CAPITAL BUDGETING & CAPITAL RATIONING

Pre-Session Learning Resource for Excel-Based Models

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1. Purpose of This Learning Resource

This learning resource is designed to be studied **before** attending classroom or Excel lab sessions on capital budgeting and capital rationing.

The objective of this document is to ensure that students:

- Clearly understand the **financial concepts** underlying capital budgeting models
- Know **why** specific Excel functions are used, not merely how to enter formulas
- Can confidently **interpret model outputs** and relate them to managerial decisions
- Are prepared to work **independently** with Excel-based capital budgeting models

After completing this material, students should be comfortable working on:

- Conventional capital budgeting models
- Unconventional capital budgeting models involving irregular cash flows
- Capital rationing and portfolio selection models using optimization logic

This document is **fully self-sufficient** and does not require any external reading.

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2. Conceptual Foundations of Capital Budgeting

2.1 What Is Capital Budgeting?

Capital budgeting refers to the process of evaluating **long-term investment decisions** undertaken by a firm. These decisions typically involve large initial investments and cash flows that are spread over several future years.

Common examples of capital budgeting decisions include:

- Establishing a new manufacturing facility
- Introducing a new product or technology
- Expanding operations into a new geographic market
- Replacing outdated equipment with modern machinery

Such decisions are strategic in nature and are usually **irreversible or very costly to reverse**. As a result, careful financial evaluation is essential before committing funds.

2.2 Why Capital Budgeting Decisions Are Critical

Capital budgeting decisions have a long-lasting impact on the firm because:

- They involve **substantial capital outlay**
- They influence the firm's **future cash-generating ability**
- A poor investment decision can affect performance for many years
- They shape the firm's **competitive and strategic position**

Because of these characteristics, capital budgeting analysis focuses on **cash flows, timing, and risk**, rather than accounting profits.

2.3 Core Decision Principle: Value Maximization

The fundamental objective of capital budgeting is **maximization of shareholder wealth**.

This means that a project should be accepted only if it increases the overall value of the firm after accounting for the time value of money and risk. Accounting profits or percentage returns alone are not sufficient criteria.

All capital budgeting techniques ultimately aim to answer a single question:

Does this investment create value for the firm?

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3. Conventional Capital Budgeting Techniques

3.1 Net Present Value (NPV)

Conceptual Meaning of NPV

Net Present Value (NPV) measures the **net increase in firm value** that results from undertaking a project. It is calculated by discounting all expected future cash inflows to their present value and subtracting the initial investment.

In mathematical terms, NPV is the sum of discounted cash flows:

$$NPV = \sum \frac{Cash\ Flow_t}{(1+WACC)^t}$$

where WACC represents the firm's cost of capital and t represents time.

Economic Intuition Behind NPV

NPV is based on the principle that **money today is worth more than money in the future**. Future cash flows must therefore be discounted to reflect this time value of money.

If the present value of expected cash inflows exceeds the initial investment, the project creates value. If it does not, the project destroys value.

Thus, NPV directly answers the question:

By how much will this project increase or decrease the value of the firm?

Decision Rule for NPV

- If NPV is positive, the project should be accepted
- If NPV is negative, the project should be rejected
- If NPV is zero, the firm is indifferent

NPV is regarded as the **most reliable and theoretically sound** capital budgeting criterion and is treated as the primary basis for decision-making.

3.2 Internal Rate of Return (IRR)

Conceptual Meaning of IRR

The Internal Rate of Return (IRR) is the discount rate at which the project's NPV becomes zero. It represents the annual percentage return generated by the project.

In simple terms, IRR answers the question:

What rate of return does this project earn on the invested capital?

Interpretation of IRR

- If IRR exceeds the firm's cost of capital, the project is acceptable
- If IRR is lower than the cost of capital, the project should be rejected

Managers often prefer IRR because it is expressed as a percentage, which makes comparison with required return easier.

Limitations of IRR

Despite its popularity, IRR has important limitations:

- It assumes that interim cash flows are reinvested at the IRR, which may be unrealistic
- Projects with multiple sign changes in cash flows can produce multiple IRRs
- IRR can give misleading rankings when projects are mutually exclusive

For these reasons, IRR should be used only as a **supporting measure**, not as the primary decision criterion.

3.3 Modified Internal Rate of Return (MIRR)

Why MIRR Is Needed

Modified Internal Rate of Return (MIRR) was developed to overcome the unrealistic reinvestment assumption of IRR.

MIRR assumes:

- Cash outflows are financed at the firm's cost of capital
- Cash inflows are reinvested at a realistic reinvestment rate

This makes MIRR a more practical measure of return.

Interpretation of MIRR

MIRR provides a single, realistic annual rate of return for a project. However, like IRR, it does not measure absolute value creation and therefore does not replace NPV.

3.4 Profitability Index (PI)

Conceptual Meaning of PI

Profitability Index (PI) measures the **value created per unit of investment**. It is calculated as:

$$PI = \frac{Present\ Value\ of\ Inflows}{Initial\ Investment}$$

A PI greater than 1 indicates that the project creates value.

When PI Is Most Useful

PI is particularly useful in situations involving **capital rationing**, where funds are limited and not all positive-NPV projects can be undertaken. It helps rank projects based on efficiency of capital usage.

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4. NPV–IRR Conflict and Crossover Rate

4.1 Why NPV and IRR Can Conflict

NPV and IRR may rank projects differently due to differences in:

- Project size or scale
- Timing of cash flows
- Reinvestment assumptions

A project with a higher IRR may create less total value than another project with a lower IRR but larger cash flows.

4.2 Crossover Rate

The crossover rate is the discount rate at which the NPVs of two projects are equal. At discount rates below or above this point, the ranking of projects can change.

In cases of mutually exclusive projects, the correct decision rule is to **select the project with the higher NPV at the firm's cost of capital**.

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5. Cash Flow Adjustments in Capital Budgeting

5.1 Tax Effects

Capital budgeting decisions are based on **after-tax cash flows**, because taxes reduce the actual cash available to the firm. Accounting profits are not relevant for investment decisions.

5.2 Salvage Value

Salvage value represents the cash inflow received at the end of the project's life. It should be treated as a terminal cash flow, adjusted for tax effects and discounted like any other future cash flow.

5.3 Incremental Cash Flows and Replacement Decisions

Only incremental cash flows should be considered in capital budgeting analysis. This means focusing on cash flows that occur **because of** the investment decision.

Sunk costs should be ignored, while opportunity costs should be included.

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6. Risk and Sensitivity Analysis

6.1 Sensitivity of NPV to Discount Rate

Projects with cash flows occurring further in the future are more sensitive to changes in the discount rate. Sensitivity analysis helps assess how robust a project's value is under different assumptions.

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7. Unconventional Capital Budgeting

7.1 Why Conventional Methods Fail

Traditional NPV and IRR methods assume equal time intervals between cash flows. These assumptions break down when cash flows occur on irregular dates.

7.2 XNPV

Conceptual Meaning

XNPV discounts each cash flow using actual calendar dates rather than assumed annual periods. It measures the value created by a project as of a specific base date.

Interpretation

If XNPV is positive, the project creates value and should be accepted. If XNPV is negative, the project should be rejected. XNPV is the primary decision metric for projects with irregular cash flows.

7.3 XIRR

XIRR calculates the internal rate of return using actual dates. While useful, it can be unstable in complex cash flow patterns and should always be interpreted alongside XNPV.

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8. Capital Rationing and Portfolio Selection

8.1 Meaning of Capital Rationing

Capital rationing arises when the firm has limited funds and cannot undertake all positive-NPV projects. The goal is to select the combination of projects that maximizes total value.

8.2 Binary Decision Variables

In capital rationing models, each project is assigned a binary variable:

- 1 if the project is selected
- 0 if the project is not selected

This converts the problem into an optimization framework.

8.3 Types of Constraints

Constraints reflect real-world limitations such as budget limits, project dependencies, mandatory investments, risk limits, and portfolio-level performance requirements.

8.4 Objective Function

The objective of capital rationing models is to maximize total portfolio NPV subject to the specified constraints.

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9. Excel Functions and Their Meaning

9.1 Financial Functions Used

Each Excel function used in capital budgeting corresponds to a financial concept. Students must understand the logic behind each function, its assumptions, and its correct application rather than treating it as a mechanical formula.

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10. Common Errors and Conceptual Checks

10.1 Common Mistakes

Common mistakes include relying blindly on IRR, ignoring timing of cash flows, mixing nominal and real values, and trusting optimization outputs without understanding the logic.

10.2 Conceptual Self-Checks

Before accepting results, students should ask whether the outputs make economic sense, whether cash flow signs and timing are correct, and whether constraints reflect real business conditions.

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11. How Students Should Use This Material

Students are encouraged to read this document fully before attending lab sessions. The focus should be on understanding concepts first and using Excel as a supporting tool rather than the primary objective.

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12. Final Takeaway

Capital budgeting is fundamentally a **decision-making discipline**, not merely an Excel exercise. Excel helps perform calculations, but sound financial judgment is required to interpret results and make correct decisions.