

# Capital Budgeting

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## Capital budgeting

- Planning process for the acquisition of large capital assets

This lecture covers the following topics

- ① Capital assets and expenditure as well as the need for a capital budgeting process
- ② Capital budgeting process
- ③ Capital asset financing options
- ④ Compounding and discounting interest
- ⑤ Net present value (NPV)
- ⑥ Cost benefit analysis

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# Capital Assets and Expenditure

# Capital Assets

## Definition

- Economic: Assets with a useful life of more than one year
- Accounting: Assets with a purchase price above a certain dollar amount

## Input in the production process of private and public goods

- Private: Highways, mass transit, railways, airports, waterways, water supply, waste water treatment facilities, etc.
- Public: Schools, hospitals, recreation areas, jails, police and fire stations, defense establishments, etc.

In general: Large and non-recurring expenditures on infrastructure

# Capital Expenditures

## Definition

- Outlay to purchase a capital asset, which produces benefits beyond current fiscal year

## Characteristics of a capital expenditure

- Extension beyond a single financial period, e.g., a fiscal year.
- Large tangible projects of high initial cost
- Non-recurring expenditure except for operation and maintenance covered by recurrent budgets

Match of current service provision with current expenditures: Borrow to support capital expenditures due to service provision over multiple years

# Examples of Capital Assets and Expenditures

## Land or land rights

- Purchase price and fees (e.g., legal) related to purchase

## Buildings

- Including all construction costs (e.g., legal, architectural, engineering services)

## Infrastructure

- Highways, airports, railways, bridges, tunnels, water and sewer systems, etc.

## Equipment, machinery, and other permanent property

- Automobiles, communications systems, computer and office equipment, etc.

Upgrades adding value or improve facilities but excluding maintenance costs

# Reasons for Capital Budgeting Process I

## Permanence (long-term consequences)

- Service provision over multiple years and/or decades  $\Rightarrow$  Taxpayer payment over capital asset life (inter-generational equity)
- Expenditure separation of capital and recurrent budget
- Temporal difference between outlays and benefits

## Risks

- Technical risk: No application of past experience due to non-recurring nature of expenditure as well as irreversible process
- Financial risk: Impact on future budgets of debt financing

## Long-term perspective on infrastructure

## Reasons for Capital Budgeting Process II

### Tax rate stabilization

- Reduction in current tax burden due to expenditures spread over time

### Absence of federal capital budgeting process

- Size of the federal government: No single project could constrain spending in other areas
- Potential tendency towards deficit spending with separate capital budget

### Potential drawbacks of capital budgets

- Excessive reclassification of operating expenditures into capital expenditures
- Bias toward borrowing to finance all capital asset purchases



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# Capital Budgeting Process

## Key steps in capital budgeting: Plan, finance, and implement

- ① Current inventory of capital assets and Master Plan
- ② Project selection and Capital Improvement Plan (CIP)
  - Identification of appropriate capital expenditures over time
  - Evaluation of cost, synergies, and priorities
  - Sequencing of projects
- ③ Financing plan and long-term financial analysis
  - Operating expenditure, revenue capacity, and multi-year debt service ability
  - Evolution of current and debt
- ④ Implementation of the capital budget and project management

# Inventory of Capital Assets

## Current inventory and condition of facilities

- Age, condition, usage, capacity, replacement cost
- May include estimates for renovation, replacement, expansion, and/or retirement
- Potential inclusion of some expenditures in recurrent budget

## Current service characteristics

- Current and future cost per unit of service

Ideal situation: Asset management plan providing list of capital assets, maintenance cost, and other information

- Basis for decisions on expansion and planning capital maintenance
- Example: [Asset Management Plan for the City of Corinth, Texas](#)

# Master Plan

Vision regarding the direction for (local) economy, land-use, and development

- Forecasting need for future facilities (e.g., roads, sewage, libraries) given community growth and economic development
- Demand estimation for services such as parks, transportation, offices, and residential needs

## Examples

- Indianapolis Parks and Recreation
- Carmel Comprehensive Plan 2022
- Saint Paul for All 2040 Comprehensive Plan

## Additional information

- Government Finance Officers Association (GFOA): Master Plans and Capital Improvement Planning

# Saint Paul for All 2040 Comprehensive Plan

## Major trends informing comprehensive plan policy

- Climate change
- Aging housing stock and infrastructure
- Constrained financial resources to pay for city services and facilities
- Changing demographics

## Challenges and opportunities for the future

- Equity
- Growth and density
- Economic development and opportunity sites
- Climate change mitigation, adaptation, and resiliency
- Designing a city for all ages and abilities
- Fostering the next generation
- New technologies and their impact on development patterns

# Project Selection

## Project cost

- Research and development
- Legal fees and other fees
- Construction cost

## Life-cycle expenses

- Operation and maintenance
- Cost of major repairs

## Project evaluation regarding effectiveness compared to renovation of existing facilities

- Project cost and life-cycle expenses
- Appropriateness given priorities in the Master Plan

# Capital Improvement Plan (CIP) I

Multi-year plan with detailed project information, documentation, and justification

- New facilities as well as renovation and replacement of existing facilities

Financial and timing of projects

- Cost and financing information
- Sequencing, e.g., sewer line and utility cables before new pavement

Example

- Noblesville Capital Improvement Plan 2019–2023 Projects

CIP updated potentially every year

# Capital Improvement Plan (CIP) II

## Advantages

- Multi-year perspective
- Long-range policy development
- Focuses attention on community goals, needs and finances
- Dynamic process that helps builds public consensus
- Financial management tool and reporting document
- Assists with credit ratings

## CIP development process

- Executive directions regarding priorities
- Cost estimates from agencies depending on needs
- Potential input from citizens



# Financing Plan and Long-Term Financial Analysis

Development of long-term financial projections and financing plan

- Projections of tax revenue and baseline expenditures over time

Financing options for capital projects and acquisitions

- Pay-as-you-go: Current revenue sources other than debt
- Pay-as-you-use: Match of debt repayment with life of asset.

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# Capital Asset Financing Options

## Pay-As-You-Go vs. Pay-As-You-Use Financing

### Pay-as-you-go

- Financing of capital projects with current revenue sources other than debt
- Example: Infrastructure investment financed with motor fuel taxes
- Other non-debt sources: Grants from state and/or federal government, accumulated reserves

### Pay-as-you-use

- Financing of capital projects with debt
- Bonds and other debt instrument issued by the government
- Debt repayment over the lifetime of the asset
- Leasing

Possibility of combination between pay-as-you-go and pay-as-you-use financing

# Advantages and Disadvantages: Pay-as-you-go

## Advantages

- Avoidance of interest payments
- Preservation of borrowing option for other projects
- Flexibility

## Disadvantages

- Increases in taxes and/or fees
- Misalignment between payments and benefits of capital asset
- Potential underinvestment in capital assets

# Advantages and Disadvantages: Pay-as-you-use

## Advantages

- Avoidance of tax increase
- Alignment between payments and benefit of capital asset

## Disadvantages

- Constraint of operating budget due to debt service
- High debt burden

# Financial Analysis over Capital Asset Lifetime I

## Revenue capacity

- Ability to generate own-source revenue and its share available for capital investments (pay-as-you-go versus pay-as-you-use)

## Borrowing capacity

- Total debt compared to size of entity/institution, interest rate, debt service, credit rating

## Generation of user charges and fees by capital asset

- Projected revenues and share dedicated for capital investment

# Financial Analysis over Capital Asset Lifetime II

Contributions by other governmental and/or private entities

- Federal aid, state aid, public-private partnerships

Impact of capital asset on operating budget

- Annual operating and maintenance costs, debt service as a percent of budget revenues

Other sources of revenue

- One-time development impact fee, special assessments, sale of assets

## Leasing and Debt Options

### Municipal bonds

- Exclusion of interest payments from taxable income (for bondholder) resulting in lower interest rates (lower cost of borrowing) for issuer
- Types of municipal bonds
  - General obligation bonds: Backed by the taxing authority of the government (strongest security pledge with low interest rates) and possibly subject to voter approval
  - Revenue bonds: Backed by the revenue generation of the capital asset and therefore resulting in higher interest rates due to risk of inadequate revenue generation

### Other options

- Leasing: Useful for specialized equipment likely becoming obsolete after leasing period
- Loans: Direct borrowing on capital markets



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# Compounding and Discounting Interest

## Compounding Interest

Situation: Initial deposit of \$100 and 5% interest over three years

	Year 1	Year 2	Year 3
Starting balance	100.00	105.00	110.25
Interest earned	$100 \cdot 0.05 = 5.00$	$105 \cdot 0.05 = 5.25$	$110.25 \cdot 0.05 = 5.51$
Ending balance	105.00	110.25	115.76

General formula

$$FV = PV \cdot (1 + r)^t$$

Notation

- $r$ : Interest rate
- $t$ : Number of time periods (years)
- $PV$  and  $FV$  as present and future value, respectively

## Discounting Interest

Determination of present value (PV) given an amount to be received in the future

- Interest rate used to determine PV: Discount rate  $r$ .

Situation: Withdrawal of \$100 in three years and 6% discount rate

	Year 1	Year 2	Year 3
Starting balance	83.96	89.00	94.34
Interest earned	$83.96 \cdot 0.06 = 5.04$	$89.00 \cdot 0.06 = 5.34$	$94.34 \cdot 0.06 = 5.66$
Ending balance	89.00	94.34	100

General formula

$$PV_t = \frac{FV_t}{(1 + r)^t}$$

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# Net Present Value

## Setup:

- Cash flow of \$100,000 in each of the next ten years
- Interest paid: 6%

## Net present value formular

$$NPV = \sum_{t=1}^T \frac{X_t}{(1+r)^t}$$

## Football Field: Setup

Consider the renovation of a football field with two options for the turf

- ① Artificial turf: Initial cost is \$500,000 but does not require any maintenance for 10 years.
- ② Natural turf: The natural turf requires spending \$200,000 initially but maintenance is required every year. The maintenance cost also vary from year to year due to re-seeding and fertilization requirements.

Assume a discount rate of 5%. The cost, discount factors (DF), and present values (PV) are summarized on the next slide.

## Football Field: Calculation

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Year	Cost	DF	PV
0	200	1.000000	200.00000
1	20	1.050000	19.04762
2	50	1.102500	45.35147
3	20	1.157625	17.27675
4	50	1.215506	41.13512
5	20	1.276282	15.67052
6	50	1.340096	37.31077
7	20	1.407100	14.21363
8	50	1.477455	33.84197
9	20	1.551328	12.89218
10	50	1.628895	30.69566

## Annuity Formula

How do you calculate monthly car or mortgage payments?

$$S = \frac{P \cdot \frac{r}{12}}{1 - \left(\frac{1}{1 + \frac{r}{12}}\right)^{12 \cdot n}}$$

Where

- $S$  is the monthly payment
- $r$  is the interest rate
- $n$  is the number of years

Example: What is the monthly payment for a \$80,000 mortgage at 7% over 20 years?



## Internal Rate of Return

Calculate the discount rate that would cause present value of benefits (returns) to equal present value of costs.

- Net Present Value=0

Find  $r$  such that:

$$C_0 = \frac{N_1}{1+r} + \frac{N_2}{(1+r)^2} + \dots + \frac{N_t}{(1+r)^t}$$

where  $C_0$  is the initial cost and  $N_t$  is the return in time period  $t$ . Can be calculated only by successive trials of  $r$ .

- Excel: IRR(range)

## Annualize Capital Costs

Split the front-end capital cost over project life

- Distribution of initial lump sum over years of life
- Cost per period such that when discounted you get the initial capital costs

Initial cost

$$IC = \frac{X}{1+r} + \frac{X}{(1+r)^2} + \frac{X}{(1+r)^3}$$

Annualization factor

$$AF = \frac{r}{(1+r)^n - 1} + r$$

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# Cost Benefit Analysis (CBA)

CBA as a systematic method to measure costs and benefits of a project

- Private sector: Private costs and benefits (i.e., impact on bottom line)
- Public sector: Social costs and benefits
- Frequent exclusion of non-monetary costs and benefits in private CBA

Steps:

- ① Identification of objective and options
- ② Identification of inputs and outputs
- ③ Valuation of inputs and outputs
- ④ Calculation of net present value

A city wants to make it easier to travel between the city and the suburbs

- Main objectives: Cut travel time
- Potential other objectives: Reduction in air pollution and traffic congestion
- Options: (1) Commuter rail, (2) expanded bus service, (3) expanded highway (car-pool lane)

Selection of least-cost option to achieve objective

# Inputs and Outputs

## Identification of inputs and outputs

- Inputs (cost) and outputs (benefit) in physical quantities to avoid excluding non-monetary items

## Valuation of inputs and outputs

- Calculate shadow price: Value to the economy
  - Input: Marginal opportunity cost, i.e., value in the next best alternative
  - Output: Marginal willingness to pay

Shadow prices not always equal to market price due to market imperfections

# Discounting of Benefits and Costs

## Calculation of net present value

- Negative NPV: Reject project
- Positive NPV: Accept project
- In the case of mutually exclusive projects: Highest NPV

## Other criteria:

- Benefit cost ratio:  $BCR > 1$
- Internal rate of return:  $IRR > r$

# Measuring Economic Cost and Benefit

## Transfers

- Exclusion of “costs/benefits” involving shift or transfer of purchasing power
- Example: Project increasing commercial logging in the national forest and hence, fees paid by logging companies

## Marginal willingness to pay (MWTP)

- Amount of income willing to be given up to consume one additional unit of output
- Use of consumer surplus due to measurement difficulty

## Marginal opportunity costs

- Value of next best alternative