Capital Budgeting

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Overview

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

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

Capital Budgeting Process

Overview

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 Managment 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.

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 therefor resulting in higher interest rates due to risk of inadequte revenue generation

Other options

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

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

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

Net Present Value

Overview

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

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:

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

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

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

Cost Benefit Analysis (CBA)

Overview

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

Example

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