Capital Budgeting

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Motivation

- Capital Budgeting usually refers to the collection of rules and procedures that firms use to make decisions regarding long-term projects
- **Finance Textbooks** focus on identifying *efficient* investment projects (single-person decision problem)
- **Alternative Perspective:** Capital budgeting as an organizational coordination problem:
  - Information asymmetries
  - Shared Assets
  - Capacity Investments and Intracompany Transfers

Motivation

- **Agency Research in Accounting and Finance** has focused primarily on:
  - Strategic reporting by managers $\longrightarrow$ "sandbagging"
  - Optimal effort incentives
- **Surveys** on capital budgeting practices:
  - *Internal Rate of Return* criteria remain prevalent
  - *Capital rationing* by means of high *hurdle rates* $\longrightarrow$ Taggart (1987); Poterba & Summers (1995)

Motivation

- **Academic Researchers and Consultants** have suggested that firms can create internal capital markets (e.g., auction mechanisms) in order to solve their capital budgeting problems
  $\longrightarrow$ Stein (1997) and Hodak (1997)
- **Question:** What type of "market mechanisms" are likely to provide an efficient solution to a firm's capital budgeting problem?
  $\longrightarrow$ *Issue:* Internal markets are typically "thin"
  $\longrightarrow$ *Illustration:* Cypress Semiconductors

Motivation

Critical features of any formal capital budgeting process:

- **Reports** elicited from better informed divisional (project) managers
- **Decision rule** for mapping reports to project funding decisions
- **Performance Metrics** that hold managers "accountable" for their reports by comparing **projected** to **delivered** results

Goal Congruence

Basic Capital Budgeting Model: $\longrightarrow$ Solomons (1965), Rogerson (1997)...

- One potential project. Decision is delegated to better informed manager
- Investment of b at the initial date generates an asset with useful life of T years
- Operating cash flows: $\tilde{c}_t = x_t \cdot \theta + \tilde{\epsilon}_t$
  $\Rightarrow$ Expected $NPV(\theta) = \sum_{t=1}^{T} x_t \cdot \theta \cdot \gamma^t - b$ with $\gamma = \frac{1}{1+r}$
- The profitability parameter θ is private information of the manager but $X = (x_1, ..., x_T)$ is commonly known

Goal Congruence

- Accounting-based **Performance Measures**:

$$\pi_t = Inc_t - \hat{r} \cdot A_{t-1}$$

  - Operating Income: $Inc_t = c_t - d_t \cdot b$
  - Assets: $A_t = A_{t-1} - d_t \cdot b$
    - with: $A_0 = b$
    - and $\sum_t d_t = 1$
  - Capital Charge Rate: $\hat{r}$
- *Goal Congruence* requires that even an "impatient" manager will have an incentive to accept all positive NPV projects– and only those!

Goal Congruence

- Intertemporal Cost Allocations:
  - Calculate depreciation charges $\{d_t\}_{t=1}^{T}$ according to the *Relative Benefit Rule* which reflects $(x_1, ..., x_T)$
  - Set capital charge rate $\hat{r}$ equal to the firm's cost of capital r

Result: *The resulting performance measure π_t is goal congruent since* $\pi_t = \frac{x_t}{\sum_{i=1}^{T} x_i \cdot \gamma^i} \cdot NPV(\theta)$

- This solution is essentially unique among all accounting based performance measures

Extensions of the Basic Model

- Disciples of *agency theory* will point out that second-best mechanisms entail under-investment (capital rationing).

Result: *Residual Income based on the relative benefit depreciation rule is an optimal performance measure for some suitably chosen capital charge* $\Rightarrow \hat{r} > r$
$\rightarrow$ Dutta & Reichelstein (2002), Christensen et al. (2002)

- *Insight:* The provision of investment incentives can be separated from ongoing effort incentives by means of accrual accounting.

Extensions of the Basic Model

- *Multiple competing projects* subject to a budget constraint $\longrightarrow$ Bareket & Mohnen (2007)
- *Sequential investment decisions* with abandonment (growth) options $\longrightarrow$ Friedl (2005), Dutta & Reichelstein (2005) and Pfeiffer & Schneider (2006)
- *Empire benefits* may intrinsically bias managers' disposition towards projects
  $\longrightarrow$ Lambert (2001) and Baldenius (2003)
- Inter-Departmental allocation of fixed costs
  $\longrightarrow$ Wei (2004)

Shared Assets

Scenario: Possible acquisition of a joint asset which benefits n divisions $\to$ Baldenius, Dutta & Reichelstein (2007)

- If the asset is acquired, division i's expected present value of cash inflows is: $PV_i(\theta_i) = \sum_{t=1}^{T} \gamma^t \cdot x_{it} \cdot \theta_i$ while the aggregate expected NPV is:

$$NPV(\theta) = \sum_{i=1}^{n} PV_i(\theta_i) - b$$

- **Decision Rule:** Accept divisional reports at "face value": Invest if and only if the sum of the *reported* PV_i's exceeds the cost of investment b.

Shared Assets

- Accounting-based **Capital Budgeting Mechanisms** for shared assets:
  - Asset shares $\lambda_i(\theta)$ add up to one.
  - Capital charge rate $\hat{r}(\theta)$
  - Based on its share of the joint asset $\lambda_i \cdot b$, each division is charged depreciation $d_{it} \cdot \lambda_i \cdot b$ in period t
  - Division i's asset balance at the end of period t:

$$A_{it} = \left(1 - \sum_{\tau=1}^{t} d_{i\tau}\right) \cdot \lambda_i \cdot b$$

Shared Assets

- **Pay-the-Minimum-Necessary (PMN) Mechanism:**
  - **Critical value** $\theta_i^*(\theta_{-i})$ given by:

    $$PV_i(\theta_i^*(\theta_{-i})) + \sum_{j\neq i} PV_j(\theta_j) = b$$

  - $\hat{r} := r^*(\theta) \leftrightarrow$ Hurdle rate equal to IRR at critical values
  - $\lambda_i(\theta) = \dfrac{\theta_i^*(\theta_{-i})}{\sum_{j=1}^n \theta_j^*(\theta_{-j})}$

    $\rightarrow$ Asset shares are assigned in proportion to critical values
  - Relative benefit depreciation applied to asset value $\lambda_i \cdot b$.

Shared Assets

Result: *The PMN mechanism is the only goal congruent (in the dominant strategy sense) capital budgeting mechanism*

- Intuition for uniqueness:
  - (i) any dominant strategy mechanism must be a Groves scheme. (ii) No-play-no-pay requirement pins down “transfer" payments
  - With potentially impatient managers, proper intertemporal cost allocation becomes imperative $\Rightarrow$ Same as in one-division model except: $\hat{r} = r^*(\theta)$

Shared Assets

- The PMN mechanism is *nominally* balanced
  $\longrightarrow$ Sum of all depreciation charges across *periods* and *divisions* is equal to investment expenditure
- Yet, HQ subsidizes asset acquisition by undercharging divisions in *real terms* since $r^*(\theta) < r$
- Moral hazard and associated agency costs will tend to raise the higher hurdle rate, just as in the single division scenario

Exclusive Assets

Scenario: The firm must choose among n competing projects

- Results are "dual" to the shared asset scenario
- The *Competitive Hurdle Rate Mechanism* is the only satisfactory mechanism
  - Each division is asked to “bid" its project IRR.
  - Highest bidder faces a capital charge rate equal to the second-highest IRR
  - The competitive hurdle rate exceeds r.

Hurdle Rate Predictions

- **Shared Assets:**
  - Positive externality between divisions leads H.Q. to subsidize capital charges $\Rightarrow$ Hurdle rate $r^* < r$
  - Higher agency costs will raise hurdle rate r^*
  - Net-effect remains ambiguous: : $r^* <? > r$
- **Exclusive Assets:**
  - Negative externality between divisions raises competitive capital charge rate to $r^* > r$
  - But uniformly higher agency costs will not raise hurdle rate further: only relative costs matter!
  - Total effect is unambiguous: $r^* > r$

Capacity Investments

Scenario: Sequence of capital investments create production capacity. An asset acquired at date t entails capacity to produce k widgets in the first period. Available capacity declines over time. $\longrightarrow$ Rogerson (2007)

- Overlapping generations of assets create total production capacity, K_t, at date t.
- Net-revenue attainable at date t is some function $R_t(K_t)$.
- The optimal capacity sequence is known to be increasing: $K^*_{t+1} > K^*_t$

Capacity Investments

Result: *Goal congruence is attained if: (i) Capital charge rate is set equal to* r *and (ii) Investments are depreciated according to the relative available capacity rule*

- **Implication:** Depreciation charges not tied to the *relative* magnitude of expected future cash *benefits*, but to the decline in available capacity
- Sequence of overlapping investment decisions effectively creates intertemporal separation here
- Yet, allocating the **sunk** costs of past investments is essential for managers to internalize at each point in time the **marginal** cost of capacity

Capacity Management

- The above result has direct implications for the pricing of intracompany transfers
- Suppose a downstream division buys widgets (intermediate product) from the upstream division.
- If widgets are priced at **full cost** comprised of any **variable** production cost **plus** the **unit (marginal)** cost of capacity required to produce the widget, goal congruence is obtained:
  - The downstream division will demand the efficient quantity of widgets for intracompany transfer
  - The upstream division will invest efficiently

Capacity Management

- The preceding solution is almost "too good to be true." It only works in a **“clockwork”** environment
- When there are **stochastic shocks** to the system, the usual issues arise:
  - Asset ownership
  - Priority rules for capacity allocation
  - Internal pricing
- These allocation- and pricing rules ultimately shape the divisional investment incentives
- Beginning of a literature on incentives for investment and capacity trading

Risk Considerations

- Risk considerations raise additional coordination issues:
  - Greater risk exposure may necessitate a higher proportion of equity (rather than debt) capital
    $\Rightarrow$ Negative externality among divisions
    $\longrightarrow$ Zechner & Stoughton (2004)
  - Aggregate risk capital decreasing due to diversification effect
    $\Rightarrow$ Positive externality among divisions
    $\longrightarrow$ Homburg & Scherpereel (2004)

Concluding Remarks

- Some progress in recent years on the incentive role of intertemporal cost allocations
- Such allocations are essential to create accountability in connection with capital budgeting decisions
- Major challenges remain along several dimensions:
  - Analysis and comparison of specific candidate mechanisms $\rightarrow$ Discrete Mechanism Design
  - Identification of integrated mechanisms for (i) investing *in* and (ii) managing *of* production capacity