REAL OPTION VALUATION FOR MUMBAI METRO RAIL PROJECT: EVALUATING FINANCIAL FLEXIBILITY FOR RELIANCE INFRA

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Abstract: *The paper aims at evaluating the financial flexibility of Reliance-Infrastructure (RInfra) as an equity sponsor in line 2 of Mumbai Metro Rail. We perform a real options valuation of the project for line 2 running from Charkop to Mankhurd. Our methodology attempts to find an expanded NPV presenting an option for investing in construction of line 2 after line 1. The approach is based on the real options theory to evaluate the investment in the Mumbai Metro Project. The investment made by RInfra in the two lines of Mumbai Metro Rail has been corroborated as per our projections drawn for the next 15-20 years. On valuation, we get the net present value of cash-flows for line 1 as negative. However, the option value when calculated for line 2 is a large positive number making the project attractive. The paper also presents a detailed analysis on the flexibility that RInfra possesses to improve its returns.*

Keywords: Financial Flexibility, Mumbai Metro, Metro Rail, Reliance Infrastructure (RInfra) and Real Option Valuation

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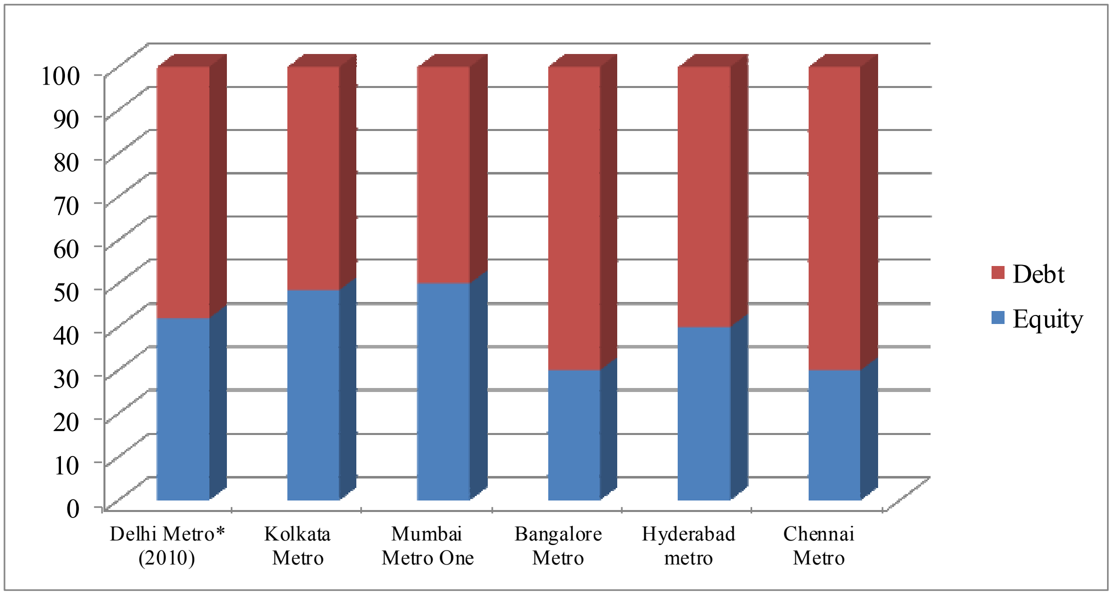
Introduction

Metro Rail or the rapid transit was introduced in India in 1984 with Kolkata Metro Rail. Currently it runs 1 line of 25km with the Indian Railways possessing the majority stake. Next in line, Delhi Metro Rail Corporation (DMRC) was setup in 1995 for construction of rapid transit transport systems in Delhi. Presently there are 6 lines with 142 stations serving over 11lk passengers daily (DMRC Annual Report, 2009-10). On similar lines metro rail construction has been undertaken in Bangalore, Mumbai and Chennai. Other cities like Hyderabad, Kochi, Jaipur and Lucknow also are part of the queue.

The construction of Delhi Metro is seen as remarkable owing to work efficiency and scheduled competition of projects. However, the figures in the annual report show that in the last 10 years, DMRC has been in the red. The losses have been carried forward despite the increment in lines and commuters. Both Delhi and Kolkata Metro Railway Systems are public sector enterprises and do not incorporate any concept of project finance. However, the recent spurt in the metro rail construction has been under the umbrella of private sponsors eager to reap benefits of the new transport system. The Mumbai Metro has both Indian and foreign players as equity partners. Michelle Chan-Fishel (2003) explains that most project finance transactions rely heavily on debt, with corporate sponsors typically providing only 20-40% funds necessary (equity) to finance a project. As a matter of fact, all of these metro projects too involve a high concentration of debt.

Exhibit 1: Share of debt and equity in the project cost



Due to the debt and high capital expenditure in such projects, the cash flows remain negative for many years. The traditional financial projections' considers these cash flows. But, it does not incorporate factors like revenue volatility and interest rate fluctuations which are crucial for financial flexibility. Real option analysis gives an investor such details that cannot be derived from methods based on net present value (NPV). The flexibility can be of strategic importance as it provides the investor the choice to exercise, delay and abandon a project (an option).

The project is evaluated using its present cost and the value obtained after the execution of the project. This comparison is made together with the expected volatility of the project (obtained from similar projects). The option value is obtained for the given circumstances. The investor can decide on delaying the project in case it provides a higher option value. The assessment of project risks and associated opportunity cost enables better decision making and gives enhanced returns to the investor.

Literature Review

Risk can be defined as the uncertainty or the probability of incurring losses. An organization faces many kinds of risks, some of which are externally driven whereas some internally. These risks can be broadly categorized (AIRM, 2002) as financial risks, operational risks, strategic risks and hazard risks. Most of these risks are dynamic and keep changing with time. Hence organizations need to have a strong and flexible risk management system in place.

Firms having **financial flexibility** will be able to make the best use of unforeseen opportunities and would be able to deal with unexpected events. The financial structure and financial policies of a firm will determine its financial flexibility (Gamba and Triantis, 2006).

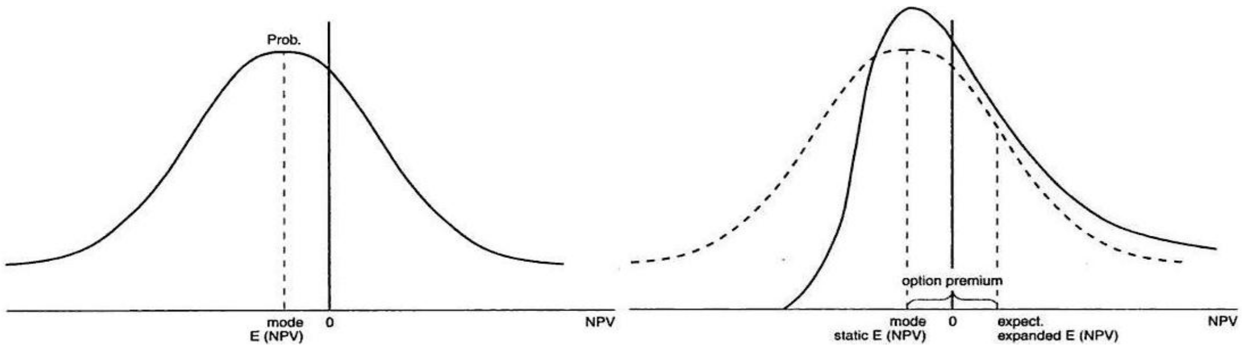
Big infrastructure projects are capital intensive and companies prefer **project finance** rather than corporate finance while taking up such projects. Some of the advantages (Padmalatha Suresh, 2006) in going for project finance are: large debt can be raised without affecting the leverage ratios of the parent firm; creditors have limited or no recourse to the sponsors; greater discipline due to strict covenants and the segregation of project assets and cash flows from that of the sponsor; contractual agreements redistribute the risk to various stakeholders; greater tax shield due to high leverage etc.

Real Options and Flexibility

Wiley (2005) suggests that traditional approaches for valuation are not incorrect, they are incomplete when modeled under actual business conditions of uncertainty and risk-but complement it with more advanced analytics to obtain a much clearer view of the business reality. They assume that the investment is an all-or-nothing strategy and do not account for managerial flexibility. Real options take into account management's ability to create, execute and abandon strategic and flexible options. Mauboussin (1999) explains that real options approach applies financial option theory (the best-known form is the Black-Scholes model) to real investments, such as manufacturing plants, line extensions, and R&D investments. This approach provides important insights about businesses and strategic investments, insights that are more important than ever, given the rapid pace of economic change.

Managerial flexibility induces asymmetry (table 2) in the probability distribution of NPV (Trigeorgis, 1996) as management can limit the down-side risk of loss, but retain the upside potential for profit (Smit and Trigeorgis, 2004). Trigeorgis (2000) gives the strategic or expanded NPV written as; Expanded (Strategic) NPV = Passive NPV + Option Premium

Exhibit 2: Expanded (strategic NPV) - Trigeorgis (2000)



Trigeorgis (1996) also suggests that theories given by Black Scholes and Merton to price financial options can be used for pricing and managing real assets. Black Scholes (1973) provides the formula for options to be exercised at the end of the term (European option). To overcome this hurdle, Cox et al. (1979) provided binomial model to price options at any point before the expiry (American option). Mumbai Metro incorporates the project finance structure for the construction using a special purpose vehicle (SPV). Nevitt and Fabozzi (2000) claim that, Project financing can sometimes be used to improve the return on the capital invested in a project by leveraging the investment to a greater extent than would be possible in a straight commercial financing of the project.

Mumbai Metro Rail

The Mumbai Metro is planned to be constructed in three phases, at a total cost of Rs. 36,000 cr. The nine lines of the system are projected to have a total length of 146.5 km, including 32.5 km of underground track. Phase 1 involving 3 lines was initially given a time frame of 2006-2016. It includes Versova - Andheri - Ghatkopar (VAG) (11.07 km), Charkop - Bandra - Mankhurd (31.8 km) and Colaba - Bandra (20 km). Presently the construction is largely delayed and 3 stations of VAG line are expected to start functioning by March 2012.

Line 1: The project that has an estimated cost of Rs. 2,356 crore is being undertaken by the SPV Mumbai Metro One Project Limited (MMOPL). The project has a debt component of Rs. 1,194 crore, equity of Rs. 512 crore and viability gap fund (VGF) of Rs. 650 crore from the Indian Government. The equity sponsor, RInfra holds 69%, MMRDA 26% and remaining 5% is held by Veolia Transport, France. This metro line encompasses a length of 11.07 km and will feature 12 stations along the corridor. The consortium of equity sponsors have the project under B-O-T (build-operate-transfer) scheme for 35 years after which it will be transferred to a new operator.

Line 2: A special purpose vehicle named Mumbai Metro Transport Private Ltd. (MMTPL) has been formed for line 2 running from Charkop to Mankhund with a length of 31.8 km encompassing 27 stations. The project costs Rs. 11,550 crore and includes a concession period of 35 years (with a 10 year possible extension). The Corridor is expected to be commissioned by 2013-14. The financial closure for the project was obtained on 14th March 2011. The equity sponsors for the project are RInfra holding 48% of share capital, SNC Lavlin Inc, Canada holding 26% and Reliance Communication Ltd. with another 26% of the capital. The project would obtain VGF from the Government of India for the amount of Rs. 2,298 crore. RInfra has pledged almost Rs. 1,400 crore for the Mumbai Metro Rail projects (line 1 & line 2).

Methodology

The financial projections are made for line 1 which is currently under-construction. Using free cash flow to equity (FCFE) method, the net present value (NPV) for RInfra is calculated. Thereafter, we make projections for line 2. The SPV for line 1 was incorporated in 2006 while that of line 2 in 2009. Hence RInfra had less than and equal to 3 years to make the decision regarding investing again in the metro project, this time for line 2. The FCFE method is used to obtain its present value (PV). Using PV and the cost of the project (defined by the SPV), the option value for the line is calculated.

Black Scholes Option Pricing Model

The Black-Scholes (Hull, 2005) formula to compute the European call and put option values on a non-dividend-paying stock is given by:

$$c = S_o N(d_1) - Ke^{-rt} N(d_2) \qquad \text{where,} \quad d_1 = [\ln(S_o/K) + (r + \sigma^2/2)T]/\sigma\sqrt{T}$$

$$p = Ke^{-rt} N(-d_2) - S_o N(-d_1) \qquad d_2 = [\ln(S_o/K) + (r - \sigma^2/2)T]/\sigma\sqrt{T} = d_1 - \sigma\sqrt{T}$$

c = European call option value

p = European put option value

S_o = Value of underlying asset at t=0

K = Strike Price

r = Continuously compounded risk-free rate

σ = Volatility of underlying asset

T = Time to maturity of the option

Binomial Option Pricing Model

The Binomial model uses an iterative procedure and a risk neutral approach during valuation. The formula for the option value is given by:

$$C - e^{-rt}[pC_u + (1-p)C_d]$$

where,

$$u = e^{\sigma\sqrt{t/n}}$$

$$d = 1/u = e^{-\sigma\sqrt{t/n}}$$

$$p = (e^{rt} - d)/(u - d)$$

σ = volatility

r = risk free rate

t = time to expiry of the option

n = number of steps/periods

p = Risk-neutral probability of up move

u = factor by which the asset price can go up

d = factor by which the asset price can go down

C = value of the option

In the case of Mumbai Metro,

S_0 and K are the PV of cash-flows and the investment required for line 2, r is the risk free rate for the project (8% - taken from a government bond rate), σ is the average volatility or standard deviation of revenues of Delhi Metro (64.89%). Thereafter the strategic NPV is obtained as:

Strategic NPV for RInfra = NPV for line 1 + Option value for line 2

Benefits from project implementation to Mumbai

Mumbai has always had the distinction and advantage of a high modal share of 78% for public Transport system. Currently, 11 million people travel daily by Public Transport with modal share of Rail - 52%, and Bus - 26%. Metro Rail Transit System would provide a new means of transport running across the breadth of the city unlike the existing local rail covering Mumbai lengthwise. Covering the vast and densely populated stretch between Versova and Ghatkopar, the Metro Rail will help reduce travel time in the section from 71 min to 21min. The project aims to become Asia's first Green Metro right from the construction stage. Possibilities on LEED certification are being looked into through a detailed environmental impact assessment and feasibility study. Metro system would require 1/5th energy per passenger km compared to road based system. It will provide a reliable, safe and comfortable means of transport to the inhabitants of Mumbai.

Cash Flow Analysis

The revenue sources are traffic (table 6, 9), feeder bus service (table 16), rental income (table 15, 16), carbon credits (table 11) and lease of land (table 15, 16). The expenses are due to traffic operations (table 15, 16), interest payment (table 7, 10), loan repayment (table 7, 10), capital expenditures (table 8) and working capital requirements (table 13) which drag profits down to considerable losses.

Projections for line 1 have been made from 2007-08 to 2022-23, a period of 16 years thereafter the terminal value is obtained using a terminal growth rate of 8% for the number of years remaining in the concession period. Projections for line 2 are made from 2010-11 to 2030-31. K_e is computed using Capital Asset Pricing Model (CAPM), by unlevering the industry beta (table 14) and re-levering it for the SPV. The PV and the NPV of FCFE is computed by using K_e as the discount rate (table 1, 2, 15, 16). Finally the option value (table 3) is computed using Black Scholes and Binomial Option Pricing Models.

Table 1: NPV for line 1

D/V	0.506791171	β Lev (Mumbai Metro - Line 1)	0.8115
E/V	0.493208829	R_m	16.86%
R_f	8%	K_e using CAPM	15.19%
T	35 years		
NPV for equity sponsors		**Rs. (288.5) crore**	
NPV RInfra (69% of equity)		**Rs. (199.1) crore**	

Table 2: PV for line 2

D/V	0.608695652	β Lev (Mumbai)	0.32178
E/V	0.391304348	R_m	21.28%
R_f	8%	K_e using CAPM	12.27%
T	45 years		
PV for equity sponsors		**Rs. 2,423.91 crore**	
PV RInfra (48% of equity)		**Rs. 1,163.48 crore**	

Option Value Analysis

Strategic NPV for RInfra = NPV for line 1 + Option value for line 2

Table 3: Option Value for line 2

S	PV of cash flows for line 2	Rs. 1,163.48 crore
K	Investment for line 2	Rs. 1,056.96 crore
T	Number of years between formation of SPV for line 1 and line 2	3 yrs
R_f	Risk free rate	8 %

σ	Volatility		64.89%
(Rs. Crore)	**NPV of Line 1**	**Option Value (Line 2)**	**Strategic NPV**
Black-Scholes Model	-199.09	607.54	**408.45**
Binomial Model		608.44	**409.35**

Sensitivity Analysis (Using Black Scholes Option Pricing Model)

The Black-Scholes (Black, F., and Scholes M.,1973) model uses the price of the underlying asset (S), strike price (K), time to maturity (T), interest rate (r) and Volatility (σ^2) to compute the option premium. Sensitivity measures for the option price can be calculated by varying each of these variables (except the strike price, which remains constant over the life of an option). Consider the function,

$$C = C\,(S, K, T, r, \sigma)$$

The first order differentiation will be,

$$C(S+\delta S, K, T+\delta T, r+\partial r, \sigma+\delta\sigma) = C(S,K,T,r,\sigma) + \delta S\frac{\partial C}{\partial S} + \delta T\frac{\partial C}{\partial T} + \delta r\frac{\partial C}{\partial r} + \delta\sigma\frac{\partial C}{\partial \sigma}$$

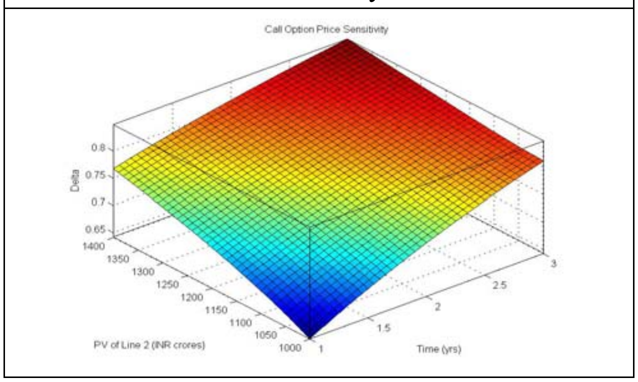
These sensitivity measures are called Greeks (Ederington and Guan, 2004). The major ones are delta, gamma, lambda, theta, rho and vega.

a. **Delta (Δ):** Delta (Hull, 2005) is the measure of the change in option price per unit change in the price of the underlying asset.

$$Delta\,(\Delta) = \frac{\partial C}{\partial S} = N(d_1)$$

If Δ is large, then price of the option is very sensitive to change in price of the underlying asset.

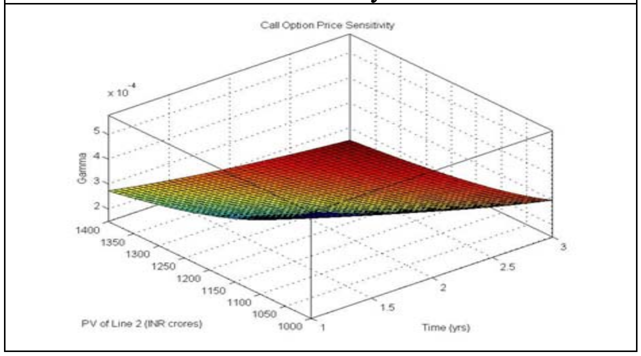
Exhibit 3: Delta Value – Call Option Price Sensitivity



The Δ for the Black-Scholes Model comes out to be 80.54%, which indicates that the option value increases by 80.54% for 1% increase in the value of PV(cash-flows) of line 2. (If PV of cash flows of line 2 increases by 1%, then the option value shoots up by Rs 489.31 crore). The sensitivity is relatively high.

b. **Gamma** (Γ): Gamma is the measure of the change in Δ per unit change in the price of the underlying asset. It is the second order partial derivative of option price with respect to the underlying asset value.

Exhibit 4: Gamma Value – Call Option Price Sensitivity



$$Gamma\ (\Gamma) = \frac{\partial \Delta}{\partial S} = \frac{\partial^2 C}{\partial S^2}$$

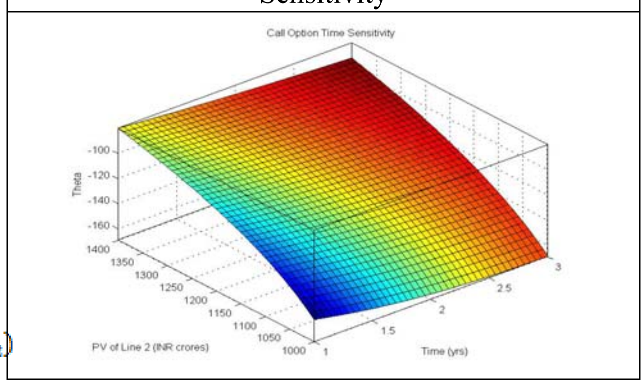
For European call or put option on a non- dividend paying stock, gamma (Hull, 2005) is given by,

$$Gamma\ (\Gamma) = \frac{e^{\frac{-d_1^2}{2}}}{S\sigma\sqrt{2\pi T}}$$

High Γ indicates that delta is very sensitive to changes in value of underlying asset. The Γ for Black-Scholes model comes as 0.02106 which is low. The figure indicates that Γ gradually decreases as the PV (line2) increases. Γ is high initially, and it decreases with the time left for making the decision regarding investment in line2.

c. **Theta (θ):** Theta is the measure of the change in option value in response to change in options time to expiration.

Exhibit 5: Theta Value – Call Option Time Sensitivity



$$Theta\ (\theta) = \frac{\partial C}{\partial T}$$

For European call option on a non-dividend paying stock, theta (Hull, 2005) is given by,

$$Theta\ (\theta) = -\frac{S\sigma e^{\frac{-d_1^2}{2}}}{2\sqrt{2\pi T}} - rKe^{-rT}N(d_2)$$

θ is negative, as the option value becomes less valuable when time to maturity decreases. For the Black-Scholes model, θ= -86.38 per calendar year, which indicates that the call option value falls by Rs 86.38 crore per annum. The figure indicates that θ increases swiftly as PV (line2) increases. Also, θ falls gradually indicating that the fall in option value is much greater as time to maturity decreases.

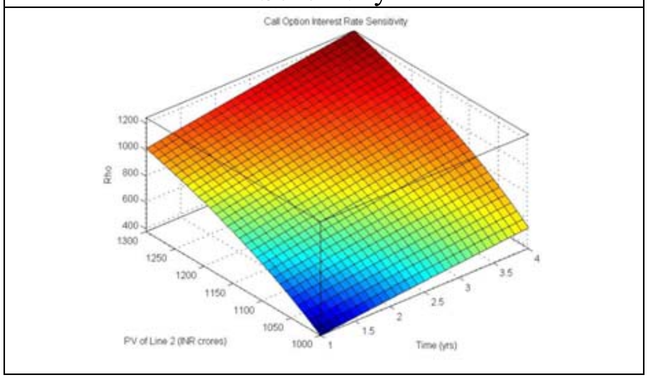
d. **Rho (ρ):** Rho is the measure of the rate of change in option value in response to change in interest rates.

$$Rho\,(\rho) = \frac{\partial C}{\partial r}$$

For European call option on a non-dividend paying stock, rho (Hull, 2005) is given by,

$$Rho\,(\rho) = TKe^{-rT}N(d_2)$$

Exhibit 6: Rho Value – Call Option Interest Rate Sensitivity



For Black-Scholes model the ρ value of the call option is 11.39, which indicates that 1% increase in risk free rate increases the call option value by 11.39%. (If the risk-free rate increases by 1%, then the option value increases by Rs. 60.02 crore). The figure indicates that ρ is almost zero initially, and it gradually increases with increase in either PV (line2) or the time to maturity.

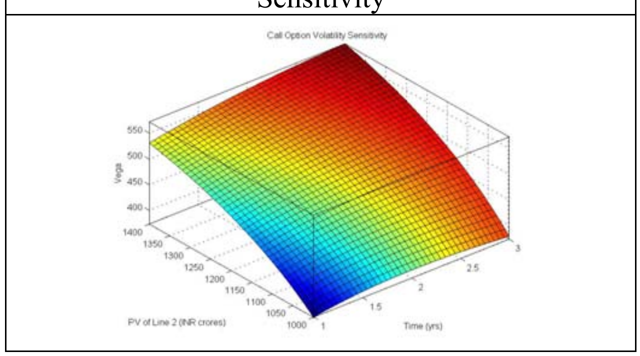
e. **Vega (ν):** Vega is the measure of change in option value in response to changes in volatility.

$$Vega\,(\upsilon) = \frac{\partial c}{\partial r}$$

For European call or put option on a non-dividend paying stock, vega (Hull, 2005) is given by

$$Vega\,(\upsilon) = \frac{S\sqrt{T}e^{\frac{-d_1^2}{2}}}{\sqrt{2\pi}}$$

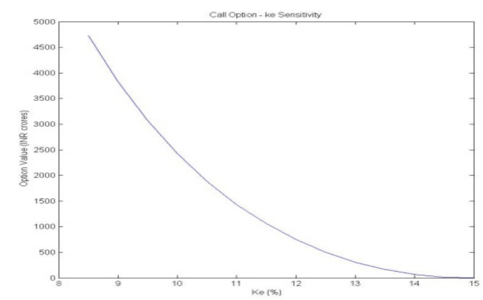
Exhibit 7: Vega Value – Call Option Volatility Sensitivity



Higher υ indicates that the option value increases drastically with changes in volatility. For the Black-Scholes model, υ = 5.55% which indicates that the call value increases by 5.55% when the underlying volatility increases by 1%. (If the volatility increases by 1%, then the option value increases by Rs. 33.72 crore). The figure indicates that the call value increases drastically as the PV (line2) increases and that the call value decreases as time to maturity decreases.

Sensitivity Analysis using K_e

Exhibit 8: Option value vs. K_e



The figure shows that option value increases as k_e decreases. This is because, as k_e decreases, the value of the underlying asset, i.e., PV of FCFE will increase, and hence the option value will increase. The k_e used for line 2 is 12.27%, which gives a PV of Rs. 1163.48 crore and option value of Rs 607.54 crore for RInfra. Historical data shows that Reliance Infrastructure has an average ROE of 9.2%.

Conclusion

This paper illustrates how major firms like Rinfra choose project finance over corporate finance for redistributing and mitigating the risks involved in such high capital intensive infrastructure projects. After taking up line 1, RInfra had the option whether to take up line 2 or not. This option was valued using Black-Scholes and Binomial Option pricing models, and the values were Rs. 408.35 crore and Rs. 409.85 crore respectively. These option values are large due to the high volatility (64.89%) in such projects. The financial projections made for line 1 provide us with a negative NPV for RInfra. Like other existing metros, we expect Mumbai Metro One, line 1 to be incurring losses mainly due to the heavy expenditure and loan repayment. However, the projections for line 2 indicate a high option value which on addition to NPV of line 1 gives a positive strategic NPV. The sensitivity analysis indicated that a rho of 9.88% could increase the call option value by Rs. 60.02 crores and the vega of 5.55% could increase it by Rs. 33.72 crore. The option value is most sensitive to PV of line 2 cash flows (high delta: 80.54%), followed by risk-free rate and then volatility. The strategic

NPV of Rs. 408.35 crore (Black-Scholes) justifies the decision of RInfra of investing in line 2.

Assumptions

Revenue: Revenues for Line 1 start from 2012-13 when the 3km stretch of metro rail starts functioning. For line 2, the inflows begin from 2016-17.

Fare collection:

Lane I		Lane II	
Distance	Metro Fare (Rs.) (2007-08)	Distance	Metro Fare (Rs.) (2003-04)
0-3 km	6	0-3 km	7
3-8 km	8	3-8 km	9
8-12 km	10	8-12 km	11
		12-15 km	13
		15-20 km	15
		20-25 km	18
		25-30 km	20
		>30 km	22

(Fares shall be fixed by the Government of Maharashtra, through a notification. 11% fare increases will reportedly take place every fourth year)

- Feeder bus (table 15): Considered only for line 2. Revenue was taken using proportion of feeder bus revenue/ticket revenue from DMRC Annual Report 2009-10 for the FY ending March 2010.
- Rental income (table 15, 6): Revenue was taken using proportion of number of stations of Mumbai and Delhi Metro and Rental income from DMRC Annual Report 2009-10 for the FY ending March 2010
- Lease land (table 15, 6): Revenue was taken using proportion of number of stations of Mumbai Metro and Delhi Metro and Lease land revenue from DMRC Annual Report 2009-10 for the FY ending March 2010.
- Other income: Sale of Carbon Credits (table 11):
- The value of revenue from carbon credit sale was obtained from the proportion of savings for Mumbai and Delhi Metro and Carbon credit revenue from DMRC Annual Report 2009-10 for the FY ending March 2010. An annual inflation of 8% was also added.
- Sale of Tender docs (table 16): Income for 2013-14 was taken using proportion of sale of tender docs/ticket revenue from DMRC Annual Report 2009-10 for FY10. Thereafter it was decreased by 20% each year for 5 years and then made null.

- **Expenses -**Traffic Operations (table 15, 16): Traffic expense was taken from DMRC Annual Report (FY10) and proportionate value is taken for Mumbai Metro based on number of stations in Delhi Metro and Mumbai Metro. Thereafter annual inflation of 8% was applied.

- Miscellaneous Expenses (table 15, 16): Average of 7-year values from DMRC Annual Report (2009-10) is taken and proportionate value was taken for Mumbai metro based on number of stations. Thereafter annual inflation of 8% was applied.
- **Interest payment -** Line 1 (table 7): The cost of borrowing for the rupee loan, which constitutes about 75% of the total debt, is 12.25%, while the foreign currency loan is at 3.5% above LIBOR. We have assumed the debts to be of 12 year duration. Also, the principal is not paid back during the first 3 years as there are no revenues.
- Line 2 (table 10): The cost of borrowing on the debt amount of Rs. 7,000 crore is 10.5-11%. The debt is assumed to be for 15 years. Annual interest payments are made from the first year, however, principal repayment begins only in 2016, 5 years after the loan was taken.
- **Tax**: Tax is taken as 11% (from DMRC). Tax savings from previous year is carry forwarded to the next year in the case of negative profits.
- **Capital Expenditure (capex) -** (table 8): We consider the capex based on the assets used for calculating depreciation. We assume that when an asset gets fully depreciated, it is bought again in the next year as part of capex.
- **Net working capital (NWC) -** (table 13): An average of 10-year values for NWC is obtained from DMRC Annual Report (2009-10). This is adjusted in proportion to the number of stations for year 1 and then inflated annually.
- **Beta of the company-** (table 14): We use the asset beta of metro rail companies listed worldwide.
- **Risk premium-** This is calculated for BSE Sensex by averaging yearly returns of 2 years until financial closure.

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Appendix

Table 6: Projections made by MMRDA for line 1

Year	2009	2011	2021	2031
Daily Boarding (lakh)	4.75046	5.13338	6.64703	8.82533
Growth in passengers boarding	3.95%	2.62%	2.88%	2.86%

	Fares (Rs.)								
	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22
0-3 km	8	8	9	9	9	9	10	10	10
3-8 km	10	10	12	12	12	12	14	14	14
>8 km	14	14	16	16	16	16	18	18	18
Daily Boarding (lakh)	5.5472	5.6924	5.8414	5.9943	6.1512	6.3122	6.4775	6.6470	6.8381

Table 7: Debt for line 1

Debt	1194 crore	Years	12 (principal payment starts after 3 years)
INR Loan	895.5 crore	Exchange rate	79.011
UK Loan(INR)	298.5 crore	UK Loan (GBP)	37,779,549.682956
Interest on INR	12.25%	Interest on UK Loan	Libor + 3.5%

Year	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
INR loan (Rs. cr)												
Debt	895.5	895.5	895.5	895.5	895.5	895.5	895.5	895.5	895.5	895.5	895.5	895.5
P+I	109.70	109.70	109.70	169.67	169.67	169.67	169.67	169.67	169.67	169.67	169.67	169.67
I	109.70	109.70	109.70	109.70	102.35	94.11	84.85	74.46	62.80	49.71	35.01	18.52
P Paid	0.00	0.00	0.00	59.97	67.31	75.56	84.82	95.21	106.87	119.96	134.65	151.15
Foreign loan (Rs. cr)												
Debt (Pound)	298.5	298.5	298.5	298.5	298.5	298.5	298.5	298.5	298.5	298.5	298.5	298.5
LIBOR+3.5%	0	0	0	0	0	0	0	0	0	0	0	0
P Paid	0	0	0	26.92	28.01	28.95	29.94	31.15	33.21	33.17	35.74	51.41
I	15.48	14.66	15.20	13.52	12.60	12.13	11.70	11.01	8.72	10.65	8.47	4.28

Table 8: Capex for line 1

(Rs. Cr)	2018-19	2023-24
Signaling & Telecom Equipment	141.265	207.564
Automatic Fare Collection	35.740	52.514
IT Systems	4.014	5.897
Office Equipment		

	1.650	2.425
Feeder Bus	1.596	2.345
Intangible Assets	1.997	2.934
Temporary Structures	Value from 2013-14 is incremented annually by inflation	
Total Cap Ex	187.061	274.854

Table 9: Projections made by MMRDA

Year	**2011**	**2021**	**2031**
Daily Boarding (lakhs)	12.75	18.77	22.16
Growth (%)	0.0394	0.0167	0.03
Average trip length (km)	7.50	7.40	7.40
Growth (%)	-0.0013	0.0000	

	Fare (Rs.)												
	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24	2024-25	2025-26	2026-27	2027-28	2028-29
0-3 km	9	9	9	10	10	10	10	12	12	12	12	14	14
3-8 km	12	12	12	14	14	14	14	16	16	16	16	18	18
8-12 km	15	15	15		17	17	17	19	19	19	19	22	22
12-15 km	17	17	17	19	19	19	19	22	22	22	22	25	25
15-20 km	19	19	19	22	22	22	22	25	25	25	25	28	28
20-25 km	23	23	23	26	26	26	26	29	29	29	29	33	33
25-30 km	26	26	26	29	29	29	29	33	33	33	33	37	37
>30 km	28	28	28	32	32	32	32	36	36	36	36	40	40
Daily Boarding (lakhs)	16.1	16.7	17.4	18.1	18.8	19.1	19.4	19.7	20.1	20.4	20.7	21.1	21.4

Table 10: **Debt for line 2** (Rs. crore)**:**

	2011	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**
D	7000	7000	7000	7000	7000	7000	7000	7000	7000	7000	7000	7000	7000	7000	7000
P + I	1176.178	1176.178	1176.178	1176.178	1176.178	1176.178	1176.178	1176.178	1176.178	1176.178	1176.178	1176.178	1176.178	1176.178	1176.178

I	752.500	752.500	752.500	752.500	752.500	752.500	706.955	656.513	600.649	538.780	470.260	394.373	310.330	217.251	114.166
P	0	0	0	0	0	423.678	469.223	519.665	575.528	637.398	705.918	781.804	865.848	958.927	1062.011

Table 11: Carbon credits

Means of transport	CO_2 (gms) emitted per passenger per 10 km	Savings (gms) for 10 km/pssgr	Savings (gms) per pssgr (total dist)	No. of passengers per day	Total Savings (gms of CO_2) /day
Bus	1300				
Delhi Metro	1200	100	1650	1,100,000	1815000000
Mumbai Metro: line1	260	1040	1151.28	494,000	568732320
Mumbai Metro: line2	260	1040	3314.48	494,000	1637353120

Table 12: **Deprecation:** This is done on a straight line basis for line 1 and line 2

Asset	**DMRC Values (2009-10)**	**Value in 2013-14 for Mumbai Metro* (line 1)**	**Value in 2016-17 for Mumbai Metro* (line 2)**	**Life of Asset**	**Depreciation rate**
Building (Lease Hold)	285415416	30383765.45	93007749.29	35	2.86%
Building (Free hold)	38417973918	4089767557	12519188124	35	2.86%
Structures (Wire, Duct, Bridge & tunnels)	32541199181	3464158234	10604135324	35	2.86%
Temporary Structures	51103084	5440155.06	16652859.51	1	100%
Plant & Machinery	11770541243	1253027497	3835642672	10	10.34%
Rolling Stock	27177289251	2296894669	8976677046	32	3.17%
Signaling & Telecom Equipment	11375733096	961422622.5	3757412346	5	0.2
Track Work(Permanent)	7323599614	618955656.5	2418989912	61	1.63%
Traction Equipment	5836032541	493233593.2	1927645501	9	11.31%
Escalators & Elevators	2146243324	228477335.5	699392008.3	32	3.17%
Automatic Fare Collection	2284935196	243241714.3	744587250.5	5	0.2
IT Systems	256602249	27316473.15	83618460.33	5	0.2
Office Equipment	105512384	11232271.8	34383109	5	0.2
Furnitures & Fixtures	282367843	30059337.49	92014642.79	11	9.50%

Vehicles	40016364	4259923.43	13040052.29	14	7.07%
Survey Equipment	2838604	239905.25	937592.8237	14	7.07%
Safety Equip	209620204	17716098.34	69237695.35	32	3.17%
Feeder Bus	99992690	10644675.34	32584417.38	5	19%
Intangible Assets	127665249	13590544.74	41602018.69	5	0.2

Table 13: **Net Working Capital (NWC):** The table provides values from DMRC financials

Year	2010	2009	2008	2007	2006	2005	2004	2003	2002	2001
Net Current Assets (NWC)	289.12	696.58	555.19	363.18	-322.33	-316.38	404.44	122.86	598.42	789.67

The average NWC is taken as the value for 2010 for Mumbai metro and projections are made for both the lines keeping inflation in mind.

Table 14: Comparable Beta

Symbol		Exchange	β levered	D/E	β(unlevered)= β levered /(1+ D/E)
CNI	Canadian National Railway Co	NYSE	0.42	0.52	0.2763158
CP	Canadian Pacific Railway Ltd.	NYSE	0.78	0.84	0.423913
JP 9022	Central Japan Railway Co	Tokyo Exchange	0.48	2.5	0.1371429
JP 9020	EAST JAPAN RAILWAY CO	Tokyo Exchange	0.39	1.89	0.1349481

Table 15: Discounted cash flows for Line 1

		2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22
Initial Investment (2007-08)	2356														
Income from Operations	fare collection					44.64	245.50	251.93	299.23	307.06	315.10	323.35	376.95	386.82	397.94
	Rental income					0.00	12.79	15.34	18.41	22.10	26.52	31.82	38.18	45.82	54.98
	Lease of land					0.00	3.37	3.64	3.93	4.24	4.58	4.95	5.34	5.77	6.23
Other Income	Sale of Carbon Credit					0.00	0.50	0.54	0.58	0.63	0.68	0.73	0.79	0.85	0.92
	Sale of Tender					0.00	0.19	0.15	0.12	0.10	0.08				

	Docs														
Total Income						44.64	262.34	271.59	322.27	334.12	346.95	360.84	421.27	439.26	460.07
Expenditure	Traffic Operations					6.04	33.23	35.88	38.75	41.85	45.20	48.82	52.72	56.94	61.50
	Misc Expenses					2.11	11.59	12.52	13.52	14.60	15.77	17.03	18.39	19.87	21.45
Total Expenditure						8.15	44.82	48.40	52.27	56.46	60.97	65.85	71.12	76.81	82.95
Operating Profit	Total income-Total expenditure					36.49	217.52	223.19	269.99	277.66	285.98	294.99	350.15	362.45	377.12
Depreciation						0.00	75.47	75.52	75.56	75.62	75.67	87.63	87.69	87.76	87.84
Interest & Finance Charges	Sum of INR and foreign debt interest	125.18	124.36	124.90	123.22	114.95	106.24	96.55	85.47	71.52	60.35	43.48	22.79	0	0
FCFE						0	0	0	0	0	0	0	0	0	0
PBT	Op.Profit - (Depreciation+interest)	-125.18	-124.36	-124.90	-123.22	-78.47	35.81	51.13	108.96	130.53	149.95	163.88	239.66	274.69	289.29
Cumulative PBT		-125.18	-249.53	-374.43	-497.65	-576.12	-540.31	-489.18	-380.22	-249.69	-99.74	64.14	239.66	274.69	289.29
Tax (11%)	for cum. PAT +ve					0.00	0.00	0.00	0.00	0.00	0.00	7.06	26.36	30.22	31.82
PAT	PBT-tax	-125.18	-124.36	-124.90	-123.22	-78.47	35.81	51.13	108.96	130.53	149.95	156.83	213.30	244.48	257.47
OCF	PAT+ depreciation	-125.18	-124.36	-124.90	-123.22	-78.47	111.28	126.64	184.53	206.15	225.62	244.46	300.99	332.24	345.30
Cap Ex							0.5	0.5	0.6	0.6	0.7	187	0.8	0.9	1.0

							4	9	3	9	4	.06	6	3	1
NWC						400.68	432.74	467.36	504.75	545.12	588.73	635.83	686.70	741.64	800.97
Change in NWC							32.05	34.62	37.39	40.38	43.61	47.10	50.87	54.94	59.33
Total P Paid					86.89	95.33	104.51	114.76	126.36	140.08	153.13	170.39	202.56	0.00	0.00
Terminal Value (8%)	5457														
FCFE	**OCF-(capex+change in NWC+P paid-initial investment)**	**-125.18**	**-124.36**	**-124.90**	**-210.11**	**-173.79**	**-25.82**	**-23.32**	**20.15**	**25.00**	**28.14**	**-160.10**	**46.70**	**276.37**	**284.96**

Table 16: Discounted cash flows for Line 2

		2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24	2024-25	2025-26	2026-27	2027-28	2028-29	2029-30
Initial Investment	11500																			
Income from Operations	fare						1315.62	1367.49	1421.41	1674.65	1740.68	1769.82	1799.45	2068.75	2103.38	2138.60	2174.40	2485.79	2527.41	2569.72
	Feeder Bus						11.74	12.20	12.68	14.94	15.53	15.79	16.05	18.46	18.76	19.08	19.40	22.18	22.55	22.92
	Rental						277.54	288.49	299.86	353.28	367.21	373.36	379.61	436.42	443.73	451.16	458.71	524.40	531.18	542.11
	Lease of land						73.02	77.40	82.04	86.96	92.18	97.71	103.58	109.79	116.38	123.36	130.76	138.61	146.92	155.74
	Consulting											23.55	23.94	27.53	27.99	28.46	28.93	33.08	33.63	34.19
	EPW						23.90	25.33	26.85	28.46	30.17	31.98	33.90	35.93	38.09	40.38	42.80	45.37	48.09	50.97
Other Incom	Carbon						0.35	0.37	0.39	0.41	0.44	0.46	0.49	0.52	0.55	0.58	0.62	0.66	0.69	0.74

e	Credit																			
	Tender Docs						41.18	32.94	26.35	21.08	16.87									
Total Income							1743.34	1804.22	1869.59	2179.80	2263.08	2312.68	2357.03	2697.40	2748.88	2801.61	2855.62	3250.07	3312.47	3376.39
Exp.	Traffic Operations						82.62	87.58	92.83	98.40	104.31	110.57	117.20	124.23	131.69	139.59	147.96	156.84	166.25	176.23
	Misc Expenses						12.81	13.58	14.39	15.26	16.17	17.14	18.17	19.26	20.42	21.64	22.94	24.32	25.78	27.32
Total Exp.							95.43	101.16	107.23	113.66	120.48	127.71	135.37	143.50	152.11	161.23	170.91	181.16	192.03	203.55
Operating Profit	Inc. – Exp.						1647.90	1703.06	1762.36	2066.13	2142.60	2184.97	2221.65	2553.90	2596.78	2640.38	2684.71	3068.91	3120.44	3172.84
Dep.							259.12	259.22	259.36	259.51	259.68	291.57	291.71	291.86	292.02	306.88	380.32	380.51	380.71	380.92
Interest	total debt	752.5	752.5	752.5	752.5	752.5	752.5	706.95	656.51	600.65	538.78	470.26	394.37	310.33	217.25	114.17				
FCFE																				
PBT		-752.50	-752.50	-752.50	-752.50	-752.50	636.28	736.88	846.49	1205.97	1344.14	1423.14	1535.57	1951.71	2087.51	2219.33	2304.40	2688.41	2739.74	2791.92
CumPBT		-752.50	-1505.00	-2257.50	-3010.00	-3762.50	-3126.22	-2389.33	-1542.84	-336.87	1007.27	1423.14	1535.57	1951.71	2087.51	2219.33	2304.40	2688.41	2739.74	2791.92
Tax	(11%)										110.80	156.55	168.91	214.69	229.63	244.13	253.48	295.72	301.37	307.11
PAT	PBT-	-	-	-	-	-	63	73	84	12	12	12	13	17	18	19	20	23	24	24

	tax	752.50	752.50	752.50	752.50	752.50	6.28	6.88	6.49	05.97	33.34	66.60	66.66	37.02	57.88	75.20	50.91	92.68	38.37	84.81
OCF	PAT + depreciation	-752.50	-752.50	-752.50	-752.50	-752.50	895.40	996.10	1105.85	1465.48	1493.02	1558.16	1658.37	2028.88	2149.90	2282.08	2431.23	2773.19	2819.07	2865.73
Cap Ex							1.67	1.77	1.91	2.06	2.22	10010.84	2.50	2.65	325.49	676.85	20.15	3.34	3.54	3.76
NWC							478.27	506.96	537.38	569.62	603.80	640.03	678.43	719.14	762.29	808.02	856.50	907.89	962.37	1020.11
Change in NWC								28.70	30.42	32.24	34.18	36.23	38.40	40.71	43.15	45.74	48.48	51.39	54.47	57.74
Total P Paid							423.68	469.22	519.66	575.53	637.40	705.92	781.80	865.85	958.93	1062.01				
Terminal Value (8%) - 2030-31	44009																			
FCFE		**-752.50**	**-752.50**	**-752.50**	**-752.50**	**-752.50**	**470.06**	**496.42**	**553.86**	**855.65**	**819.22**	**-9194.83**	**835.66**	**1119.68**	**822.33**	**497.49**	**2362.60**	**2718.46**	**2761.05**	**2804.23**