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Corporate Finance

Capital Budgeting Process

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Capital rationing

- In a perfect world capital budgeting would be straightforward
- In the real world, capital is often 'rationed'
- What is an optimal capital budget?
- Typology of capital expenditure projects

Capital budgeting under a capital constraint

- How a capital constraint is determined?
- Trial and error versus integer linear programming
- Example 1
- Example 2
- Example 3

In a perfect world capital budgeting would be straightforward

Capital budgeting would be straightforward in a perfect world.

- A set of enterprise value enhancing projects is determined (e.g. all positive NPV projects);
  - There is very little uncertainty about future cash flows of each project;
  - The firm can manage as many NPV projects it can find regardless of their size;
- The capital requirements are communicated to capital markets
  - Notably by being transparent, e.g. divulging projects' nature and NPV;
  - It results in no information asymmetries between investors and management being created;
- Capital markets agree with firm as per information received and provide capital accordingly at fair market price by having the firm issue debt and/or equity (i.e. capital markets are efficient);
  - Fair market price for equity: stock is issued at its 'true/fundamental value';
  - Fair market price for debt: interest rate to reflect creditworthiness.
- The cost of raising capital by issuing securities is negligible.

Accessing the required amount of capital is not an issue in a perfect world since there is are frictions.

In the real world, capital may be 'rationed'

	In theory	In practice	Source of rationing
Project discovery	The firm uncovers a good investment opportunity.	The firm believes, given the underlying uncertainty, that it has a good project.	Uncertainty about true value of projects may cause rationing.
Information revelation	The firm conveys information about the project to financial markets.	The firm attempts to convey information to financial markets.	Difficulty in conveying information to markets may cause rationing.
Market response	Financial markets believe the firm; i.e., the information is conveyed credibly.	Financial markets may not believe the announcement.	The greater the credibility gap, the greater the rationing problem.
Market efficiency	The securities issued by the firm (stocks and bonds) are fairly priced.	The securities issued by the firm may not be correctly priced.	With underpriced securities, firms will be unwilling to raise funds for projects.
Flotation costs	There are no costs associated with raising funds for projects.	There are significant costs associated with raising funds for projects.	The greater the flotation costs, the larger the capital rationing problem.

Source: adapted from Damodaran (2015)

Recall: Typology of capital expenditure projects

One challenge to select or rank new investments on an analytical/rational basis is that the very nature of projects might differ across projects.

- The stand-alone project: has not impact on any other project;
- The mutually exclusive projects: approval of one project rules-out approval of another or even several other projects;
- The scalable project: (e.g. new retail store at multiple locations);
- The multi-year project: a project that requires an initial multi-year investment (might reduce firm's ability to seize new opportunities);
- Some projects might have some inter-dependencies (e.g. synergies or cannibalization of sales);
- Some projects are routine while others are strategic;
- Some projects by their nature are likely to provide for new opportunities in the future (i.e. follow-on projects).

Since projects are likely to be different not only quantitatively but also qualitatively, in addition to be possibly interrelated contemporaneously or through time, one has to be very careful when evaluating the optimal set of projects to be approved at a given point in time.

Optimal capital budget and capital rationing

The capital budgeting process seeks to identify the 'optimal capital budget' which is the set of projects that maximizes the value of the firm (i.e. the highest possible combined net present value).

- Each project is first evaluated/analyzed, its riskiness assessed, and various investment criteria calculated (e.g. NPV, IRR, PI, etc);
- In the absence of capital constraints, negative NPV projects are rejected while positive NPV projects are accepted, subject to qualitative considerations (e.g. is the project 'strategic'?).

However, the firm might nevertheless decide to limit its total capital spending to less than the set of projects as above identified.

- If the firm has excellent access to capital markets (i.e. is not facing much frictions), it might choose a '**soft rationing**' approach, mostly to improve its financial control over the capital budgeting process (i.e. use budget limits to incite management to make good rational choices).
- If the firm has limited or no access to capital markets (i.e. is facing frictions), it has to implement a '**hard rationing**' approach to limit its capital spending to the funds that are available.

Capital budgeting under a capital constraint

Given the real-world issues already alluded to, as well as for various managerial reasons, it is common for the Board of Directors to kick start the capital budgeting process by selecting the size of next year capital budget (i.e. 'we are looking this year for projects worth $100 million next year'). By doing so, it creates a capital constraint. Management usually respond by targeting the budget to the constraint (i.e. planning for $100 million of projects).

The above is typically not a final decision. If not enough reasonably attractive projects could be found, less than the initially indicated budget will be approved. A contrario, if many very attractive projects manifest themselves, then the Board of Directors might be amenable to approve a higher capital expenditure budget than initially indicated.

As soon as a capital constraint has been set (aka 'capital rationing'), it further complicates the identification of the optimal set of projects.

Some projects given their nature (e.g. a large acquisition) might be 'off capital budget' and therefore not subject to the annual capital budget constraint.

How a capital constraint is determined?

Factors considered by Boards for determining the size of the capital budget.

- The size of the capital budget over the last few years.
- The amount of capital committed in previous years to be spent this year.
- How successful the capital budgeting process has been recently.
  - Have positive NPV projects been plentiful (or not)?
  - Have cash flows projections been realistic?
  - Have projects recently approved been successful?
- Does the current strategy requires a lot of new projects to be successful?
- Is the macroeconomic environment expected to be favorable (or not)?
- Are competitors investing a lot (or not)?
- How ‘favorable’ are capital markets? (now and in the near term)
  - Is the firm already capital constrained through some debt covenants?

Practically speaking

- The baseline is often a percentage of EBITDA.

Trial and error versus integer linear programming

Trial and error or intuition can identify the optimal capital budget under a budget constraint, as long as the number of projects is fairly limited.

Linear programming (aka linear optimization) can be used to determine the optimal capital budget.

- Such structured approach is required as soon as many projects are considered simultaneously.
- Excel solver is able to solve integer linear programming.
- Taking into consideration the qualitative aspects can be challenging.

We will review how integer linear programming with Excel can be used for fairly simple situations.

- These are examples of using a structured approach;
- In real life, firms use analytical and decision processes for capital budgeting that are more or less complex and sophisticated according to their business models and available analytical expertise.

Example 1

Project	CF_0	CF_1	CF_2	NPV @ 10%	IRR	PI
A	-10	+30	+5	21.4	216%	2.1
B	-5	+5	+20	16.1	156%	3.2
C	-5	+5	+15	11.9	130%	2.4

Optimal set of projects without capital constraint

- A, B and C (total NPV of 49.4).

Example 1

Project	CF_0	CF_1	CF_2	NPV @ 10%	IRR	PI
A	-10	+30	+5	21.4	216%	2.1
B	-5	+5	+20	16.1	156%	3.2
C	-5	+5	+15	11.9	130%	2.4

Optimal set of projects without capital constraint

- A, B and C (total NPV of 49.4).

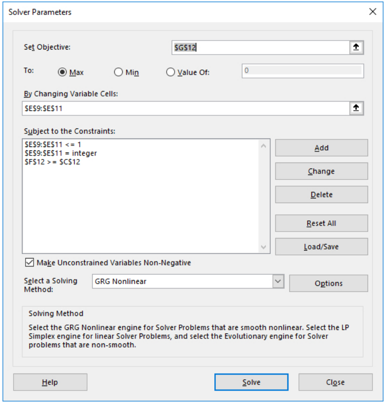
Optimal set of projects with a capital contraint of 10

- A: NPV of 21.4 or B and C: NPV of 28, therefore B and C.
- The profitability index ('PI') could appear as a useful indicator.

Example 1 using integer linear programming with Excel solver

Project	C0	C1	C2	10% NPV	IRR	PI
A	-10	30	5	21.4	216%	2.1
B	-5	5	20	16.1	156%	3.2
C	-5	5	15	11.9	130%	2.4
				49.4		

Project	Inv.	NPV	Accept=1	Total Inv.	Total NPV
A	-10	21.4	1	-10	21.4
B	-5	16.1	1	-5	16.1
C	-5	11.9	1	-5	11.9
Constraint	-10			-20	49.4



- What is the optimal set if the projects are 'normal'? (i.e. non-scalable)
- What is the optimal set if the projects are scalable? (i.e. 0, 1, or 2)

Example 2

Project	CF_0	CF_1	CF_2	NPV @ 10%	IRR	PI
A	-10	+30	+5	21.4	216%	2.1
B	-5	+5	+20	16.1	156%	3.2
C	-5	+5	+15	11.9	130%	2.4
D	0	-40	+60	13.2	50%	0.3

Optimal set of projects without capital constraint

- A, B, C and D (total NPV of 62.6).

Example 2

Project	CF_0	CF_1	CF_2	NPV @ 10%	IRR	PI
A	-10	+30	+5	21.4	216%	2.1
B	-5	+5	+20	16.1	156%	3.2
C	-5	+5	+15	11.9	130%	2.4
D	0	-40	+60	13.2	50%	0.3

Optimal set of projects without capital constraint

- A, B, C and D (total NPV of 62.6).

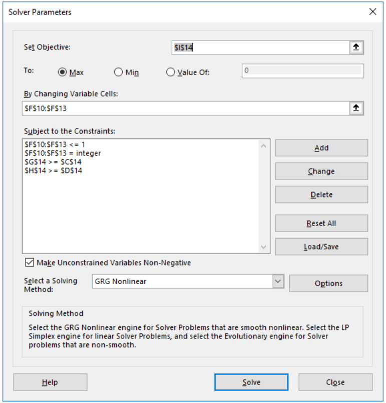
Optimal set of projects with a capital contraint of 10 in the first two periods (i.e. CF_0 and CF_1)

- A and D: NPV of 34.6 or B and C: NPV of 28, therefore A and D.
- The profitability index ('PI') can be a misleading indicator.

Example 2 using integer linear programming with Excel solver

Project	C0	C1	C2	10% NPV	IRR	PI
A	-10	30	5	21.4	216%	2.1
B	-5	5	20	16.1	156%	3.2
C	-5	5	15	11.9	130%	2.4
D	0	-40	60	13.2	50%	0.3
				62.6		

Project	Inv. 1	Inv. 2	NPV	Accept=1	Tot. Inv. 1	Tot. Inv. 2	Tot. NPV
A	-10	30	21.4	1	-10	30	21.4
B	-5	5	16.1	1	-5	5	16.1
C	-5	5	11.9	1	-5	5	11.9
D	0	-40	13.2	1	0	-40	13.2
Constraint	-10	-10			-20	0	62.6



- What is the optimal set if the projects are 'normal'? (i.e. non-scalable)

Example 3

Project	CF_0	CF_1	CF_2	NPV @ 10%	IRR	PI
A	-10	+30	+5	21.4	216%	2.1
B	-5	+5	+20	16.1	156%	3.2
C	-5	+5	+15	11.9	130%	2.4
D	-10	+20	+20	24.7	173%	2.5

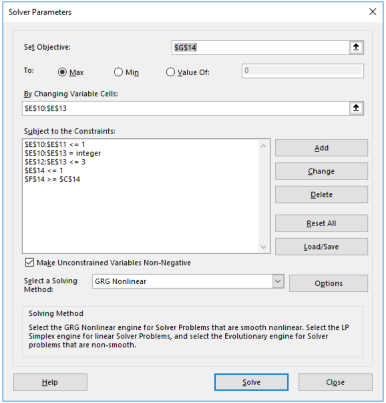
Optimal set of projects with a capital contraint of 20, 25 or 30

- A and B are mutually exclusive while C and D are scalable (0, 1, 2, or 3)
- There are many possibilities to test by trial and error...

Example 3 using integer linear programming with Excel solver

Project	C0	C1	C2	10% NPV	IRR	PI
A	-10	30	5	21.4	216%	2.1
B	-5	5	20	16.1	156%	3.2
C	-5	5	15	11.9	130%	2.4
D	-10	20	20	24.7	173%	2.5

Project	Inv. 1	NPV	Accept=1	Tot. Inv. 1	Tot. NPV
A	-10	21.4	1	-10	21.4
B	-5	16.1	1	-5	16.1
C	-5	11.9	1	-5	11.9
D	-10	24.7	1	-10	24.7
Constraint	-20	A+B	2	-30	74.1



- 20: B, C and D; 25: B and D2; 30: B, C and D2