Evaluation of Flexible Capital Investments - With Consequences for Decisions and Suppliers

Persson, Ingvar; Nilsson, Carl-Henric; Nordahl, Håkan

Published in:
Production Research: Approaching the 21st Century

1991

Document Version:
Publisher’s PDF, also known as Version of record

Link to publication

Citation for published version (APA):

Creative Commons License:
Unspecified

General rights
Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

• Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
• You may not further distribute the material or use it for any profit-making activity or commercial gain
• You may freely distribute the URL identifying the publication in the public portal

Take down policy
If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.
Acknowledgement

Financial support to the first author from the Natural Sciences and Engineering Research Council of Canada for the completion of this research is gratefully acknowledged.

References

Flexibility of the machinery

Flexibility related to the design of the products and the flow of goods is well analyzed. Several authors (Gerwin, 1983; Browne et al., 1984) have discussed and made definitions of flexibility in the manufacturing process. These definitions have one major shortcoming; the analysis is only executed in two dimensions, the product dimension and the material flow dimension. This classification does not consider the possibilities of re-using the equipment in different manufacturing processes. A method which takes this prospect into account already at the acquisition stage implies that the flexibility is evaluated as well as analysed.

Flexibility concerning investment analysis of the manufacturing process is given three dimensions: (1) material flow, (2) products, and (3) machinery.

Capital-back (CB) is a method for evaluating the flexibility of the machinery. Flexibility of machinery means having the possibility of using the machinery for other purposes than originally intended, either inside the company or in some other manufacturing process outside the company.

CB implies that every investment proposal is split into two parts, one flexible and one inflexible. It is true that the different parts constitute one and the same investment, but from the point of uncertainty they are quite different. The inflexible part of the investment is denominated 'The Risky Investment'.

One part of the investment \( G_F \) is flexible enough to be used for some other purposes. This may happen if, for example, the market expectations are not fulfilled, or if the machinery becomes obsolete due to a radical change in the manufacturing process. Examples of this type of equipment are robots, CNC machines or parts of FMS. Due to the flexibility and hence lower degree of uncertainty a lower interest rate is acceptable for the capital invested in this type of equipment.

The rest of the investment constitutes those parts that are dedicated for a specific manufacturing process or product. These parts are inflexible and belong to the part of the investment called the risky investment \( G_R \). The parts belonging to the risky investment cannot be used to produce other products in other manufacturing processes. The residual value is zero irrespective of how long the set-up has been used. Examples of this type of components are fixtures and gripping appliances that are intended for a specific product. Included as part of the capital investment are also expenditures for projection and design as well as for the physical installation. These expenditures are usually not possible to re-utilize if the project fails and are hence a part of the risky investment.

The total investment \( G \) is the sum of the flexible part of the investment and the risky investment \( G_F + G_R \). This categorization of the parts constitutes the capital investment into one flexible part and one risky in itself an important distinction. One possibility is to stop here and specify a measurement of profitability together with the size of the flexible investment or the risky investment.

**Capital-back and Pay-back**

With the Capital-back method (Nilsson and Nordahl, 1988; Persson, 1988) we advance further and the profitability and the flexibility are weighted to form a single measurement.

The need of a new method depends on, for example, the high Pay-back demands in the manufacturing industry. The object of Capital-back (CB) is to release flexible investments of the unreasonably high demands of a short Pay-back (PB) period, requested due to a high degree of uncertainty and short-term planning. The PB demands are especially high for rationalization investments where, for example, robots are of current interest. According to Hayes and Gare (1982), 25% of the American companies had a demand for a PB period no longer than three years. Ten years earlier only 20% of the companies had this demand. PB demands in the Swedish industry range from 2.7-3.1 years (Yard, 1987). According to Yard its not quite clear if consideration has been given to the rate of interest or to the inflation. This means that these two methods can be executed in two dimensions, the product dimension and the material flow dimension. This classification does not consider the possibilities of re-using the equipment in different manufacturing processes. A method which takes this prospect into account already at the acquisition stage implies that the flexibility is evaluated as well as analysed.

Flexibility concerning investment analysis of the manufacturing process is given three dimensions: (1) material flow, (2) products, and (3) machinery.

Capital-back (CB) is a method for evaluating the flexibility of the machinery. Flexibility of machinery means having the possibility of using the machinery for other purposes than originally intended, either inside the company or in some other manufacturing process outside the company.

CB implies that every investment proposal is split into two parts, one flexible and one inflexible. It is true that the different parts constitute one and the same investment, but from the point of uncertainty they are quite different. The inflexible part of the investment is denominated 'The Risky Investment'.

One part of the investment \( G_F \) is flexible enough to be used for some other purposes. This may happen if, for example, the market expectations are not fulfilled, or if the machinery becomes obsolete due to a radical change in the manufacturing process. Examples of this type of equipment are robots, CNC machines or parts of FMS. Due to the flexibility and hence lower degree of uncertainty a lower interest rate is acceptable for the capital invested in this type of equipment.

The rest of the investment constitutes those parts that are dedicated for a specific manufacturing process or product. These parts are inflexible and belong to the part of the investment called the risky investment \( G_R \). The parts belonging to the risky investment cannot be used to produce other products in other manufacturing processes. The residual value is zero irrespective of how long the set-up has been used. Examples of this type of components are fixtures and gripping appliances that are intended for a specific product. Included as part of the capital investment are also expenditures for projection and design as well as for the physical installation. These expenditures are usually not possible to re-utilize if the project fails and are hence a part of the risky investment.

The total investment \( G \) is the sum of the flexible part of the investment and the risky investment \( G_F + G_R \). This categorization of the parts constitutes the capital investment into one flexible part and one risky in itself an important distinction. One possibility is to stop here and specify a measurement of profitability together with the size of the flexible investment or the risky investment.

**Figure 1. A comparison between Capital-back and Pay-back.**
difference is: $a - G_f \cdot \text{ann}(n \text{ years, } i\%$). This difference is then calculated as the annual net receipt of the risky investment and accumulated in the same way as in the PB method.

In analytical terms, CB is calculated by analogy with PB, i.e. the investment divided by the annual net receipt:

\[ CB = \frac{G_c}{a - G_f \cdot \text{ann}(n \text{ years, } i\%}) \]

From the formula it may be concluded that the gradient of the line decreases as the interest rate increases. The interest rate that will generate a CB period equal to the PB period is of special significance. This is illustrated with the dotted line in Figure 1. At this rate of interest the rate of return on the risky investment is as high as the rate of return on the flexible part of the investment. (This calculation presupposes that the lifespan of the risky investment is as long as the lifespan of the flexible part of the investment).

The CB method is an especially valuable aid if the CB period is shorter than the PB period. If this is not the case the profitability for the risky investment is lower than for the flexible one. The described calculation of the CB period is valid only if the annual net receipt is equal every year. If the annual net receipts vary, they have to be added together until the sum equals the amount invested in the risky part. Also this is analogical to the PB method.

The CB condition for the investment is then:

\[ G_c = \sum_{x=1}^{n}(a_x - G_f \cdot \text{ann}(n \text{ years, } i\%)) \]

where $a_x = \text{annual net receipt year } X (\£), n = \text{lifespan of the flexible part (years)}, i = \text{the discount rate of the company (})$, $\%$).

**Consequences for decisions and suppliers**

**Consequences for the decision-making**

Using the CB method will affect the investment process as well as the crucial decisions being made. CB presupposes that the components that constitute the capital investment are divided into one flexible part and one inflexible part. The process of dividing the components will force the decision makers to analyse as well as evaluate the flexibility of the different investment proposals. This process in itself is therefore important.

The rate of change in the manufacturing industry is constantly increasing. New models and new products are superseding each other at a rapid pace. This means that flexibility in the manufacturing process is, or ought to be, a strategic goal for companies in the manufacturing industry. CB is an excellent aid to incorporate the strategic importance of flexibility in the capital budgeting process. The CB method illuminates the importance of flexibility and promotes flexible investment-alternatives. Traditional capital budgeting techniques do not take flexibility into consideration but regard the flexible and the risky parts of the capital investment as equally uncertain.

Neither CB, nor any other capital budgeting technique gives any information about the degree of uncertainty that prevails if the inflexible, or risky, investment becomes obsolete. Neither will it tell anything about when the investment will be obsolete.

**Evaluation of flexible capital investments**

**Financing and consequences for suppliers**

Dividing the investment into one flexible part and one risky part will also have consequences for the financing of the capital investment. The risky investment will be regarded in the same way as the total investment is today. The company will buy the machinery and take all the risks. The flexible part on the other hand can be treated differently depending upon the nature of the company that is investing. One possibility is that the company in a traditional manner invests in the flexible part as well as in the risky part of the investment. In this case the CB method will be a relevant capital budgeting technique to use when evaluating the proposal. Since the method assumes alternative uses for the flexible part, it is more consequent to consider the flexible part as a potential resource for all the different workshops in the company. Larger companies could buy the flexible part of investments on a company-wide basis. Proceedings such as this, with central administration, are already a reality in some companies today.

In reality different machinery has different degrees of flexibility. When CB is used the possibility exists to differentiate the rent according to the degree of flexibility. Doing this guides the different subdivisions toward more flexible machinery. Using CB will give the management an opportunity to release the right 'signals' early in the capital budgeting process. The subdivisions will accordingly receive an incentive to invest in flexible machinery.

An interesting alternative way to finance the investment is that the supplier of the flexible parts directly grants a lease of these parts. The supplier has a better knowledge of the market and is best fitted to find new users for the flexible machinery. The advantages of this procedure are greatest for smaller companies, lacking the possibility to find new users for the flexible machinery within their own company. The supplier's leasing firm will in this case take over the function of the central administration found in the larger company.

When working under uncertainty, an external leasing procedure such as the one described is favourable, especially for smaller companies. If the leasing procedure is used then CB is reduced to a PB calculation. The investment is the risky part and the flexible part is taken on lease thus charging the annual receipt with the rent.

**Deeper analysis of the Capital-back method**

The CB period is influenced by four factors:

(1) the flexible share of the investment,

(2) the level of the discount rate,

(3) the profitability of the total investment (measured with for instance the Internal Rate of Return (IRR) or the PB period),

(4) the lifespan of the flexible part of the investment.

There is no room to carry out a total analysis here, but we will illustrate how the different parameters influence the outcome. The flexible part of the investment has been chosen as main parameter. The effect on the CB period is then analysed for different levels of discount rate and profitability, and lifespan.

**The discount rate level**

In order to select discount rates we will proceed from earlier research. Those studies carried out in Swedish companies show that the average discount rate is 20% with no consideration given to taxation. The variation however, is high. Yard (1987) found that the minimum discount rates varied between 10% and 30% and that the maximum rates amounted to 50%. Tell (1978) also found discount rates slightly
The CB period as a function of the flexible share of the investment. The discount rate is 0%, 10% and 20%. The PB period is four years and the lifespan of the flexible part is ten years.

Figure 2. The CB period as a function of the flexible share of the investment. The discount rate is 0%, 10% and 20%. The PB period is four years and the lifespan of the flexible part is ten years.

Profitability of the total investment

In Figure 2 the PB period is four years. If the PB period becomes any shorter, then the CB period becomes less dependent upon the level of the discount rate. This is due to a high IRR and the fact that the annuity method has been chosen to calculate the annual cost.

If the IRR is high, then the annual net receipt is high and, accordingly, the amount that goes to the risky investment. For instance, an investment with a PB period of two years has a very high profitability. If the lifespan of the total investment is ten years, the CB period is close to 50%. If the demand for profitability of the flexible part of the investment is 20% then the remaining part of the CB will be added on to the risky investment. This means that if the IRR is very high, then it does not matter much how high the discount rate is.

The result is also influenced by the annuity method. When using the annuity method in the calculations will be affected too. In order not to complicate the analysis we will assume that all the parts of the investment have the same lifespan.

The lifespan of the flexible part

The CB period is here close to the PB period, which is four years. The significance of this is that the IRR is very close to the discount rate, in this case slightly above 20%. The share of flexibility has to be 70% or more in order to show significantly different periods for PB and CB.

If the discount rate is 10%, the CB period decreases more smoothly and the difference between PB and CB is more significant, even if the share of flexibility is low. This is representative of the CB method. A low discount rate generates a low annual cost for the flexible part of the investment. Thus the share of annual net receipt that goes to the risky investment increases. The CB period is then improved, i.e. becomes shorter.
Table 1. PB, CB and profitability, a comparison.

<table>
<thead>
<tr>
<th>PB (years)</th>
<th>CB (years)</th>
<th>Flexible share</th>
<th>Lifespan</th>
<th>Internal rate of return (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>r = 20%</td>
<td>r = 10%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>4</td>
<td>2-61</td>
<td>0-7</td>
<td>10</td>
</tr>
<tr>
<td>B</td>
<td>3</td>
<td>2-67</td>
<td>0-3</td>
<td>10</td>
</tr>
</tbody>
</table>

IRR is higher. Consequently, the CB period is shorter. The lower limit reveals the CB period if the lifespan of the installation is ten years. The CB period is considerably shortened when the flexible share of the investment is increased.

Capital-back and priorities

An important factor is how the method orders the different investment proposals. We will look at the preferences when using CB compared to the preferences when using the IRR or PB. In Table 1 two different investment proposals, A and B, are compared. The profitability and the flexible share of the proposals are chosen in order to change the priorities when the discount rate is reduced from 20% to 10%. The flexible share of proposal A is high but it has a low IRR, 21%. This makes alternative A sensitive to the discount rate. Alternative B on the contrary has a low flexible share but a high IRR. This means that alternative B is not so sensitive to changes in the discount rate.

For the competing investment proposals in Table 1 the CB recommendations are:

- A company with a high requirement for profitability, i.e. willing to take risks, will prefer proposal B. B has a high profitability, IRR 30%, and a high risk, 70% inflexible share.
- A company with a low requirement for profitability, i.e. risk-averse, will prefer proposal A. A has a low profitability, IRR 21%, and a low risk, 70% flexible share.

References

Gerwin, D., 1983, A Framework for Analyzing the Flexibility of Manufacturing Process (School of Business Administration University of Wisconsin).