six jurisdictions: City of Sunrise; Town of Davie; City of Plantation; City of Fort Lauderdale; Town of Dania; and unincorporated areas of Broward County. A major component of the project is the construction of three at-grade reversible express toll lanes known as 595 Express, serving express traffic to/from the I-75/Sawgrass Expressway from/to east of SR 7, with a direct connection to the median of Florida's Turnpike. These lanes are operated as managed lanes with variable tolls to optimize traffic flow, and reverse direction in peak travel times (eastbound in the AM and westbound in the PM). The project is a public-private partnership between FDOT and a private concessionaire to design, build, finance, operate, and maintain the roadway

Project	Juris-diction	Com. close/ Fin. close	Value ($mil.)	Pay. mech.	Description
					for a 35-year term. FDOT provides management oversight of the contract; installed, tested, operates and maintains all tolling equipment for the express lanes; and sets the toll rates and retains the toll revenue. Funding: State and federal resources: - Support FDOT's final acceptance payments ($686 million YOE) and availability payments ($65.9 million annual Maximum Availability Payment [MAP] in 2009 dollars) made to concessionaire (Federal aid receipts, state motor fuel tax receipts, toll receipts) Concessionaire's financing sources for repayment: - Senior bank debt - $781.1 million (backed by final acceptance/availability payments) - TIFIA loan - $603 million + capitalized interest during construction (backed by final acceptance/availability payments) - Equity - $207.7 million - Revenues - $10.0 million - FDOT qualifying development funds - $232 million Notes: - First U.S. application of availability payments to a transportation project. - I-595 Express, LLC will receive no compensation from FDOT until the facility is fully operational. Upon FDOT's final acceptance of the project construction, I-595 Express, LLC will receive a series of annual lump sum final acceptance payments, including potential incentive bonuses for completing a series of interim milestones (related to major construction activities) within established contractual deadlines.

Project	Juris-diction	Com. close/ Fin. close	Value ($mil.)	Pay. mech.	Description
					- Performance-based availability payments will be made monthly during the operating period of the project. A maximum availability payment of $65.9 million (in 2009 dollars) begins in 2014 and escalates annually. If quality and performance requirements stipulated in the contract as well as availability of the roadways to traffic are not met, then the availability payments will be subject to downward adjustment in accordance with the contract.
Port of Miami Tunnel	Florida	June 2, 2009/ October 15, 2009	$651	AP	The Port of Miami Tunnel improves access to and from the Port of Miami, serving as a dedicated roadway connector linking the Port (located on an island in Biscayne Bay) with the MacArthur Causeway (State Road A1A - which connects Miami to Miami Beach) and I-395 on the mainland. Previously the Port was linked to the mainland only by the Port Bridge. The tunnel: (i) improves access to the Port helping to keep it competitive and efficient, (ii) improves traffic safety in downtown Miami by removing cargo trucks and cruise line buses from congested city streets, and (iii) facilitates ongoing and future development plans in and around downtown Miami. The project includes a tunnel under the Main Channel (the shipping channel between Dodge and Watson Islands), roadway work on Dodge Island and Watson Island/MacArthur Causeway and widening the MacArthur Causeway Bridge. Twin tubes, each 3,900 feet long and 41 feet in diameter, reach a depth of 120 feet below the water. The project has been developed as a public-private partnership with Miami Access Tunnel, LLC (MAT). The state agreed to pay for approximately 50 percent of the capital costs (design and construction) and all operations and maintenance, while the remaining 50 percent of the capital costs is provided by the local governments. Under the concession agreement, FDOT paid MAT a total of $100 million in milestone payments during the construction period between 2010 and 2013 and a $350 million final acceptance payment upon construction completion. This is followed by 30 years of availability payments during the operating period. The annual payment is $32.479 million (2009$), with adjustments

Project	Juris-diction	Com. close/ Fin. close	Value ($mil.)	Pay. mech.	Description
					for inflation. Deductions are made from this amount if MAT's operation of the facility does not meet prescribed performance standards. Funding: Total Eligible Project Costs: $1,072.9 million Senior bank debt - $341.5 million TIFIA loan - $341 million Equity contribution - $80.3 million FDOT milestone payments during construction - $100 million FDOT development funds - $209.8 million TIFIA capitalized interest during construction is not included in total eligible costs in the amount of $40.1 million Notes: - Second U.S. application of availability payments to finance a transportation project (the first also being in Florida - the I-595 Corridor Roadway Improvements).
North Tarrant Express (1&2A)	Texas	June 23, 2009/ December 16, 2009	$2,000	Tolled	On June 23, 2009, TxDOT awarded two Comprehensive Development Agreements (CDAs - equivalent to public-private partnerships) for the North Tarrant Express (NTE) project to NTE Mobility Partners. The first Concession CDA includes the design, development, construction, finance, maintenance, and operation of 13 miles along Interstate (IH) 820 (Segment 1) and State Highway (SH) 121/SH 183 from IH 35W to SH 121, from north of Fort Worth to just southwest of Dallas-Fort Worth International Airport (Segment 2A). The duration of the concession is 52 years. The existing highway includes two general purpose lanes in each direction. Proposed improvements include three general purpose lanes in each

Project	Juris-diction	Com. close/ Fin. close	Value ($mil.)	Pay. mech.	Description
					direction with two managed lanes in each direction for a total of ten lanes with frontage roads for future traffic volumes. The second CDA for Segments 2-4 includes developing master plans for the remainder of the corridors along SH 183 from SH 121 to SH 161 (Segment 2E), IH 820 east from SH 121/SH 183 south to Randol Mill Road (Segment 4), and along IH 35W from IH 30 to the Eagle Parkway in Tarrant and Dallas counties (Segments 3A, 3B, and 3C), as well as other facilities for connectivity, safety, and financing. As a result of the master planning activities, TxDOT and the concessionaire entered into a Facility Agreement to construct Segment 3A and operate and maintain this segment as well as Segment 3B, which is being constructed by TxDOT. TxDOT will also construct Segment 3C. When all phases are completed, the Project will comprise 36 miles of managed lanes. <u>Funding</u>: - Private Activity Bond Proceeds - $398 million - TIFIA Loan - $650 million - Public Funds - $573 million - Equity Contribution - $426 million - Total does not include TIFIA capitalized interest of $54 million <u>Notes</u>: - When completed, this project will have a state-of-the-art electronic toll collection system with open architecture, ensuring a seamless, free flow operation of the managed lanes. - Innovative financing package including PABs and TIFIA credit assistance. Only the second PABs issuance ever under the $15 billion of authority provided to DOT by SAFETEA-LU.

Project	Juris-diction	Com. close/ Fin. close	Value ($mil.)	Pay. mech.	Description
					- The first transportation infrastructure project in the US to reach financial close with direct investment by a pension fund.
IH-635 LBJ	Texas	September 4, 2009/ June 21, 2010	$2,600	Tolled	The IH 635 Managed Lanes Project, known as the LBJ Express, relieves congestion north of Dallas on 13 miles of IH 635 (LBJ Freeway) from just west of I-35E (near Luna Road) to just east of US 75 (near Greenville Ave.), and south on I-35E from I-635 to Loop 12. The project involved: - Reconstruction of the main lanes and frontage roads along IH 635 - Addition of six managed lanes (mostly subsurface) along IH 635 from I-35E to US 75 and four managed lanes west and east of that stretch - Addition of six elevated managed lanes along I-35E from Loop 12 to the I-35E/IH 635 interchange The project is being built under a public-private partnership (Comprehensive Development Agreement [CDA]) between TxDOT and LBJ Infrastructure Group, which will operate and maintain the facility for 52 years. Construction is expected to take five years. The managed lanes are dynamically priced following a six-month introductory fixed-price schedule. HOV2+ users receive a 50 percent discount during peak operating periods. Tolls are collected by the North Texas Tollway Authority. <u>Funding</u>: - Private Activity Bonds (PABs) - $615 million - TIFIA loan - $850 million - Equity contribution - $664 million - Toll Revenues - $17 million - Public Funds - $490 million <u>Notes</u>:

Project	Juris-diction	Com. close/ Fin. close	Value ($mil.)	Pay. mech.	Description
					- When completed, this project will have one of the most comprehensive managed HOV lane systems in the country, deploying Automatic Vehicle Identification (AVI) technology capable of reading the transponders of passing vehicles. - Innovative financing package includes PABs and TIFIA credit assistance.
PR-22 & PR-5	Puerto Rico	June 27, 2011/ 2011 Extended contract (10 more years) signed April 21, 2016	$1,136	Lease	PR-22 (also known as the Jose de Diego Expressway) is a 52-mile, 4- and 6-lane toll highway that stretches westward from San Juan to Arecibo along Puerto Rico's northern coast. It is considered part of the U.S. Interstate Highway System as a component of the unsigned Interstate PR-2. The road was constructed over a period of 10 years beginning in 1971 and is the island's most heavily traveled. The journey along the nearest parallel untolled road averages about 45 extra minutes. PR-5 (Rio Hondo Expressway) is a 2.5-mile eastward extension of PR-22 to Puerto Rico's second most populous city (Bayamon) that opened in 2006. An RFP to lease the two toll roads was issued in June 2010 and a preferred bidder selected one year later. The total $1.436 billion administrative concession will finance, rehabilitate, operate, and maintain the facilities over 40 years. Of that total, $1,080 million is an upfront payment of which about 90% was used to defease all outstanding tax-exempt toll-revenue debt ($902 million), and approximately $350 million will be expended on expected upgrades over the concession period, $56 million of which was spent in the first three years on "accelerated safety improvements." Two reversible dynamic toll lanes between San Juan and Toa Baja (approximately 10 kilometers) were opened in August 2013 to automobiles during rush hours. Tolls vary by level of traffic congestion. <u>Funding</u>: Sources - $1,280 million debt/equity - $825 million - Senior bank debt

Project	Juris-diction	Com. close/ Fin. close	Value ($mil.)	Pay. mech.	Description
					- $455 million - Private equity Uses of Lease Proceeds - $1,080 million - total lease payment - $902 million - Public Debt Defeasance on PR-22 & PR-5 - $178 million - Value Extraction Notes: - First P3 toll road under the Puerto Rico P3 Act of 2009 (and P3 toll road brownfield project in the U.S. since 2006)
Elizabeth River Tunnels	Virginia	December 2011/ April 12, 2012	$2,100	Tolled	The Downtown Tunnel / Midtown Tunnel / MLK Extension consists of five construction components involving three facilities in the Hampton Roads region of Virginia. Collectively, the project is known as the Elizabeth River Tunnels. The Midtown Tunnel portion consists of a new two-lane tolled tunnel under the Elizabeth River parallel to the existing Midtown Tunnel connecting the Cities of Norfolk and Portsmouth as well as modifications to the existing tunnel to provide increased capacity for east-west travel linking U.S. Route 58 and I-264 in Portsmouth to the interchange at Brambleton Avenue/Hampton Boulevard in Norfolk. Modifications to the interchange were also made. The planned improvements to the Downtown Tunnel have brought it into compliance with current fire and life safety standards. The MLK Extension portion of the project consists of an extension of Route 58 south from London Boulevard, approximately 0.8 mile to I-264 with an interchange at High Street. The $2.1 billion project has been delivered on a design, build, finance, operate, and maintain (DBFOM) concession basis by Elizabeth River Crossings Opco, LLC (ERC) composed of Skanska Infrastructure Development and Macquarie Group. ERC is operating the concession for 58 years. Funding:

Project	Juris-diction	Com. close/ Fin. close	Value ($mil.)	Pay. mech.	Description
					Senior Debt (Private Activity Bonds) - $675 million TIFIA loan - $422 million Equity Contributions - $272 million Public Funds - $408 million Toll Revenues - $268 million TIFIA Capitalized Interest - $43 million Notes: - Virginia's Commonwealth Transportation Board issued its first GARVEE bonds under the Commonwealth of Virginia Federal Transportation Grant Anticipation Revenue Notes Act of 2011 to provide the public subsidy to support the project's private financing.
Presidio Parkway II	California	2011/ June 14, 2012	$362	AP	The Presidio Parkway project is a replacement of Doyle Drive, a 1.6-mile segment of Route 101 in San Francisco that is the southern access to the Golden Gate Bridge, connecting Marin and San Francisco counties and providing a major regional traffic link between the peninsula and North Bay Area counties. The existing structure, built in 1936, did not meet current highway standards and was seismically deficient. The Presidio Parkway project area extends from the Golden Gate Bridge Toll Plaza on the west to Broderick Street on the east, and includes Richardson Avenue, Gorgas Avenue and Marina Boulevard. The Presidio Parkway is a six-lane facility with a southbound auxiliary lane between the Park Presidio Interchange and the new Presidio access at Girard Road. The roadway consists of various sections (from the toll plaza east to Richardson Avenue) with a landscaped median: - a high-viaduct between the Park Presidio Interchange and the San Francisco National Cemetery (Presidio Viaduct)

Project	Juris-diction	Com. close/ Fin. close	Value ($mil.)	Pay. mech.	Description
					- shallow cut-and-cover tunnels past the cemetery to Battery Blaney (Battery Tunnels) - at-grade roadways to the Main Post - cut-and-cover tunnels from the Main Post to east of Halleck Street (Main Post Tunnels) - a low causeway from Halleck Street to Girard Road - at-grade connection to Richardson Avenue The project has been developed in two phases. Caltrans was responsible for the design, financing and construction of Phase I. Phase I, delivered through a traditional design-bid-build process, consisted of a replacement bridge at the Park Presidio Interchange, the new southbound Presidio Viaduct, the southbound Battery Tunnel, and a temporary bypass east of the Main Post to allow construction of the Main Post Tunnels and roadway to Richardson Avenue. Through a competitive procurement process, Caltrans selected a private consortium, the Golden Link Concessionaire, to deliver Phase II as a design, build, finance, operate, and maintain (DBFOM) availability-pay concession. The P3 Project Agreement with GLC was executed on January 3, 2011. GLC is receiving milestone payments as construction activities reach substantial completion and will continue to receive quarterly availability payments through the concession period, based on performance. Funding: - Bank Loan - $166.6 million - TIFIA Tranche A Loan - $89.8 million - TIFIA Tranche B Loan - $60.2 million - Parent Company Contribution - $2.6 million - Private Equity - $43.0 million

Project	Juris-diction	Com. close/ Fin. close	Value ($mil.)	Pay. mech.	Description
					- TIFIA Capitalized Interest - $2.5 million Notes: - California's first P3 transaction under its new (2009) legislation (prior P3 projects include the South Bay Expressway and SR 91 Express Lanes) - California's first availability payment contract for transportation infrastructure - First project with direct Federal-aid participation in availability payments. - First TIFIA loan to be repaid in part with a milestone payment following substantial completion. - Incorporation of numerous Context Sensitive Design features to minimize traffic impacts and to protect and enhance environmental and cultural resources.
I-95 Express Lanes	Virginia	2011/ PABs sold July, 2012; TIFIA fin. Close November 20, 2012	$922.6	Tolled	The I-95 Express Lanes will be the second major step in creating a regional network of tolled managed lanes in Northern Virginia. The project consists of the development, design, finance, construction, maintenance and operation of 29.4 miles of High Occupancy Vehicle (HOV)/High Occupancy Toll (HOT) Lanes along I-95 and I-395 in Northern Virginia, from Garrisonville Rd. in Stafford County to Edsall Rd. in Fairfax County over a 76-year concession period. The project is divided into four segments: - 8.3 miles of new construction - two-lane reversible (includes 7 new brides) - 7.0 miles of two-lane HOV conversion - two-lane reversible - 11.9 miles of two-lane HOV conversion - three-lane reversible - 2.2 miles of two-lane HOV conversion - three-lane reversible (including connection to 495 Express Lanes at the Springfield Interchange) The new managed lanes will provide congestion relief and connectivity to users travelling to and from major employment centers in Northern

Project	Juris-diction	Com. close/ Fin. close	Value ($mil.)	Pay. mech.	Description
					Virginia, such as Tysons Corner and Washington, D.C., and five major military sites, including Ft. Belvoir, Quantico Marine Corps Base, and the Pentagon, while providing a reliable pathway for transit vehicles and carpools to travel throughout the region. In many areas, the project will provide first-time, direct HOV and transit access to these destinations. Funding: TIFIA loan - $300.0 million Private Activity Bonds - $252.6 million Commonwealth of Virginia Grant - $82.6 million Private Equity - $280.4 million TIFIA Capitalized Interest - $6.5 million Interest Earnings - $0.6 million * A TIGER III (Transportation Investment Generating Economic Recovery) grant will be used to pay the subsidy cost of the loan to the federal government. Notes: - The Sponsors, together with VDOT, are also partners in the 495 Express Lanes project. The I-95 Express will be linked directly into 495 Express Lanes at the Springfield Interchange. The two projects have common traffic and tolling management systems and will share the same operations center/operator.
East End Crossing	Indiana-Kentucky	December 27, 2012/ March 28, 2013	$763	AP	The East End Crossing project includes a new bridge facility across the Ohio River, and associated roadway, tunnel, and facilities, connecting Clark County, Indiana and Jefferson County, Kentucky, approximately eight miles east of Louisville. The project is one half of the bi-state Ohio River Bridges project, which also includes the new Abraham Lincoln Bridge that expands the capacity of I-65 across the Ohio River into downtown Louisville and the reconstruction of the Kennedy Interchange between I-65, I-64, and I-71. The

Project	Juris-diction	Com. close/ Fin. close	Value ($mil.)	Pay. mech.	Description
					State of Indiana leads the East End Crossing project, and the Commonwealth of Kentucky leads the Downtown Crossing project. The East End Bridge will be an approximately 2,500-foot-long cable-stayed bridge featuring two convex diamond towers, two lanes in each direction, expandable to three, and a 13-foot-wide pedestrian and bicycle path. The Kentucky approach will be an extension of I-265 (Gene Snyder Freeway) from U.S. 42 to the new bridge, 3.3 miles long and two lanes in each direction, including a 1,680-foot tunnel under U.S. 42 and a redesigned interchange at U.S. 42 to allow traffic to enter and exit KY 841. The Indiana approach will be a 4.1-mile extension of I-265/SR 265 (Lee Hamilton Highway) from IN 62 to the new bridge. The extension will be two lanes in each direction and include the addition of a new full interchange at Old Salem Road and reconstruction of the I-265/IN 62 interchange. The East End Crossing project will complete the I-265/KY 841/SR 265 corridor in the eastern part of the Louisville metropolitan area. The East End Crossing project is being delivered as an availability-pay design-build-finance-operate-maintain concession with a four-year construction and a 35-year operation term. The concessionaire will be responsible for the operations and maintenance of the project with the exception of the Kentucky approach's tunnel, which will be maintained by the Commonwealth of Kentucky. The East End Bridge (and Abraham Lincoln Bridge) will be tolled, with operations and toll collection managed by the State of Indiana. The concessionaire will be compensated with milestone payments during construction and availability payments during operation of the facility supported by tolls and traditional state revenues. Funding: Indiana: - State and federal funding (milestone payments) - $392 million (includes $162 million TIFIA loan) - Other state and federal funding - $201.7 million

Project	Juris-diction	Com. close/ Fin. close	Value ($mil.)	Pay. mech.	Description
					- Milestone Private Activity Bonds (Series A) - $488.9 million - Long-term Private Activity Bonds (Series B) - $18.9 million Kentucky: - State and federal funding - $94.2 million Equity contribution - $78.1 million Relief Events Reserve Account - $45 million Notes: - The East End Crossing is part of the Ohio River Bridges project, which also includes the Downtown Crossing in Louisville. Together, the Louisville and Southern Indiana Bridges Authority, a bi-state agency, has been responsible for the financing of the $2.3 billion Ohio River Bridges. Indiana has chosen to finance the East End Crossing through an availability payment P3, while Kentucky is delivering the Downtown Crossing through a more traditional design-build contract. These innovative delivery approaches have combined significant cost savings.
North Tarrant Express (3A&3B)	Texas	March 1 2013/ Sept 18 2013	$1,350	Tolled	On June 23, 2009, TxDOT awarded two Comprehensive Development Agreements (CDAs - equivalent to public-private partnerships) for the North Tarrant Express (NTE) project to NTE Mobility Partners. The first Concession CDA includes the design, development, construction, finance, maintenance, and operation of 13 miles along Interstate (IH) 820 (Segment 1) and State Highway (SH) 121/SH 183 from IH 35W to SH 121, from north of Fort Worth to just southwest of Dallas-Fort Worth International Airport (Segment 2A). The duration of the concession is 52 years. The existing highway includes two general purpose lanes in each direction. Proposed improvements include three general purpose lanes in each

Project	Juris-diction	Com. close/ Fin. close	Value ($mil.)	Pay. mech.	Description
					direction with two managed lanes in each direction for a total of ten lanes with frontage roads for future traffic volumes. The second CDA for Segments 2-4 includes developing master plans for the remainder of the corridors along SH 183 from SH 121 to SH 161 (Segment 2E), IH 820 east from SH 121/SH 183 south to Randol Mill Road (Segment 4), and along IH 35W from IH 30 to the Eagle Parkway in Tarrant and Dallas counties (Segments 3A, 3B, and 3C), as well as other facilities for connectivity, safety, and financing. As a result of the master planning activities, TxDOT and the concessionaire entered into a Facility Agreement to construct Segment 3A and operate and maintain this segment as well as Segment 3B, which is being constructed by TxDOT. TxDOT will also construct Segment 3C. When all phases are completed, the Project will comprise 36 miles of managed lanes. Funding: Segment 3A: Private Activity Bond Proceeds - $270.6 million TIFIA Loan - $524.4 million Public Funds - $163.8 million (Federal + State funds) Interest income - $5.6 million Equity - $412.9 million Segment 3B: Proposition 12 Bond Proceeds - $100.0 million Federal and State Funds - $150.2 million Private Activity Bond Proceeds - $3.4 million TIFIA Loan - $6.6 million

Project	Juris-diction	Com. close/ Fin. close	Value ($mil.)	Pay. mech.	Description
					Notes: - Concession = DBFOM on Segment 3A + OM on Segment 3B (Segment 3B to be built as DBB by TxDOT earlier) - With the Project, the IH 35W corridor will become a "Smart Corridor", using active traffic management technology to dynamically control traffic based on real-time roadway conditions, to provide information to the traveling public, to improve transit travel times, and allow transportation and law enforcement officials to better detect and respond to incidents in a timely manner. The technology will provide real-time information for congestion pricing in the managed lanes to maintain 50 mph travel. - This is the third transportation infrastructure project in the US to reach financial close with direct investment by a pension fund.
Goethals Bridge Replaceme nt	New York-New Jersey	2013/ Nov 5 2013	$1,500	AP	The Goethals Bridge carries I-278 over the Arthur Kill, connecting Staten Island to New Jersey and providing critical access for commuters and freight carriers between New Jersey and New York. The project replaces the existing 85-year-old bridge, which is functionally obsolete, with a new six-lane, cable-stayed bridge directly south of the existing bridge. The current bridge will be demolished upon completion of the new bridge. The replacement bridge will consist of six, 12-foot travel lanes, 12-foot outer shoulders, and 5-foot inner shoulders, as well as a 10-foot bike/pedestrian path along the northern edge of the New Jersey-bound side. The bridge design also includes a central area between the eastbound and westbound roadways to accommodate future transit service. The replacement bridge is being delivered as a design-build-finance-maintain (DBFM) P3 under a 40-year concession, a first for the Port Authority. The Port Authority will continue to operate the facility, set and collect tolls. It will make annual availability payments of $56.5 million to the concessionaire.

Project	Juris-diction	Com. close/ Fin. close	Value ($mil.)	Pay. mech.	Description
					Funding: TIFIA loan - $473.7 million (amount does not include $31.6 million in capitalized interest) Private Activity Bonds - $453.3 million Equity - $106.8 million Port Authority Milestone Payments - $125.0 million Pre-development costs funded by the Port Authority - $300.2 million Notes: - The Goethals Bridge Replacement is the first surface transportation P3 project in the Northeast U.S. that includes project finance and long-term maintenance.
US 36 (phase II)	Colorado	2013/ Feb 25 2014	$175	Tolled	U.S. 36 is a four-lane divided highway that connects the City of Boulder to Denver, Colorado at its intersection with I-25. The highway experienced significant congestion and had been targeted for improvements by the Colorado Department of Transportation (CDOT) since the late 1990s. The U.S. 36 Express Lanes Phase 2 project extends the 10-mile Phase 1 express lane facility five miles further northwest to Boulder and includes the following components: - One express, high occupancy toll (HOT) lane in each direction from 88th Street in Louisville/Superior to Table Mesa/Foothills Parkway in Boulder and reconstruction of the general purpose lanes, including widening to accommodate 12-foot inside and outside shoulders - Replacement of the Coal Creek Bridge, rehabilitation and widening of the South Boulder Creek Bridge, and widening of the McCaslin Boulevard Bridge to accommodate a diverging diamond interchange

Project	Juris-diction	Com. close/ Fin. close	Value ($mil.)	Pay. mech.	Description
					- Bus rapid transit (BRT) improvements, including bus priority at ramps and electronic signage (new and more frequent bus service will be provided) - Bikeway along much of the corridor - Intelligent transportation system (ITS) equipment, including for tolling, transit information, and incident management - Improvement of the Regional Transportation District (RTD) station at McCaslin Boulevard Phase 2 is being delivered as a design, build, finance, operate, and maintain (DBFOM) public-private partnership (P3). Pursuant to a competitive procurement process, HPTE selected Plenary Roads Denver Ltd. (PRD) in April 2013 as the concessionaire for Phase 2, completing improvements to the entire U.S. 36 corridor between Denver and Boulder. PRD financed, designed, and constructed Phase 2, and is operating and providing routine maintenance and lifecycle maintenance on the Phase 1, Phase 2 and the existing I-25 Express Lanes under a 50-year agreement. PRD is an affiliate of Plenary Roads Finco; the TIFIA Borrower. Funding: Plenary Funding: HPTE Capital Payment - $49.7 million TIFIA loan - $60.0 million Private Activity Bonds (PABs) - $20.0 million Equity - $20.6 million Subordinated Debt - $20.6 million I-25/US 36 Toll Revenues - $8.6 million Other - $3.4 million HPTE/CDOT Funding:

Project	Juris-diction	Com. close/ Fin. close	Value ($mil.)	Pay. mech.	Description
					State Funds - $8.2 million Federal Funds - $2.6 million Local Funds - $14.8 million Notes: - Addition of the HOT lanes will connect to the existing I-25 Express lanes that extend from U.S. 36 to downtown Denver and add to a network of regional toll-ways - Project represents a multimodal solution to alleviate congestion along the corridor by combining managed (HOT) lanes, Bus Rapid Transit (BRT) service, and a commuter bikeway. The new BRT service will use the managed lanes to reduce trip time and maximize travel time predictability for transit riders. - The Project will improve connections to the entire regional transit system through Denver Union Station, which serves as a multimodal transportation hub, integrating light rail, commuter rail, and intercity rail (Amtrak), as well as regional, express, and local bus service; - The P3 arrangement enables the project to be completed years sooner than originally planned
I-4	Florida	2014/ Sep 4 2014	$2,323	AP	The I-4 Ultimate project is the reconstruction and widening of 21 miles of I-4 from west of Kirkman Road in Orange County, Florida through downtown Orlando to east of State Road 434 in Seminole County. The project will: - Fully reconstruct the existing general purpose lanes - Add four express toll lanes in the median - Reconstruct 15 major interchanges - Reconstruct, construct, or widen 140 bridges

Project	Juris-diction	Com. close/ Fin. close	Value ($mil.)	Pay. mech.	Description
					The existing general purpose lanes, which range from three to four lanes in each direction are approximately 50 years old and experience significant levels of congestion. The Florida Department of Transportation (FDOT) will set toll rates and collect all revenue. Access and egress will be provided at five exchange areas (crossover zones) and by direct connectors at major intersections. The project is being procured as a 40-year design-build-finance-operate-maintain availability payment concession, with the private partner receiving milestone and completion payments during and immediately following construction completion. These milestone payments and availability payments during the operational period are not tied to toll revenue collections. Funding: Senior bank debt - $484 million TIFIA Tranche A loan - $127.3 million TIFIA Tranche B loan - $822.2 million Equity contribution - $103 million FDOT milestone payments during construction - $1.035 billion TIFIA capitalized interest and interest income - $306 million Notes: - The project includes numerous aesthetic treatments, including a signature pedestrian bridge, accent lighting, fountain illumination, art sculptures and monuments, and other architectural treatments - The project incorporates 25 approved technical concepts that exceed the minimum requirements established by FDOT for basic configuration, project scope, and design criteria. These include innovations in traffic flow, safety, community connections, sustainability, and use of technology.

Project	Juris-diction	Com. close/ Fin. close	Value ($mil.)	Pay. mech.	Description
I-77 HOT	North Carolina	2014/ May 2015	$655	Tolled	The I-77 HOT Lanes project will add 26 miles of variably priced managed lanes along I-77 and I-277 in Charlotte, North Carolina north through Mecklenburg and Iredell Counties. The project will provide two 17.5-mile HOT lanes in both directions from I-277 (Brookshire Freeway) near Charlotte Center City to Catawba Avenue in Cornelius and one HOT lane per direction for an additional eight miles from to NC 150 in Mooresville. At the southern end of the corridor, direct connector ramps will extend the lanes an additional 1.3 miles along I-277. The project will convert the existing HOV lanes between I-277 to north of I-485 in Huntersville (southbound) and between I-85 and I-485 (northbound) to High Occupancy Toll (HOT) operation. Second HOT lanes will be constructed on new right-of-way in both directions on this segment. The HOT lanes north of I-485 will also be built on new capacity. The project will include up to 12 points of access and egress and will utilize all-electronic tolling. The occupancy requirement for free travel on the HOT lanes will be HOV3+. Motorcycles, buses, and emergency vehicles will also be able to use the lanes at no cost. The project will enhance mobility and travel time reliability in the I-77 corridor north of Charlotte. This region has experienced significant population growth over the past 25 years, particularly in the communities along the northern portion of the corridor in Iredell County. Population growth in this portion of the region expanded at a rate 50 percent greater than the average state rate between 2000 and 2010. As a result, the I-77 corridor currently experiences significant which would worsen in the absence of the improvements. Funding: Private Activity Bonds (PABs) - $100 million TIFIA loan - $189 million Public funding - $94.7 million

Project	Juris-diction	Com. close/ Fin. close	Value ($mil.)	Pay. mech.	Description
					Equity contribution - $248 million Interest income - $0.5 million Bond premium - $3.6 million Notes: - A Developer Ratio Adjustment Mechanism (DRAM) is available to the private partner if toll revenues are insufficient to cover operational and/or debt service costs over specified periods of time. - The private developer's construction cost, including right-of-way acquisition, is $30 million less than NCDOT's estimated cost if it had built the project. - Project improvements will be realized an estimated 20 years sooner than otherwise anticipated relying on state funding alone.
Rapid Bridge Replacement Program	Pennsylvania	Jan 9 2015/ Mar 18 2015	$1,119	AP	The Pennsylvania Rapid Bridge Replacement Project will replace 558 structurally deficient bridges across the commonwealth under a design-build-finance-maintain (DBFM) public-private partnership (P3) arrangement between PennDOT and Plenary Keystone Partners. The concessionaire will also be responsible for demolishing the existing bridges, maintaining traffic during construction, and then maintaining the bridges for 25 years following construction. PennDOT will retain ownership of the bridges throughout the concession period. Most of the bridges included in the program range from 40 to 75 feet in length and are located in rural regions on the state highway system. The bridges are clustered in two groups, one in northeastern Pennsylvania and the second in the southwest. The project will be completed in two phases with the first involving the replacement of 87 Early Completion Bridges (ECBs), and the second including the 471 Remaining Eligible Bridges (REBs). All work is anticipated to be complete by December 2017. PennDOT chose the P3 structure to accelerate the replacement of the bridges and facilitate efficiencies in design and the construction of bridge

Project	Juris-diction	Com. close/ Fin. close	Value ($mil.)	Pay. mech.	Description
					components. This has resulted in a 20 percent cost savings over the life of the concession period compared to PennDOT's replacing the bridges itself. Total Project Funding (construction period): Private Activity Bond (PAB) Proceeds (Series 2015) - $721.5 million PAB Sale Premium - $71.9 million Equity (Plenary/Walsh) - $59.4 million Mobilization and Milestone Payments - $224.7 million Availability Payments - $35.8 million Interest Earned - $4.9 million Notes: - First project to be completed under Pennsylvania's 2012 P3 enabling legislation. - The batching of the projects will allow the bridges to be replaced and maintained at an average cost of $1.6 million each versus $2 million each if completed by PennDOT. - Largest road project in Pennsylvania history. - Largest PAB financing to date in the United States. - PennDOT obtained a SEP-15 waiver to delegate NEPA/permitting responsibility to the concessionaire as part of the agreement. - The concessionaire is subcontracting all rehabilitation work to a total of 11 local contractors and will use locally-based staff to perform long-term maintenance. - Bond Buyer Deal of the Year awards winner 2015.
Portsmouth Bypass	Ohio	2015/ Mar 21	$819	AP	A $646 million, 16-mile, four-lane, limited-access highway around the City of Portsmouth in Scioto County in South Central Ohio. Designated as State

Project	Juris-diction	Com. close/ Fin. close	Value ($mil.)	Pay. mech.	Description
		2015			Route 823, the project will improve travel and regional mobility allowing motorists to avoid traffic signals and intersections on the current 26-mile route using US 52 and US 23. The Portsmouth Bypass will have five interchanges and is expected to provide travel time savings of up to 16 minutes per trip compared to the current route. The project will also provide a largely access-controlled alternative to I-77 and I-75 for motorists making trips between southern Ohio and the Columbus region, saving over 70 miles on some trips. The project is being delivered as an availability payment design-build-finance-operate-maintain (DBFOM) concession. The term of the concession will extend for 35 years once the highway is open. <u>Funding:</u> Portsmouth Gateway Group Funding - $556.8 million (design, construction, financing) Private Activity Bonds (PABs) - $227.3 million PABs premium - $24 million TIFIA Loan - $209.3 million Private equity - $48.9 million Interest earnings - $4 million ODOT Funding - $89.5 million (preconstruction activities including environmental analysis, preliminary engineering, right-of-way acquisition) + $44 million (milestone payments) Appalachian Development Highway System funds - $97 million Other federal and state funds - $36.5 million <u>Notes</u>: - The project is the first availability payment P3 concession in Ohio. - By procuring the project on a DBFOM basis, ODOT has consolidated the implementation period for the project from 13 to 5 years.

Project	**Juris-diction**	**Com. close/ Fin. close**	**Value ($mil.)**	**Pay. mech.**	**Description**
SH 288	Texas	Mar 7 2016/ May 9 2016	$425	Tolled	SH 288 is a 61-mile highway between Houston and the Gulf of Mexico providing a vital route for commuters, freight and commercial trucking, and hurricane evacuation. The highway's configuration has remained essentially unchanged since 1984. It extends from I-45 in downtown Houston to US 36 in Freeport, intersecting three major orbital roadways in the metropolitan region: I-610, Sam Houston Tollway (Beltway 8), and SH 6. SH 288 links the major employment center of downtown Houston and the Texas Medical Center with the rapidly growing residential communities of Harris County and Brazoria County. The SH 288 Toll Lanes project is located within Harris County and involves the development, design, construction, financing, operation, and maintenance of four new toll lanes that extend 10.3 miles along the median of SH 288, as well as the maintenance of the existing general purpose lanes along the SH 288 corridor. The project also includes the reconstruction of 75 percent of the I-610 interchange, the addition of direct connector ramps at Beltway 8, and 1.3-mile direct connector ramps to the Texas Medical Center (TMC Connector). Funding: Private Activity Bonds (PABs) (senior debt) - $298.6 million TIFIA Loan - $357.0 million Private Equity - $375.3 million TxDOT Funds (for the Texas Medical Center Connector) - $17.1 million TIFIA Capitalized Interest - $14.9 million Interest Income - $0.7 million Notes: - The project is wholly financed by the private sector with the exception of TxDOT's contribution to the Texas Medical Sector direct connectors' construction

Project	Juris-diction	Com. close/ Fin. close	Value ($mil.)	Pay. mech.	Description
					- An Alternative Technical Concept proposed by the private partner will reconstruct about 75 percent of SH 288's interchange with I-610.

8 Appendix B. Supplementary Information for Chapter 3: Actual Contractual Language of Risk Sharing Mechanisms

Relief event: *"Relief Event means any of the following events, subject to other limitations, requirements and deductibles that may be set forth in the Agreement for such events: (a) Force Majeure Event; (b) Change in Law; (c) Department Change (other than a Discriminatory O&M Change and Non-Discriminatory O&M Change); (d) Discriminatory O&M Change; (e) Non-Discriminatory O&M Change; (f) The Department's failure to perform or observe any of its material covenants or obligations under the Agreement or other Contract Documents (except where such failure is within another defined Relief Event);…"* (Project Presidio Parkway, Appendix 1, page 48).

Compensation event: *"Compensation Event means any of the following events, provided that such events are beyond Developer's control and are not due to any act, omission, negligence, recklessness, willful misconduct, breach of contract or Law or violation of a Governmental Approval by any of the Developer-Related Entities, and further provided that such events (or the effects of such events) could not have been avoided by the exercise of caution, due diligence, or reasonable efforts by Developer (and subject to any limitations, claims submission requirements and other conditions set forth in the Agreement): (a) Discriminatory Change in Law; (b) Discriminatory Action; (c) Material breach by NCDOT of its material obligations under the Agreement or other CA Documents, including unreasonable failure to issue a certificate of Substantial Completion or certificate of satisfaction of conditions precedent to Final Acceptance or Final Completion after Developer satisfies all applicable conditions and requirements for obtaining such a certificate; (d) NCDOT-Caused Delay; (e) NCDOT Change;…"* (Project I-77, Exhibit 1, page 13).

Delay event: *"Delay Event means: (a) with respect to the Construction Period, the occurrence of one or more of the following during the Construction Period: (i) a Force Majeure Event; (ii) discovery of a Differing Site Condition or Unknown Geotechnical Condition; (iii) an unreasonable and unjustifiable failure by a Governmental Authority to issue, or an unreasonable and unjustified delay by a Governmental Authority in issuing, any Governmental Approval or other authorization required for the Project or the Work; …(b) with respect to the Operating Period, the occurrence of one or more of the following during the Operating Period:(i) a Force Majeure Event;(ii) issuance by a Governmental Authority of competent jurisdiction of an injunction or other order enjoining or estopping either the Department or the Concessionaire from the performance of its rights or obligations under the Agreement; (iii) a Change in Law occurring after the Service Commencement Date that imposes one or more changed or additional requirements that directly and materially adversely impact the performance of the Work and that could not have been reasonably anticipated by a reasonable concessionaire;…"* (Project I-95, Exhibit A, page A-15).

External reference: "*Fair Market Value means with respect to the Developer's Interest the following, determined according to the procedures set forth in Exhibit 22 to the Agreement: (a) The amount that a willing buyer would offer, and a willing seller would accept, for the purchase and sale of the Developer's Interest, in an arm's length transaction, assuming (i) neither party is under economic compulsion or has special bargaining power, (ii) the buyer possesses all information in the possession of Developer relating to the Facility, its condition, the Work, the FCA Documents, and the revenues and expenses of Developer,…"* (Project SH-130, Exhibit 1, page A-31).

Force majeure event: *"Force majeure event means the occurrence of an event, act, omission, condition, or circumstance beyond either parties' reasonable control and due to no fault of either party, or those for whom either party is responsible, that materially prevents or delays the Concessionaire from performing any of its obligations pursuant to the Agreement. An event is not a Force Majeure Event if such event is otherwise specifically dealt with in the Agreement or arises by reason of: …(i) market conditions and economic conditions affecting traffic volumes… (j) weather conditions, other than hurricane force winds, tornadoes and floods to the extent not excluded by the above."* (Project I-95, Exhibit A, page A-26).

Require further interpretation: *"Discovery of (i) subsurface or latent physical conditions at the actual boring holes identified in the geotechnical reports included in the Reference Information Documents that differ materially from the subsurface conditions indicated in such geotechnical reports at such boring holes, excluding any such conditions known to Developer prior to the Proposal Due Date, or (ii) physical conditions within the Project Right of Way of an unusual nature, differing materially from those ordinarily encountered in the area and generally recognized as inherent in the type of work provided for in the Agreement, excluding any such conditions known to Developer prior to the Proposal Due Date or that would become known to Developer by undertaking reasonable investigation prior to the Proposal Due Date…"* (Project IH-635, Exhibit 1, page 53).

Negotiation: *"The Parties shall conduct all discussions and negotiations to determine any compensation amount…*" (Project I-4 Ultimate, Concession Agreement, Section 10.3).

Extension: *"Extended Relief Event means and is limited to the occurrence of any of the following events that is beyond Developer's control and directly causes one of the results described in Section 19.2.1.2 of the Agreement for more than 270 consecutive Days: (a) Discovery at, near* *or on the Facility Right of Way of any Hazardous Materials or archeological, paleontological or cultural resources, …; (b) Discovery at, near or on the Facility Right of Way of any species listed as threatened or endangered …(c) The issuance of a temporary restraining order or other form of injunction by a court that prohibits prosecution of any portion of the Work…"* (Project SH-130, Exhibit 1, page A-27).

Deductible: *"(A) the Concessionaire will be solely responsible for the Net Cost Impact for performing Excess Rehabilitation Work up to $5 million in the aggregate ("Excess Rehabilitation Work Deductible"); and (B) the Department will be solely responsible for the Net Cost Impact for performing Excess Rehabilitation Work in excess of the Excess Rehabilitation Work Deductible but less than or equal to $20 million…"* (Project Elizabeth River Tunnels, Comprehensive Agreement, Section 8.11.c).

Proration: *"The Parties shall negotiate in good faith to determine the Refinancing Gain. FDOT will receive a payment equal to 50% of any of Refinancing Gains received in connection with any Refinancing other than an Exempt Refinancing. FDOT will receive its portion of the Refinancing Gains in the manner provided in Appendix 11. Concessionaire shall bear all risks for any Refinancing that negatively affects its Equity IRR, debt coverage ratios or financial performance."* (Project I-4, Concession Agreement, Section 16.4.3).

Extra work costs and delay costs: *"Extra Work Costs means those costs incurred by Concessionaire or its first tier Contractor(s) for the Construction Work in the provision of additional goods or services as the result of an FDOT Change or a Relief Event, which shall be calculated as set forth in Section 4-3.2 of Division I of the Technical Requirements. In addition to those amounts provided for in Section 4-3.2 of Division I of the Technical Requirements, Extra Work Costs shall include direct, out-of-pocket costs beyond the cost of goods and services incurred* *as the result of a Relief Event only and the cost to finance the additional goods or services if FDOT elects to compensate Concessionaire in a manner other than payment of the Extra Work Costs as they are incurred and properly invoiced by the Concessionaire to FDOT."* (Project Port of Miami Tunnel, Appendix 1, page 17).

"Delay Costs means those costs for actual idle labor and equipment, and indirect costs, expenses and profit thereon as set forth in Section 4-3.2.1 (d) of Division I of the Technical Requirements, in each case, incurred by Concessionaire or its first tier Contractor(s) for the Construction Work as set forth in, and the other compensation contemplated in Section 5-12.6.2 of Division I of the Technical Requirements for FDOT Caused Delays or Critical Path delays to the Project Schedule caused by a Relief Event. In addition to those amounts provided for in Section 5-12.6.2 of Division I of the Technical Requirements, Delay Costs shall include any additional finance costs incurred by the Concessionaire as a result of an FDOT -Caused Delay or a Critical Path delay to the Project Schedule caused by a Relief Event. Delay Costs shall not include any compensation for rental costs for the tunnel boring machine." (Project Port of Miami Tunnel, Appendix 1, page 11).

Insurance: *"The Concessionaire shall obtain All Risk Property Insurance at full replacement cost, covering all loss, damage or destruction to the Parkway, including improvements and betterments; provided, however, that the limits of such coverage may be based on a probable maximum loss analysis, subject to the Authority's Approval of such probable maximum loss analysis by an independent third party that is reasonably acceptable to the Authority, which Approval shall be provided prior to Closing…"* (Project Colorado Northwest Parkway, Concession and Lease Agreement, Section 13.1).

Cost adjustment: *"After the adjustments to the Base Maximum Availability Payment as provided in Section 13.7.8, the Maximum Availability Payment in any year exceeds the Annual MAP Limit for that year and IFA gives Notice to Developer of its exercise of the right to terminate this Agreement as provided in Section 20.6.1;"* (Project The East End Crossing, Public-Private Agreement, Section 13.7.7.2)

Relief event (for the governments): *"The Parties acknowledge that Concessionaire may incur certain losses due to delays in commencement of Availability Payments by the Baseline Substantial Completion Date. For the delay in receiving Availability Payments beyond the Baseline Substantial Completion Date, FDOT agrees to compensate Concessionaire for its losses, but only to the extent such losses are caused by Relief Event Delays. Such compensation shall be calculated in accordance with the formula set forth in Section 10.2.2.2."* (Project I-4, Concession Agreement, Section 10.2.2)

Maximum reimbursement: *"The Route One Improvements will be treated as a Compensation Event unless the Highest Revenue Share IRR has been reached as of the Commencement of Use of the Route One Improvements."* (Project I-95, Comprehensive Agreement, Section 12.05)

9 Appendix C. Supplementary Information for Chapter 4: Pseudo code for scenario analysis

Scenario 2 – DRAM

$ST_i = \max\{0, D_i - CFD_i\}$ (1)

$DRAM\_X_i = \min\{\$12\ mil, DRAM\_BL_i, ST_i\}$ (2)

$DRAM\_BL_{i+1} = DRAM\_BL_i - DRAM\_X_i$ (3)

$CFR_i = CFD_i + DRAM\_X_i - D_i$ (4)

$TV\_CF_i = CFR_i / (1 + WACC)^i$ (5)

$DSCR_i = CFD_i / D_i$ (6)

$APL_i = \sum_{j=1}^{i} DRAM\_X_j$ (7)

Where (in year i):

ST – shortage; DRAM_X – DRAM exercised (guarantee payable); DRAM_BL – DRAM balance; TV_CF – Time value of residual cash flow; APL – Aggregate public loss (total DRAM exercised)

Scenario 3 – Barrier put option

First year:

$W_1 = \min\{A_1, ST_1\}$ (8)

$SP_1 = CFD_1 - D_1$ (9)

$DEP_1 = \min\{max\_A - A_1, SP_1\}$ (10)

$ST'_1 = ST_1 - W_1$ (11)

$EX_1 = \min\{max\_EX, ST'_1\}$ (12)

$CFR_1 = CFD_1 – D_1 – DEP_1$ (13)

$DSCR_1 = (CFD_1 + EX_1 + W_1 – DEP_1) / D_1$ (14)

In year i:

if (W_{i-1} >= X) *then* {$trigger_i = 1$} (15)

else {$trigger_i = 0$} (16)

if ($trigger_i = 1$) *then* {

$EX_i = \min \{PBL_i, max\_X, ST_i\}$ (17)

$ST'_i = ST_i - EX_i$ (18)

$W_i = \min \{A_i, ST'_i\}$ (19)

$DEP_i = \min \{max\_A – Ai, SP_i\}$ (20)

$PBL_{i+1} = PBL_i – EX_i$ (21)

}

if ($trigger_i = 0$) *then* {

$W_i = \min \{A_i, ST_1\}$ (22)

$DEP_i = \min \{max\_A – A_i, SP_i\}$ (23)

$ST'_i = ST_i – W_i$ (24)

$EX_i = \min \{max\_EX, ST'_i\}$ (25)

}

$CFR_i = CFD_i – D_i – DEP_i$ (26)

$TV\_CF_i = CFR_i / (1 + WACC)^i$ (27)

$DSCR_i = (CFD_i + EX_i + W_i - DEP_i) / D_i$ (28)

$APL_i = \sum_{j=1}^{i} EX_j$ (29)

Last year of debt service (year n), the project company is entitled to the rest of the TIFIA reserve account:

$CFR_n = CFD_n - D_n + An$ (30)

Where:

W – Withdraw from TIFIA reserve account;

A – Current balance of TIFIA account

SP – Surplus of cash flow after debt service

DEP – Deposit into TIFIA account

ST' – residual shortage after withdrawing/depositing from/to TIFIA account

EX – Exercised amount of put option

max_EX – yearly maximum exercisable ($12 mil.)

X – down-and-in barrier of the put option ($5 mil.)

PBL – balance of aggregate put exercised

Scenario 4 – Put and gap call option

For the regular put: same as DRAM but with increased maximum yearly and aggregate exercisable.

For the gap call:

if {$SP_i > 0$} *then* {

$$EX\_gap_i = \max\{0, y^*(CFDi - x^*Di)\} \quad (31)$$

}

$$CFR_i = CFD_i - EX\_gap_i \quad (32)$$

$$APL_i = \sum_{j=1}^{i} EX\_put_j - \sum_{j=1}^{i} EX\_gap_j \quad (33)$$