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Transportation Research Procedia00 (2018) 000–000

Transportation Research Procedia

www.elsevier.com/locate/procedia

World Conference on Transport Research - WCTR 2019 Mumbai 26-31 May 2019

Feasibility of Flexible Term Concession based Real Options in Public Private Partnerships in Indian Highway Sector

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Abstract

Public Private Partnerships (PPPs) enable transfer of responsibility in Infrastructure creation from Public sector to Private sector. Different PPP models were developed over time with varying degrees of responsibility sharing, and models such as Build Operate Transfer (BOT) have minimal dependence on Public resources for Infrastructure creation. Variation of actual traffic from the forecasts resulted in underperforming projects, leading to losing attractiveness of the BOT model in Indian Highway sector. Acknowledgement of uncertainty in traffic forecasts had led to the development of Least Present Value of Revenue (LPVR) based Flexible Term Concessions (FTC). This model offers a flexible term concession period that expires on attaining a pre-determined Net Present Value (NPV) of Revenues, thereby addressing the traffic demand risk. Real traffic data from two Indian Highway projects were used to build a Geometric Brownian Motion based stochastic model to assess the feasibility of FTCs in Indian Highway PPPs. To add more value to the use of FTCs in India it is proposed to offer FTCs as Real Options to delay the decision making till uncertainty in traffic demand is resolved. Real Options analysis was conducted using Monte Carlo Simulations on the model and the incremental net revenues to the concessionaire was noted as the value of the Real Option. Feasibility of implementing FTCs as Real Option was further studied through interactions with practitioners in Indian Highway PPPs.

*Keywords:*Real Options Analysis; Flexible Term Concessions; PPP; Least Present Value of Revenue

1. Background

Public Private Partnerships can be a powerful aid to public sector for efficient creation of infrastructural assets such as highways. The huge infrastructural deficit in developing economies can therefore be addressed by employing tools

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such as PPPs. India had actively explored PPP for infrastructure asset creation over the past years, with special focus in Highway projects (FICCI, 2017). Such tools allow transfer of various risks and responsibilities between the private and public sector, aiming at a common goal of infrastructure development. However, transfer of higher volume of risks to private sector comes at a premium cost, and prudent choice of PPP models with effective risk distribution between stakeholders is very necessary to create successful PPPs (Ng & Loosemore, 2007).

1.1. Demand Uncertainty

Almost entire project cost is incurred in the construction phase for highway projects, and revenues are spread over a long operational phase. This creates a huge risk in the form of traffic demand, as revenue is directly driven from traffic in tolled roads. The project revenue models are based on initial estimates made before construction and is susceptible to significant errors and biases (Flyvbjerg et. al, 2005; Bain & Polakovic, 2005). Estache et. al (2000) had discussed the limitations in traffic forecasting methods. Flyvbjerg et. al (2005) notes that forecasts are prone to over-optimism bias, resulting in actual traffic to be lesser than forecast in most cases. Since Built Operate Transfer (BOT) based projects transfer entire traffic risk to private concessionaires, presence of such large uncertainties in forecasts makes use of such models a risky proposition to private investors. Such uncertainties can result in scenarios where concessionaires make huge profits(losses) in higher(lower) than forecasted traffic (Vassalo, 2006), with losses being more likely due to the optimism bias. Lower traffic in BOT projects, can lead to project distress and has resulted in a lowering interest from private sector in developing BOT projects (FICCI, 2017). Currently in India most highway projects are being awarded in Engineer Procure construct (EPC) or Hybrid Annuity Model (HAM), with government absorbing most project risks.

1.2. PPP Models Used in India

BOT models were a common tool for developing Highway projects in India, however, is being used significantly lesser in recent years (Iyer and Sagheer, 2011). In BOT projects, concessionaire is required to finance, construct and operate the project through a fixed concession duration and the revenues are mostly driven from tolls. The projects also feature a negative grant or viability gap funding to adjust for the difference in project revenue forecasts and costs. Aggressive bidding and unreliable traffic forecasts have resulted in multiple distressing projects and demands for renegotiations. This has been a cause for losing interest in BOT model, leading to development of other models, that transfer most project risks from private stakeholders to government.

The Hybrid Annuity Model is a novel model developed to enhance competitiveness in the sector. This model features a complete absorption of project revenue risk by the government, with 40% of project costs paid to the concessionaire during construction phase and 60% paid semiannually during operations phase. The revenue risk absorption resulted in increased private sector attractiveness in Indian Highway projects (FICCI, 2017). Some projects are also being developed under the Engineer Procure Construct (EPC) model, where concessionaire responsibility is limited to construction. Such models present limited avenues for risk sharing and heavily relies on government resources for project creation, unlike BOT model.

2. Literature

2.1. Real Options

Real Options are considered as a powerful tool to create and value flexibility in projects. Amran and Kumaratilaka (1999) defines Real Options as “the right but not the obligation to take specific future actions depending on how uncertain conditions evolve”. Real Options were derived from Options theory in finance and the value of such Options are due to their flexibilities and cannot be captured in traditional modelling. Various methods for valuing Real Options were developed such as Black Scholes Option Pricing Model (BSOPM), Binomial Option Pricing Model (BOPM), the Risk-Adjusted Decision Trees (RADT), the Monte Carlo Simulation (MSC), and Hybrid Real Options (HRO) (Martins et. al, 2013).

Real Options in engineering were classified as Options “In” projects and Options “On” projects by Wang and Neufville (2005). Options “in” projects deal with flexibilities embedded in project design. Options “on” projects presents flexibilities in operations, with limited impact on design. Real Options “in” projects can offer much more flexibility and value but is more challenging to model. Krüger (2012) and Ashuri & Kashani (2011) had presented phased development of Highway projects as a Real Option “in” projects. Literature exploring Real Options “on” projects mainly focus on contractual flexibilities. Offering Minimum Revenue Guarantee was studied as a Real Option “on” highway projects by many scholars (Iyer and Sagheer, 2011; Shan et. al, 2010; Ashari et. al, 2010a; Ashari et.al 2010b; Carbonara et.al 2014).

2.1. Flexible Term Concessions

Another form of flexibility that mitigates revenue risk is flexible term highway concessions (FTC). This was introduced in Chile through Least Present Value of Revenue based auctions, as a mechanism for highway concession allocation (Engel et.al, 2001). The bids are made on the Net Present Value (NPV) of revenues required from the project, at a predetermined discount rate. The project is awarded to the lowest bidder, and project termination attained when NPV of actual revenues matches this bid value. LPVR therefore accommodates the traffic risk by introducing Flexible Term Concession to traditional BOT model. In FTCs, the traffic risk is shifted from the concessionaire to the highway users (Carpintero et. al, 2013). The concessionaire is indemnified from traffic risk and since revenue is determining project completion, the progress can be calculated with more transparency. This offer simpler compensation terms in events of early project termination or government takeovers (Engel et. al, 1997). LPVR based FTCs therefore offer superior benefits to the public and government by managing the traffic risk with no additional burden on the concessionaire (Engel et. al, 1997; Albalate and Bell, 2009). During an economic recession in Chile, most highway concessions were affected and demanded renegotiations, except the one that was awarded through LPVR auction (Vassallo, 2006).

However, LPVR based auctions were not popular among private sector developers in Chile. Vassalo (2010) notes that FTCs offer an asymmetric risk profile, since the project will terminate early in event of a higher than anticipated traffic without fully eliminating the downside risk. In very low traffic turnouts, due to compound discounting the impact of later year traffic is diminished, especially if a high discount rate is used. Extension in concession duration beyond serviceable life of highways can rapidly escalate operational expenses. To make FTCs attractive to developers, Vassalo (2010) proposed two improvements. First to create an upper and lower limit for FTC duration, the lower limit will ensure concessionaire can benefit in an upside traffic turnout and upper limit protects concessionaire from operating a non performing project in a downside traffic turnout. The second was a compensation of deficit revenues from government to meet the original LPVR target, to fully indemnify concessionaire from revenue risks. Nombela and Rus (2003) proposed Least Present Value of Net Revenue (LPVNR) based auctions to indemnify concessionaire from escalations in operational costs. However, the reluctance of concessionaire in sharing actual cost can hinder adoption of LPVNR based FTCs.

Real Options are a powerful tool to introduce flexibilities to manage demand uncertainties in highway sector. However, most literature focused on using Minimum Revenue Guarantee for managing traffic risk. Asao et. al (2013) had noted that FTCs are of superior advantage in managing traffic risks for governments with budgetary constraints. And Liu et. al (2017) had presented how FTCs are limited in comparison to MRGs in managing projects with high revenue volatility. This article explores the effectiveness of FTC based Real Options in Indian Highway sector, by considering two BOT projects in operational phase. The value of the Real Option thus calculated is presented to practitioners and their feedback is used to understand some of the challenges to their implementation.

3. Methodology

3.1. Projects Considered

Both the projects considered were awarded in BOT model with a fixed concession duration of 20 years. First project, hereafter referred to as Project A was a Greenfield project and was a short urban corridor. Second Project, hereafter referred to as Project B was a relatively longer rural corridor, and the Brownfield project aimed to widen an existing

2 lane corridor to 4 lanes. The information available at the preconstruction phase was taken from the Model Concession Agreement (MCA) for both the projects. The consortiums operating both projects were led by the same firm, and weekly traffic data across vehicle categories were obtained for 7 years from this firm. Information on construction schedule, actual costs etc were obtained from secondary sources and through interactions with this firm. A comparison of the expected revenue from initial forecasts and actual toll revenue obtained during these 7 years are presented in table 1 for Projects A and B.

Table 1: Expected and Actual Revenues from Project A and Project B (Millions)

	Year	2009	2010	2011	2012	2013	2014	2015	2016
Project A	Forecast	₹ 145	₹ 590	₹ 650	₹ 751	₹ 823	₹ 885	₹ 983	₹ 1,114
	Actual	₹ 282	₹ 376	₹ 407	₹ 453	₹ 486	₹ 562	₹ 620	₹ 629
Project B	Forecast	₹ 230	₹ 710	₹ 791	₹ 880	₹ 978	₹ 1,087	₹ 1,208	₹ 1,341
	Actual	₹ 95	₹ 699	₹ 834	₹ 967	₹ 1,054	₹ 1,100	₹ 1,348	₹ 1,384

Project A indicate a large variation in actual revenues from the initial forecast. Such errors are in accordance with the literatures discussed in section 1.1. The actual traffic for Project B was however comparable to the initial forecasts.

3.2 Deterministic Revenue Modelling

Based on bid time forecast from the MCA and initial assumptions on cost and schedule obtained from the concessionaire, a project revenue model was constructed for both projects. The returns from this deterministic model were presented to the analysts at the lead firm of the consortia, for validation. These returns represent the initially expected returns from both the projects. The total returns till end of the 20 years of concession was discounted at 12% to arrive at the NPV of expected revenue from the fixed term BOT model. The choice of 12% discount rate was in accordance with the Manual for Economical Evaluation of Highway Projects in India (IRC SP30) and was also validated with the lead firm. In LPVR based FTCs, the present value of revenue is the bid parameter and hence serve as a direct metric to identify completion of the flexible concession schedule. The bid for BOT projects in India is usually based on the viability gap funds or negative grants, hence there is no direct method to identify FTC completion as in case of LPVR based auctions. However, the deterministic model developed is based on the initial assumptions and is a good estimate of the concessionaire's initial expectations from the project. Therefore, this article used the NPV of toll revenues from the deterministic model for identifying the target for FTC completion.

3.3 Traffic Forecast

The deterministic model is incapable of acknowledging the variability in traffic forecasts discussed in section 1.1 and cannot capture the value associated with flexibilities, such as FTC. The 7 years of traffic data presented an opportunity to capture actual observed growth rates and use it to develop a probabilistic forecast of traffic for subsequent years. Geometric Brownian Motion method was chosen to stochastically forecast future traffic, as it is extensively used for demand forecasts under risk.

The exponential growth rates from actual traffic growth curves for each vehicular segment was obtained using the method of curve fitting and iterated to minimize the mean squared error in fitting. However, complete reliance on actual data might bias the forecast with short term trends and miss out on long term macroeconomic trends that the forecast in MCA might have captured. Therefore, actual growth rate used for forecast was based on both observed rates, from curve fitting as well as the initial rates, presented in the MCA. The actual rate was computed based on these two rates using equation 1.

$$r_u = \sqrt{(r_o * r_f)} \tag{1}$$

where,

r_u : actual used rate,
r_o : observed rate, and
r_f : initial forecast rate.

The use of Geometric Mean, brings r_u closer to the smaller of r_o and r_f, limiting any over optimism present in either r_o or r_f, due to short term trends and biases.

In the Geometric Brownian motion approach, the forecast at every point for each vehicle segment is only based on the outcome at previous point and the growth rate. This relation is presented in equation 2

$$T_{n+1} = T_n[1 + (dr + vol)] \quad (2)$$

where,

T_{n+1} : forecast for next time interval,
T_{n+1} : forecast/ actual traffic at current time interval,
dr : drift factor, and
vol : volatility factor.

The drift component is the average exponential rate at which demand is expected to grow. In this model, the growth rate r_u, as computed from equation 1 for each vehicle segment, was used as the drift factor. In Geometric Brownian motion, while the demand is expected to grow exponentially, it is also expected to demonstrate random variations. Possibility of such variations necessitates a stochastic forecast and the volatility factor (vol) in the equation 2, is responsible for that variations. In this model, the forecasts are based on actual data and hence such variations in forecast can be expected to be similar to the variations actual data had demonstrated in the exponential curve fitting. Such fluctuations in actual data were captured as the standard deviation of the square of errors in curve fitting. Hence the volatility factor was modelled as a normal random variable with mean 0 and standard deviation as square root of the standard deviation of square of errors observed in curve fitting.

3.4 Stochastic Revenue Modelling

The revenue model developed in section 3.2 was based on expected costs and a deterministic traffic forecast. To compute the real returns from the project, information on actual costs and schedule were collected from the concessionaire and secondary data sources. The revenues were calculated from the traffic forecasts made from actual data, as mentioned in section 3.3. The NPV of total returns till end of 20th year (BOT concession duration) was calculated as the possible returns from the projects by continuing in BOT model. However, the returns thus calculated represents only one of the many possible outcomes from the stochastic traffic forecast. Therefore, Monte Carlo simulations were applied on the BOT revenue model to obtain outcomes from 1000 iterations, and thereby identify the probabilistic nature of the returns. Plotting a value at risk curve for this provide insights into what actual returns from both projects will look like at end of the concession period.

3.5 Real Options Modelling

This article explores the feasibility of offering FTC as a Real Option. The value of such an option can be calculated as the incremental revenue the concessionaire can incur from a flexible term concession, compared to a fixed term concession. To arrive at the returns from using FTC, first the stochastic traffic forecasts developed as mentioned in section 3.3 was extended for 50 years, and the revenue model developed as mentioned in section 3.4 also similarly extended. The FTC duration was computed as the year at which NPV of actual toll revenues meet/exceed the NPV of expected toll revenues. Monte Carlo simulations was applied on this to obtain the distribution of FTC durations and note the probability of exceeding practical limits. For evaluating FTCs as Real Options however the duration was limited between 15 and 25 years as per recommendations of Vassalo (2010). The value of the Real Option was computed as the average incremental net returns incurred by the concessionaire on using flexible term concession compared to the fixed term concession.

Vassalo (2010) had also recommended a guaranteed government payout of deficit revenues, if target was not attained within maximum permitted duration of FTC. This was modelled as another Real Option, where the flexibility was limited between 15 and 25 years, with a provision of government payout of deficit revenues on 25th year. The government payout ensures that on exercising this option, the concessionaire is assured a minimum net revenue as presented in the deterministic model. The value of this Real Options was also calculated as the incremental NPV of net revenues by exercising this option, compared to fixed term BOT. The NPV of net revenue from deterministic model was considered as the minimum net revenue assured to the concessionaire through this option.

4. Results

4.1 Initially Expected Returns

The expected returns from Projects A and B form the baseline for comparing viability of FTC based Real Options. Table 2 indicate the initially expected returns from both projects as calculated from the deterministic model developed in section 3.2.

Table 2: Expected Returns from Projects A and B

	NPV of Net Revenue (at 12%)	NPV of Toll Revenue (at 12%)	IRR (%)
Project A	INR 0.3 Billion	INR 7.3 Billion	14.2 %
Project B	INR 0.7 Billion	INR 9.4 Billion	15.5 %

4.2 Duration of FTC

The major concern regarding applicability of FTCs is the possibility of attaining toll revenue targets within a reasonable duration. Very long extensions can result in extensive maintenance costs and repeated discounting can lead to situations where toll revenue target may never be met. Figure 1 and 2 respectively represents the probability histograms for FTC durations for projects A and B.

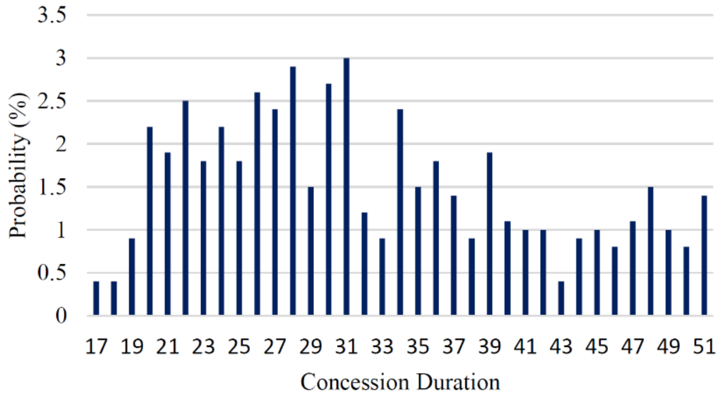

Figure 1: FTC duration for Project A

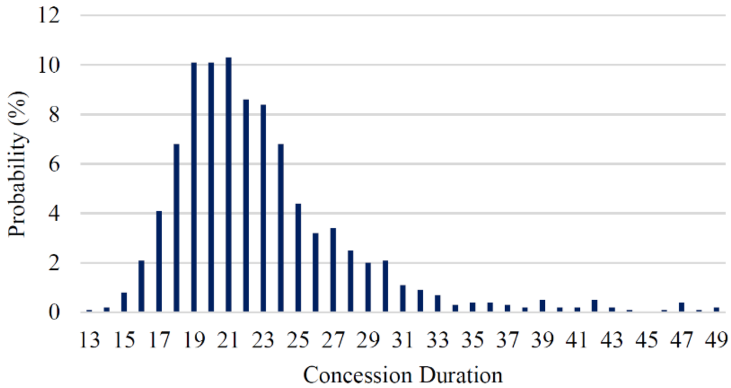

Figure 2: FTC duration for Project B

The FTC duration was modelled for both projects till a maximum duration of 50 years, and the results indicated that the duration will exceed 50 years for Projects A and B with probabilities of 45% and 7% respectively and the figures 1 and 2 represent only the durations that were lower than 50 years. From figure 2, very large durations are highly likely for Project A, and are practically not feasible, hence FTCs cannot benefit projects with extremely low traffic turnout, such as Project A.

4.3 Real Option Value

The net benefit to the concessionaire by choosing a Real Option can be computed as the difference in NPVs with and without the Real Option. The stochastic traffic model was used to calculate the probable net returns to concessionaire using Monte Carlo simulations, with fixed term concession as well flexible term concession. The difference in average net returns in both cases was calculated as the value of the Real Option. The Value was also calculated for the option with the provision of government payout. These values are presented in Table 3 below:

Table 3. Expected NPV* of Net Revenue and Value of Real Option

Project	Project A	Project B
NPV of Net Revenues, regular BOT	- INR 989 Million	+ INR 492 Million
NPV of Net Revenues, FTC	- INR 644 Million	+ INR 553 Million
Value of Real Option without govt: payout	+ INR 345 Million	+ INR 30 Million
Value of Real Option with govt: payout	+ INR 1,345 Million	+INR 220 Million

**Computed at 12% discount rate, with reference point as commencement of concession period*

Both options indicate a positive value for the concessionaire, in both projects. The option with guaranteed government payout has very higher value, as it eliminates the downside risk entirely.

The Value at Risk plot for net revenues are presented in figure 3 and figure 4, respectively for Projects A and B. The plot is for the option without government payout, to demonstrate how the flexible concession duration alone can impact the project performance.

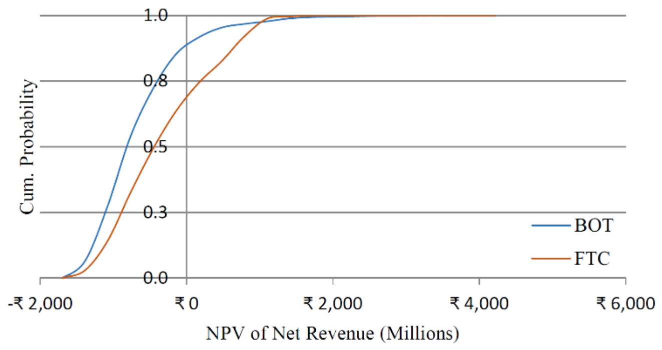

Figure 3. Probability of NPV of Net Revenues from Project A

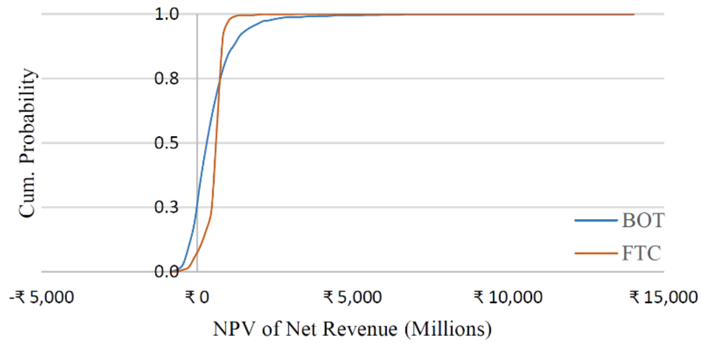

Figure 4. Probability of NPV of Net Revenues from Project B

From table 3 and figure 3, it can be noted that Project A is likely to yield negative returns with fixed term BOT as well as with flexible term concession duration. Project B is likely to incur positive returns with fixed term BOT, and this can be improved by use of FTC. Figure 4 demonstrate how the VAR curve for FTC has lower variance in comparison to the same for fixed term BOT. The right sided tail of VAR curves in figure 4 indicate a higher probability of earning very high returns with use of fixed term BOT concessions in comparison to FTCs, due to the early termination of FTC in events of high traffic turnouts.

5. Discussions

5.1 Practitioners Feedback on FTC based Real Options

The results from the valuation of Real Options, presented in table 2 indicate positive values for FTC based Real Options, with and without government pay out. The results were presented to the Chief Financial Officer of the lead firm in the consortia for the projects and later to the government executives from the department of finance.

The interactions identified that for Project A, the Real Options without government pay out was not attractive enough for the private sector as the net returns remained negative, despite the flexibility. The option with government payout of deficit revenues was however found attractive as it fully indemnified the concessionaire from downside risks. The government representatives opposed the idea of payout of deficit revenues on FTC completion, as the huge deficit computed at a 12% discount rate will be a very large value by end of the concession period.

For Project B, the private sector demonstrated confidence in continuing the project in fixed term concession-based BOT and was concerned of losing the possible upside opportunity by introducing FTC into the project model. The right end of the VAR curves in figure 4 represents events with high traffic turnout, and the FTC cannot let the concessionaire benefit from such events. However, a risk neutral valuation indicated a positive value for using FTC in Project B, as indicated in table 3. This demonstrate risk seeking behavior from the concessionaire for the project.

5.2 Increasing Competitiveness

A major challenge faced by Indian PPP Highway projects is the limited competition and overoptimistic bids. Under performing projects are likely to demand for renegotiations and the culture of renegotiations is detrimental to competition, incentivizing existing players to bid aggressively hoping for renegotiations, and keeping new entrants outside the sector (Vassallo, 2006, 2010). The low competitiveness in Indian highway sector was demonstrated by the government efforts to absorb most risks and was also mentioned as a key challenge during the interactions with government officials. These officials mentioned their apprehension to implement any flexibilities that can alienate the few private players in the Highway sector.

As mentioned in section 4.1, the concessionaire did not find the Real Option offered in Project B attractive enough, indicating a risk seeking behavior. And fixed term BOTs are relatively high-risk projects, hence mostly unattractive to risk averse bidders. Therefore, FTCs based BOTs can make the sector attractive to such players. Hence offering FTC as a Real Option will result in projects that offer a ‘high-risk high-return’ profile for risk seeking bidders and a ‘low-risk low-return’ profile for risk averse bidders. Thus, the use of Real Options can make individual projects attractive to more participants and increase competition in the overall sector.

5.3 Pricing the Option

Offering FTC based Real Options to fixed term BOT projects can improve the project value as represented in table 3. Offering such flexibility at the time of bidding can reduce the project risk and reflect in lower bids, thereby adding value to the public. This article models FTC based Real Option on operational BOT projects, however offering such flexibility post project award is not favorable to the competition in the sector, as it is unfair to the unsuccessful bidders. This dilemma can be solved by effectively pricing the option. With availability of the value of the options, it is possible to price the option as a percentage of this value. Since the reliability of forecasts will improve with availability of more years of operation data, the pricing can be set at a higher percentage of Real Options value, with delay in choosing the option.

The private sector opposed the idea of pricing the Real Option offered, as additionally imposing an expenditure in the form of cost of Option on an underperforming project, can further deteriorate its cash flows. Hence, an effective pricing strategy for offering Real Options post project award need to be developed to aid underperforming BOT projects and reduce the demand for renegotiations.

5.4 Organizational Barriers to Real Options

The valuation of FTC based Real Options demonstrated positive value, however the private and public sector were not attracted to the flexibility offered. The interactions provided insights into some of the barriers to implementing Real Options based flexibilities. Herder et. al (2010) had identified the following barriers to implement Real Options.

- Problems of Reputation
- Applicability
- Lock –in Nature
- Lacking Capacity
- Decisive nature of planning
- Compound Uncertainty

Exercising a Real Option is a deviation from the status quo mode of project operation and can be wrongly judged as an untoward favor to concessionaire. Cases of extreme scrutiny for corruption in Indian projects by media, poses a risk of reputational damage by introducing such flexibilities without clear communication to public. The issue of applicability was pointed out by the private sector as the options, despite positive valuation was not sufficiently attractive. Cardin et. al (2007) presents a methodology to identify multiple Real Options on single project and screen them based on applicability, such methods are to be used to create flexibilities that benefits most stakeholders.

The issue of capacity and compound uncertainty can be addressed by investing in capacity, which private sector can be expected to do, if offered flexibilities are worth the investments. The decision-making practices can be influenced by issues of Lock-In nature and decisive nature. Offering highly relevant Real Options can be expected to force stakeholders to change their decision-making practices to benefit from the added competitive advantage by using Options.

6. Conclusion

FTCs offer an asymmetric risk profile, which can only be partially addressed by limiting the flexibility in concession duration. Hence Flexible term highway concessions cannot benefit all underperforming projects. Offering FTCs as a Real Option allow the concessionaire discretion on project choice, enabling an informed decision. However other options such as Minimum Revenue Guarantee, will be required to fully indemnify the concessionaire from revenue risks.

FTCs are usually used in projects through LPVR based auctions, the methodology used in this article presents a way to introduce FTCs as Real Options to ongoing BOT projects. However, effective pricing based on the Option value is required to maintain the competitiveness and fairness in the industry. Offering such Real Options over ongoing BOT projects can therefore improve the project performance and reduce the demand for renegotiations, in marginally underperforming projects.

Choice of Real Options is influenced by the decision makers preferences over risk and returns. Exploring the behavioral and organizational aspects of Real Options are required to effectively price and implement these flexibilities.

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