# Infrastructure Planning and Management

## Infrastructure Economics and Finance

# Agenda

- Principles of Finance
- Infrastructure Economics
- Developing Financial Models for Infrastructure
- Introduction to Project Finance

# Present Value

- Present value is the value today of money tomorrow. It is denoted by the formula below, where C is the future cash flow, r is the discount rate and n is the number of years in the future when this cash flow will present itself
- $PV = C / (1+r)^n$
- Selecting the discount rate is often a difficult task and is determined by the riskiness of the investment

# Net Present Value

- NPV = PV – **Required Investment**
- **$NPV = C_0 + C_n/(1+r)^n$**
- Cash Outflow is negative
- Cash Inflow is positive

# IRR, Risk and Opportunity Cost

- IRR is the Internal Rate of Return
  - The rate of return where the NPV is zero
  - The rate of return on an investment
- What is the risk free rate?
  - Typically it is the bank interest rate
- Why cant I use the risk free rate always to discount cash flows?
  - The risk facing your project might be larger. You may be supporting an infeasible project
- So how do I decide what ‘r’ to use?
  - **‘r’** represents the risk **in** the venture – not the risk **of** the venture
  - Use the same **‘r’** you use for a venture of comparable risk – use the **Opportunity Cost of Capital**

# Discounted Cash Flows

- NPV = $\sum C_t / (1+r)^t$
- The time period ‘t’ for which the NPV is zero is often called the “break-even” point
- The rates of return can vary over different time periods. If this is so, the above formula should be broken down into a sequential stream of cash flows.
- Generally you should invest in a project when the NPV is positive or the IRR is greater than the opportunity cost of capital.

# Perpetuities

- What are they?
  - Cash-flows over an infinite time period
- What equation governs static perpetuity?
  - PV = C/r
- What equation governs growing perpetuities?
  - PV = C / (r-g), where g is the rate of growth

# Annuities

- What are they?
  - Cash-flows for a certain period of time
- What's the present value of an annuity?
  - $PV = C \left[ 1/r - 1/r(1+r)^t \right]$

# Funding

- 2 major components
  - Debt
  - Equity
- Weighted Average Cost of Capital
  - WACC = $K_d$ (D/D+E) + $K_e$ (E/D+E)
  - D and E are the relative proportion of Debt and Equity respectively

# Infrastructure Economics

- The concepts in the previous slides are often used to evaluate the viability of an infrastructure project or to compare infrastructure alternatives.
- This analysis is a key part of the project preparation and analysis process

# Problem 1 – Adapted from "Infrastructure Planning Handbook" 2007

- An agency obtains Rs, 2,00,00,000 in order to construct a project by borrowing five equal beginning-of-year amounts. The project is then operated for 20 years. At the end of the first year of operation, the project is credited with Rs, 50,00,000 of revenues and the revenues increase by Rs. 1,00,000 per year for each year of operation. Estimate the present worth of the revenues and costs, and the average net revenues (with the effect of interest) over the twenty-five years of construction and operation. Take 7 percent interest into account for all calculations

# Assumptions

- Costs are incurred at the beginning of the year while revenues are realized at the end of the year
- Standard NPV formula is used to discount cash flows
  - $NPV = \sum C_t / (1+r)^t$

| Year | Costs | Revenues |
|---|---|---|
| 1 | 4000000 | 0 |
| 2 | 4000000 | 0 |
| 3 | 4000000 | 0 |
| 4 | 4000000 | 0 |
| 5 | 4000000 | 0 |
| 6 | | 5000000 |
| 7 | | 5100000 |
| 8 | | 5200000 |
| 9 | | 5300000 |
| 10 | | 5400000 |
| 11 | | 5500000 |
| 12 | | 5600000 |
| 13 | | 5700000 |
| 14 | | 5800000 |

| | | |
|---|---|---|
| 15 | | 5900000 |
| 16 | | 6000000 |
| 17 | | 6100000 |
| 18 | | 6200000 |
| 19 | | 6300000 |
| 20 | | 6400000 |
| 21 | | 6500000 |
| 22 | | 6600000 |
| 23 | | 6700000 |
| 24 | | 6800000 |
| 25 | | 6900000 |

| | | |
|---|---|---|
| NPV | Rs. 17,548,845.03 | Rs. 43,293,217.56 |
| Net Revenues | | Rs.25,744,372.53 |

# Problem 2 – Adapted from "Infrastructure Planning Handbook" 2007

1. A new pipeline is to be installed. Alternative sizes considered are 8", 12" and 16" diameter. For 8", the construction cost is Rs. 20,000 and the annual OMR including pumping cost is Rs. 5,000. For 12" the costs are Rs. 25,000 and Rs. 800 respectively and for 6" they are Rs. 40,000 and Rs. 200. What is the most economic size of pipeline if it is needed for 10 years and there is no salvage value at the end of that time? The applicable discount rate is 10%.

| Year | Option 1 - 8" | | Option 2 - 12" | | Option 3 - 16" | |
|---|---|---|---|---|---|---|
| | Fixed | Variable | Fixed | Variable | Fixed | Variable |
| 1 | 20000 | 5000 | 25000 | 800 | 40000 | 200 |
| 2 | | 5000 | | 800 | | 200 |
| 3 | | 5000 | | 800 | | 200 |
| 4 | | 5000 | | 800 | | 200 |
| 5 | | 5000 | | 800 | | 200 |
| 6 | | 5000 | | 800 | | 200 |
| 7 | | 5000 | | 800 | | 200 |
| 8 | | 5000 | | 800 | | 200 |
| 9 | | 5000 | | 800 | | 200 |
| 10 | | 5000 | | 800 | | 200 |
| 11 | | | | | | |
| NPV | 20000 | Rs. 30,722.84 | 25000 | $4,915.65 | 40000 | Rs. 1,228.91 |
| **Total NPV** | **Rs. 50,722.84** | | **Rs. 29,915.65** | | **Rs. 41,228.91** | |

**Option 2 is the best option**

# Problem 3 – Adapted from "Infrastructure Planning Handbook" 2007

- Projects A and B are to be compared in terms of the present worth of their net benefits. Project A requires one year for construction and costs Rs. 1,00,000. It involves an annual O&M cost of Rs. 10,000 per year of operation and provides benefits for five years after construction. These benefits start from Rs. 20,000 and increase by Rs. 20,000 annually. Project B requires two years for construction and costs Rs. 2,00,000. It involves an annual O&M cost of Rs. 20,000 per year of operation and provides benefits for ten years after construction. These benefits start from Rs. 40,000 and increase by Rs. 20,000 annually, capping out at Rs. 2,00,000. All amounts are end-of-year values. Which project is better? Assume a discount rate of 10%

| Year | Project A | | | Project B | | |
|---|---|---|---|---|---|---|
| | Const Cost | OMR Cost | Revenues | Const Cost | OMR Cost | Revenues |
| 1 | 100000 | 0 | 0 | 100000 | 0 | 0 |
| 2 | | 10000 | 20000 | 100000 | 0 | 0 |
| 3 | | 10000 | 40000 | | 20000 | 40000 |
| 4 | | 10000 | 60000 | | 20000 | 60000 |
| 5 | | 10000 | 80000 | | 20000 | 80000 |
| 6 | | 10000 | 100000 | | 20000 | 100000 |
| 7 | | | | | 20000 | 120000 |
| 8 | | | | | 20000 | 140000 |
| 9 | | | | | 20000 | 160000 |
| 10 | | | | | 20000 | 180000 |
| 11 | | | | | 20000 | 200000 |
| 12 | | | | | 20000 | 200000 |
| NPV | Rs. 90,909.09 | Rs. 34,461.70 | Rs. 193,683.42 | Rs. 173,553.72 | Rs. 101,563.09 | Rs. 575,122.86 |
| Overall NPV | Rs. 68,312.64 | | | **Rs. 300,006.05** – Better Project | | |

# Problem 4 – Adapted from "Infrastructure Planning Handbook" 2007

- A municipal agency is considering building an exhibition hall. Its feasibility will depend on whether the average cost per visitor is reasonable. Investment cost including interest during construction is Rs 5,00,00,000; repayment is done by 5 percent bonds over a 20 year operating period. Annual OMR is Rs. 2,50,000. Annual visitors are projected to be 500,000 the first year and increasing by 50,000 per year. Perform an analysis to determine the annual cost of the facility for each year over a twenty-year period of operation, the unadjusted cost per visitor for each year, and the levelized cost per visitor over the operating period based on a discount rate of 5 percent

| Year | Const Cost | OMR | Annual Visitors | Cost Per Visitor per year | Levelized Cost Per Year |
|---|---|---|---|---|---|
| 1 | ($4,012,129.36) | -250000 | 500,000 | 8.52 | 2380683.5 |
| 2 | ($4,012,129.36) | -250000 | 550,000 | 7.75 | 2618751.85 |
| 3 | ($4,012,129.36) | -250000 | 600,000 | 7.10 | 2856820.2 |
| 4 | ($4,012,129.36) | -250000 | 650,000 | 6.56 | 3094888.55 |
| 5 | ($4,012,129.36) | -250000 | 700,000 | 6.09 | 3332956.9 |
| 6 | ($4,012,129.36) | -250000 | 750,000 | 5.68 | 3571025.25 |
| 7 | ($4,012,129.36) | -250000 | 800,000 | 5.33 | 3809093.6 |
| 8 | ($4,012,129.36) | -250000 | 850,000 | 5.01 | 4047161.95 |
| 9 | ($4,012,129.36) | -250000 | 900,000 | 4.74 | 4285230.3 |
| 10 | ($4,012,129.36) | -250000 | 950,000 | 4.49 | 4523298.65 |
| 11 | ($4,012,129.36) | -250000 | 1,000,000 | 4.26 | 4761367 |
| 12 | ($4,012,129.36) | -250000 | 1,050,000 | 4.06 | 4999435.35 |
| 13 | ($4,012,129.36) | -250000 | 1,100,000 | 3.87 | 5237503.7 |
| 14 | ($4,012,129.36) | -250000 | 1,150,000 | 3.71 | 5475572.05 |
| 15 | ($4,012,129.36) | -250000 | 1,200,000 | 3.55 | 5713640.4 |
| 16 | ($4,012,129.36) | -250000 | 1,250,000 | 3.41 | 5951708.75 |
| 17 | ($4,012,129.36) | -250000 | 1,300,000 | 3.28 | 6189777.1 |
| 18 | ($4,012,129.36) | -250000 | 1,350,000 | 3.16 | 6427845.45 |
| 19 | ($4,012,129.36) | -250000 | 1,400,000 | 3.04 | 6665913.8 |
| 20 | ($4,012,129.36) | -250000 | 1,450,000 | 2.94 | 6903982.15 |
| **NPV** | ($50,000,000.00) | ($3,115,552.59) | | | $53,115,552.68 |

# Methodology

- Rs 5,00,00,000 is paid back over 20 years at 5% leading to an annuity payment of Rs. 40,12,129.36 per year
- Cost per visitor per year is calculated such that in every year the costs equal the revenues
- The levelized tariff is calculated such that the overall NPV of the project is 0 and comes to Rs. 4.76 per person

# Infrastructure Finance Models

- When preparing a detailed report and study of an infrastructure project, the earlier economic analysis might not suffice.
- Detailed models have to be built that identify cash inflows and outflows over every year of the project, the rates of interest and discount for each item etc
- A comprehensive NPV calculation can then be performed to determine the feasibility of the project.
- Sensitivity analysis can be performed by changing interest rates, loan payment schedules etc to see if the project can be structured differently

# Problem – Adapted from "Infrastructure Planning Handbook" 2007

1. A project for Water Supply was envisaged in city A. Construction costs totalled Rs. 33,250.94, to be paid back over 8 years starting one year after the start of the project, with the majority of the payments backloaded. Operations costs were set at Rs 1058 in the first year and were set to increase by 10% per year. Distribution costs were estimated at 20% of the total water tariff. The analysis estimated that of the total capacity of 5.98 billion gallons per year, 0.84 billion would be needed to meet the incremental demand in the first year and six additional years would be needed before the full capability of the scheme is realized. There was expected to be a loss in efficiency of supply of 16%. Tariffs started at Rs. 1.88 and increased by Rs. 0.12 every year, with an increase of 0.16 every third year. The net operating income each year is used to meet the loan payment due, and if this is inadequate the water utility's income from other sources could be utilized.

# Cost Model

| Year | OMR & Treatment | Distribution Costs |
|---|---|---|
| 1981 | 1058 | 263.2 |
| 1982 | 1164 | 600 |
| 1983 | 1280 | 945.52 |
| 1984 | 1408 | 1395.36 |
| 1985 | 1549 | 1852.8 |
| 1986 | 1704 | 2363.76 |
| 1987 | 1874 | 2690.72 |
| 1988 | 2062 | 2811.2 |
| 1989 | 2268 | 2931.68 |
| 1990 | 2495 | 3092.32 |
| 1991 | 2744 | 3212.8 |
| 1992 | 3019 | 3333.28 |
| 1993 | 3321 | 3493.92 |
| ….. | ….. | ….. |
| 2005 | 10422 | 5100.32 |
| 2006 | 11464 | 5220.8 |
| 2007 | 12610 | 5341.28 |

# Revenue Model

| Year | Incremental Prod. (billion gal/yr) | Incremental Water Sold (billion gal/yr) | Water Tariff per 1000 gal | Incremental Annual Revenue |
|---|---|---|---|---|
| 1981 | 0.84 | 0.7 | 1.88 | 1316 |
| 1982 | 1.78 | 1.5 | 2 | 3000 |
| 1983 | 2.66 | 2.23 | 2.12 | 4728 |
| 1984 | 3.65 | 3.06 | 2.28 | 6977 |
| 1985 | 4.59 | 3.86 | 2.4 | 9264 |
| 1986 | 5.58 | 4.69 | 2.52 | 11819 |
| 1987 | 5.98 | 5.02 | 2.68 | 13454 |
| 1988 | 5.98 | 5.02 | 2.8 | 14056 |
| 1989 | 5.98 | 5.02 | 2.92 | 14658 |
| 1990 | 5.98 | 5.02 | 3.08 | 15462 |
| 1991 | 5.98 | 5.02 | 3.2 | 16064 |
| 1992 | 5.98 | 5.02 | 3.32 | 16666 |
| 1993 | 5.98 | 5.02 | 3.48 | 17470 |
| …… | ….. | ….. | ….. | ….. |
| 2005 | 5.98 | 5.02 | 5.08 | 25502 |
| 2006 | 5.98 | 5.02 | 5.2 | 26104 |
| 2007 | 5.98 | 5.02 | 5.32 | 26706 |

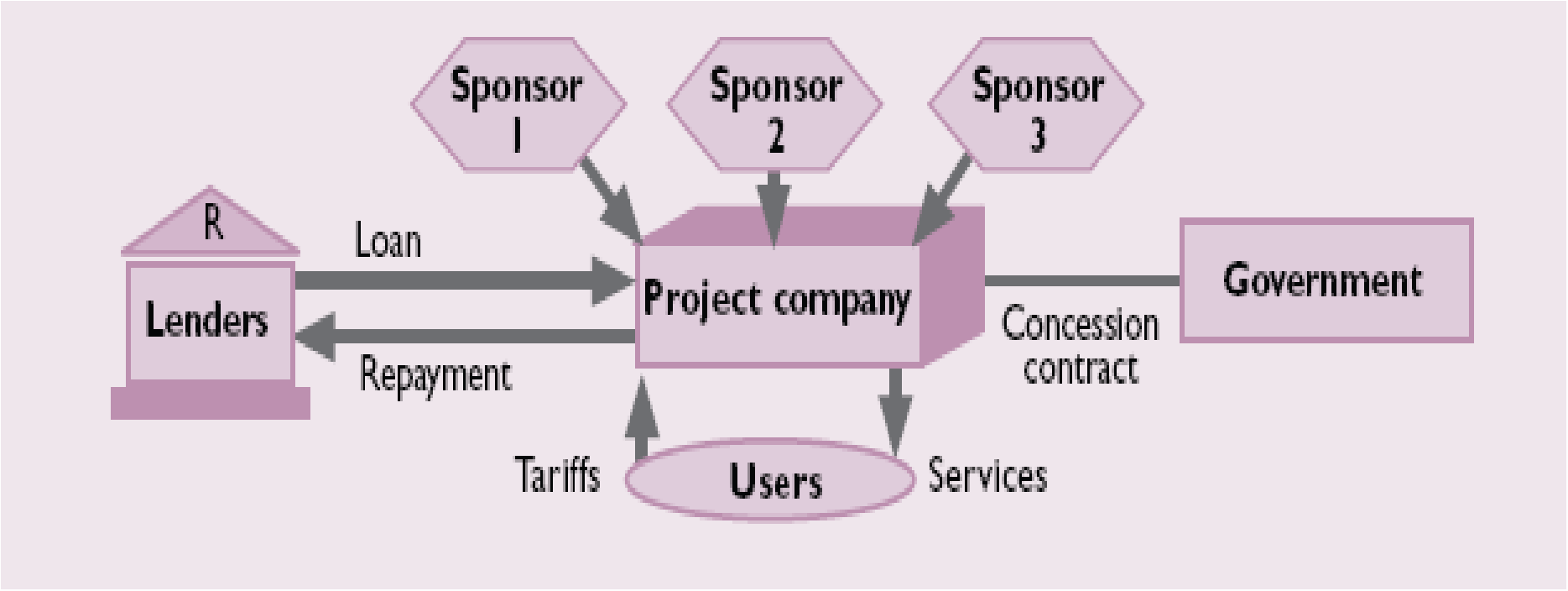
# Overall Model

| Year | Net Operating Income | Loan Repayment | Project Balance | Income from other sources | Cash Flow |
|---|---|---|---|---|---|
| 1981 | -5 | 0 | -5 | 40,349 | 40344 |
| 1982 | 1236 | 333 | 903 | 42924 | 43827 |
| 1983 | 2502 | 5092 | -2590 | 45499 | 42909 |
| 1984 | 4173 | 10,235 | -6062 | 48933 | 42871 |
| 1985 | 5862 | 10,235 | -4373 | 51509 | 47136 |
| 1986 | 7751 | 10,235 | -2484 | 54084 | 51600 |
| 1987 | 8888 | 10,235 | -1347 | 57518 | 56171 |
| 1988 | 9183 | 10,235 | -1052 | 60094 | 59042 |
| 1989 | 9459 | | 9459 | | 9459 |
| 1990 | 9874 | | 9874 | | 9874 |
| 1991 | 10107 | | 10107 | | 10107 |
| 1992 | 10314 | | 10314 | | 10314 |
| 1993 | 10655 | | 10655 | | 10655 |
| ….. | …… | | ….. | | ….. |
| 2005 | 9980 | | 9980 | | 9980 |
| 2006 | 9420 | | 9420 | | 9420 |
| 2007 | 8755 | | 8755 | | 8755 |

# Project Finance

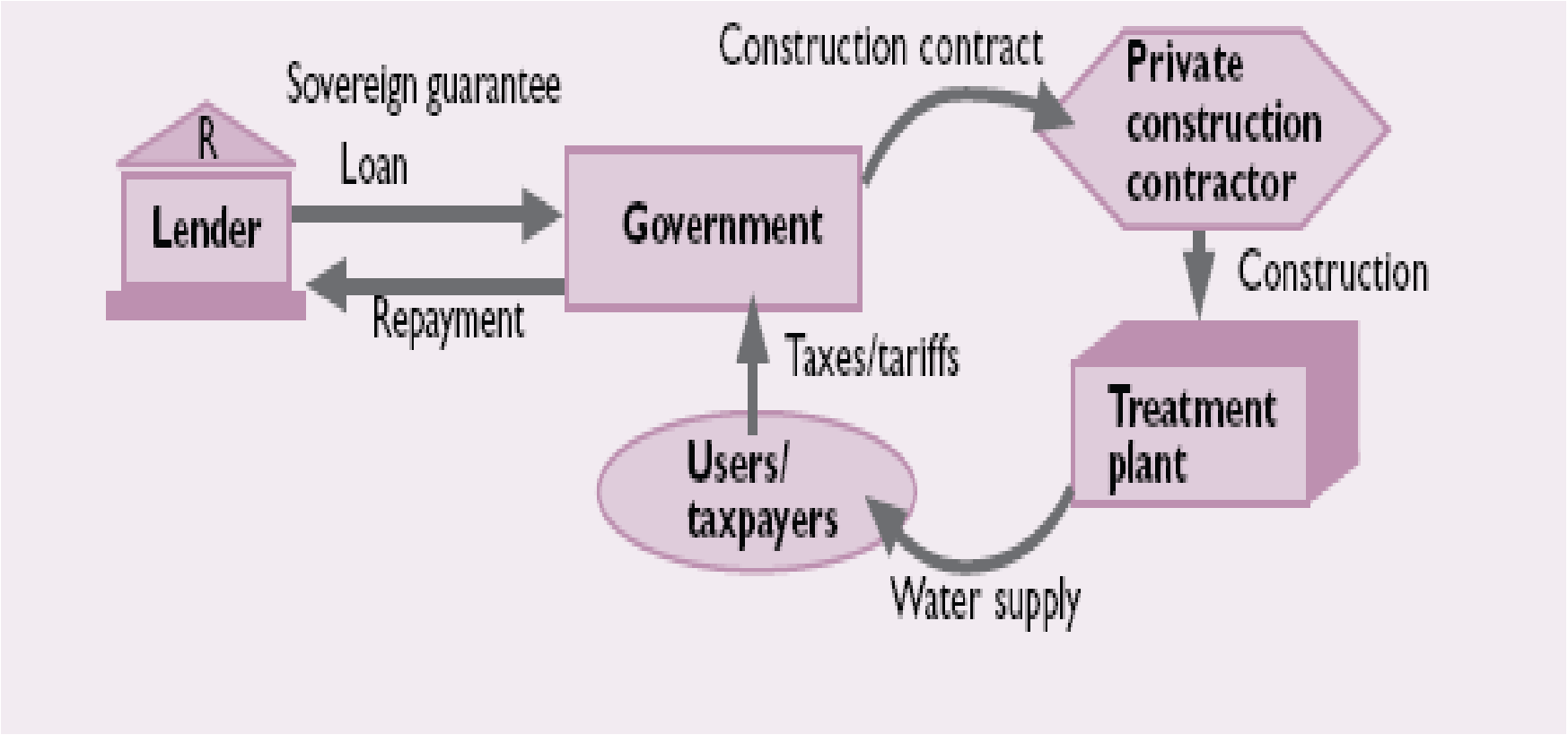
- A project Company or a Special Purpose Vehicle is created to execute a project
  - Project Company makes limited guarantees
  - Also known as **non-recourse financing**
  - Lenders have recourse **only** to the project vehicle and not to the parent companies
  - Typically the asset being financed has a limited life

# Project Finance



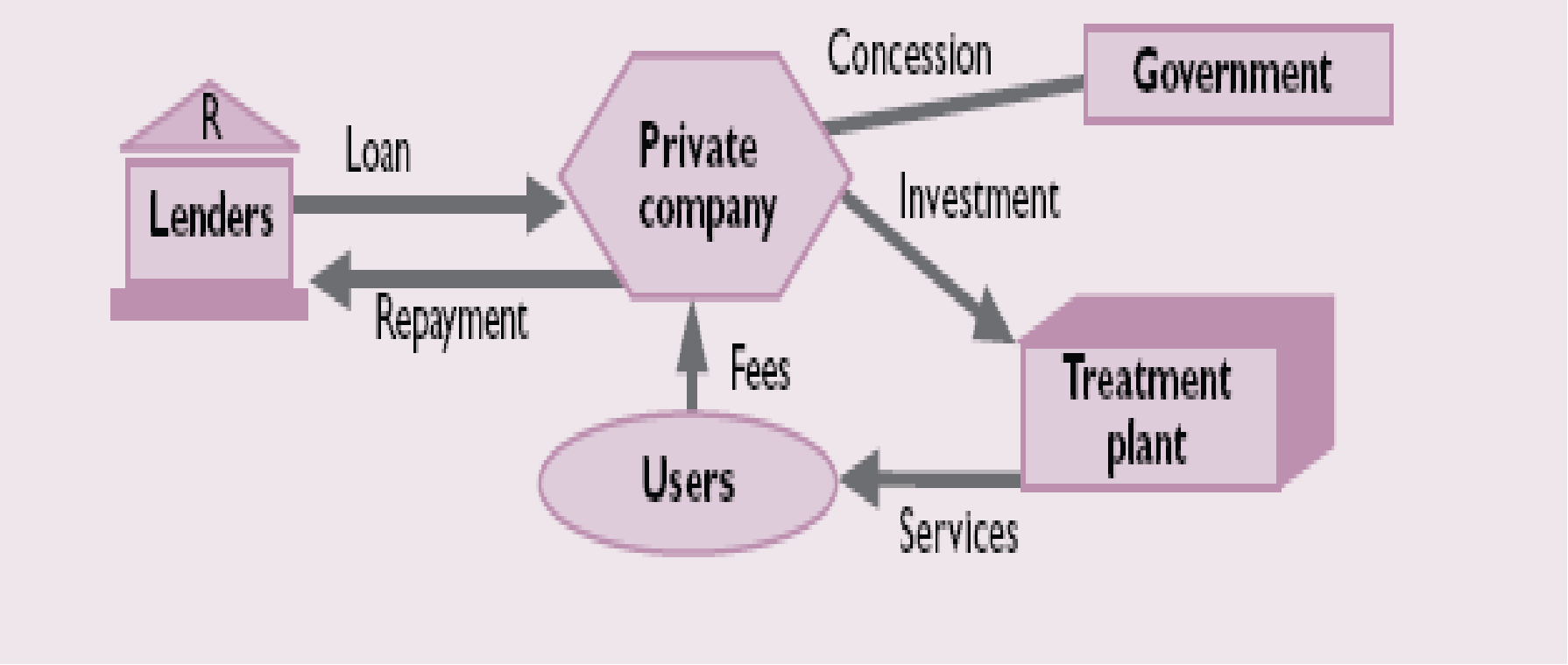

Adapted from Project Finance Manual, January 2001

# Public Finance




Adapted from Project Finance Manual, January 2001

# Corporate Finance




Adapted from Project Finance Manual, January 2001

# The evolution of project finance

- Is it a recent phenomenon?
  - No it isn't! It has been around since medieval times.
- Became very popular in mining and oil exploration projects in the 70s
- Adopted by the power industry in the US in the 80s
- PPP's in other sectors now use it extensively
- Volume of project financed projects is growing rapidly

# Key Terms

- Loan Amount – Total value of the loan
- Drawdown conditions
- Loan Pricing – rate at which the loan is given
- Term of Loan – duration over which the loan must be repaid
- Debt Service Coverage Ratio (DSCR)
  - (Earnings before Income Tax)/(Loan amount to be repaid)

# Is Low DSCR good?

- For lenders?
  - Yes. They get their money back quickly
- For borrowers?
  - No. They have lesser returns on Equity since a lot of money is spent paying the loan
  - Borrowers prefer to pay lesser over longer periods

# Why Project Finance?

- From the borrowers perspective
  - Less risk as their other assets are not at stake
  - Comparatively fewer covenants
  - Large transaction costs in putting the deal together

# The lenders perspective

- Pros
  - More transparency
  - Greater project-based incentives
  - Guaranteed and high returns?
  - But there are risks
- What criteria do lenders consider?
  - Technological risks
  - Strength of sponsors, financial credibilities?
  - Government backing/ Guarantees, expropriation risks?
  - Project economics
  - Social and Environmental Risks?
  - Equity invested by sponsors
  - Absence of competition


Thank You