Cypher's Centrum

Analysis of Investments by means of time-related Bound Capital Method

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I. Time as coordinate of economic processes

Dynamic methods of investment analysis (compound value method, capital value method, annuity method, internal rate of return method, and others) (#1) (#2) incorporate the passage of time in their calculations by compounding and discounting. However, they normally limit themselves to constant time intervals - traditionally a year - so that the investment-mathematical formulas of compound interest calculation can be applied to the expenses and receipts of an investment. (#3) Clearly, this leads to several premises which limit the informative value of the calculated data. (#4)

Analysing economic processes becomes simpler if time is introduced into the calculation as what it naturally is: the time coordinate of all events, i.e., including economic processes. One has to imagine a system of coordinates, where the amounts of capital are entered on

the Y-axis, the course of time is shown on the X-axis and the Z-axis represents the spatial coordinates of the process. Surely, the spatial dimension is negligible in most cases, unless capital is invested in different locations. However, it is impossible to describe a process without including time.

If earning a profit is the purpose of economic activity, all processes can be expressed in a dynamic profit formula, as follows:

Profit = Capital * Time * Profit factor

We meet this correlation almost every day in the form of the well-known simple interest formula:

$$I = C * t * \frac{r}{100}$$

In this case, the result of capital and time (C * t) represents the capital volume in the passage of time. (C) represents the respectively bound capital (#5), (t) the time for which the capital is bound and (r/100) is finally the interest rate as those economic factor which yields the interest proceeds from the capital in the passage of time.

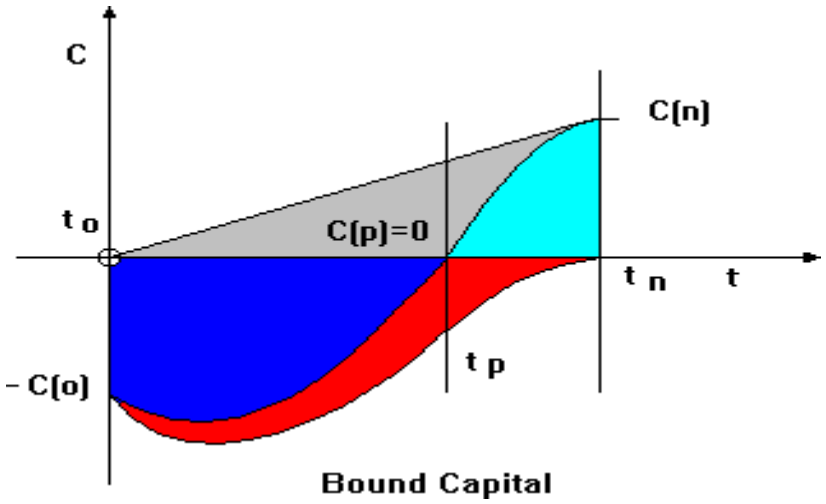
The following is intended to describe a method for establishing the profit factor of an investment (similar to the internal rate of return on an investment) by means of the simple interest formula and arbitrary time intervals (day, month, quarter, half-year and year). In this case, the analysis extends over the normal course of an investment, as shown in the following graphical illustration. The surplus of the investment is considered to accrue constantly and evenly during the total period of the investment. The effective profit factor will then be derived by iteration from the linear profit factor, calculated on the basis of this premise (approximate solution) (#6).

II. Investment as economic process

1. The abstract form of an investment

a) Course of investment in a graphical illustration

Enveloped into an abstract form, the normal development of an investment in a graphical manner is as follows:



Bound Capital

The value (C) stands for the dimension of the invested capital (in monetary units) and (t) for the dimension of the commitment period (in time units, such as days, months, years or other intervals). Here, in this theoretical analysis, the really discontinuous development of the values is smoothed to joining curves. This makes no fundamental difference to the basic correlations between bound funds, bound capital, periods and profit factor. (#8)

As a result of outgoing payments, an investment will initially follow a course in the negative range of values as from t(o) until, due to receipts, the point of time t(p) is reached, when receipts balance previous outgoings. This time period is also known as capital payback period, or cutoff period. (#8) At this point, the bound funds C(p) stand at zero. From now on (hopefully), the flow of funds from the investment will only involve positive amounts. The analysis ends at the point of time t(n). This may be a sale of the investment project, a termination of the investment activity or only the end of the analysis. In the latter case, an appraisal at market value takes the place of a sale and is shown as notional income.

As shown in the graph, the area below the time axis provides a capital value for the time from start of the investment t(o), up to the time t(p) for the funds bound during this period (M * t). The area above the time axis, between the payback date t(p) and the end of the analysis t(n), represents the release of funds from their commitment over time. These free funds will continue to increase by marginal incomes at the final point of time. However, as they only pertain to the last time unit they are not graphically expressed in the area. Finally, the value C(n) represents the surplus of the investment as an absolute amount at the point of time t(n).

b) Definition of terms

The terms used in the further analysis are defined as follows:

Payback date: The point of time t(p), at which the total receipts (incomings) equal the total of the previous expenses (outgoings). This point of time is at the end of the capital payback period (cutoff period). (#8)

Bound funds: Volume of invested (or released) funds during the respective commitment period (M * t) (in case of infinitesimal consideration: the integral of funds over time).

Bound capital: Bound funds during the period from start of the investment t(o) up to the payback date t(p) (bound capital period) as the result of capital and time (C * p). The bound capital period corresponds with the capital payback period. (#8)

Release of funds: Volume of released funds (F * t[n-p]) as from the payback date t(p) until the end of the investment t(n). Free funds are those amounts which still flows back after the complete return of bound capital.

Investment surplus: The surplus C(n) of incoming payments over outgoing payments at the end of the investment t(n). (#9) The surplus of the investment will be apportioned to bound capital and release of funds.

Bound profit: The result of profits accruing pro rate over time (E(i) * t). The profit per time unit E(i) is the proportional surplus of the investment which, in case of equal apportionment, will become applicable to the time unit t(i).

Profit volume: The total of bound profits (E * t) (in case of infinitesimal consideration: the integral of profits over time).

Capital volume: Total of bound funds and profit volume (M * t) + (E * t) (in case of infinitesimal consideration: the integral of invested capital over time).

c) Payback date as classification criterion

The bound capital method is fundamentally different from traditional investment analyses. In the latter, as is known, incomings flowing from the investment are separated into an interest element and a redemption element and only the redemption element reduces invested capital (#10). However, the bound capital method there is no allocation of individual incomings to interest and redemption. A profit is only assumed after the complete return flow of the invested funds. The surplus of the investment may then retrospectively relate to bound capital as profit (#11).

In this case, basically three scenarios must be distinguished:

1. The investment never reaches the payback date. Expenses are in excess of receipts. The investment finishes with shortfall. This case may only be of interest for an analysis of the causes which led to that shortfall. They will be excluded for the ongoing analysis.

2. The bound capital does not flow back in full amount prior to the last income (sale, dissolution or appraisal at the end of the investment period) so that the payback date coincides with the end of the investment. If receipts exceed expenses then the result is a surplus of the investment (profit). (#9)

3. The payback date is exceeded and further receiptss are accruing which, in addition to covering the invested capital, lead to a release of funds. The investment closes with a surplus (profit). (#9)

There is the following basic correlation between bound funds (M * t), bound capital (C * p) and release of funds (F * t[n-p]):

$$\mathbf{M * t = - (C * p) + (F * t [n-p])}$$

In this context it must be observed that in the illustrated system the value (C * p) is negative, in principle, as all outgoings are to be found in the negative area of the capital axis below the time axis. As the bound funds develop from negative to positive values during the passage of time, the following observations apply:

If the bound funds are negative, bound capital is higher than the release of funds. In this case, the release of funds may be between zero up to the amount of the bound capital.

If the bound funds are zero, bound capital and release of funds are then equal.

If the bound funds are positive, bound capital is then lower than the release of funds. Release of funds may range from the amount of bound capital to infinity.

If the release of funds is zero, the payback date and the end of the investment are identical.

If bound capital is zero or positive, then there is no investment.

d) Analysis of correlations with simple investment formula

The amount of invested capital and the profit achieved from it as its yield are the decisive criteria for assessing an investment. Let us remember the heated discussions when analyzing participations in property companies with special depreciations, whether tax savings constitute profits or reductions of invested capital.

If the surplus of an investment C(n) as profit and the capital volume (C * t) are known, the profit factor of the investment as interest rate (r/100) can be derived from the simple interest formula as follows:

Profit

$$\textbf{Profit factor} = \frac{\text{---------------------}}{\textbf{Capital volume}}$$

However, up to now only the bound funds (M * t) are known from the outset. They will not remain constant over time. Bound funds change with every inpayment and outpayment. Therefore, the total of bound funds can only be established from the total of the individual partial binding of funds.

e) Establishing bound funds

The value (M) corresponds with the respective amount of bound funds, resulting from the balance between inpayments and outpayments. The time value (t) decreases to the interval (a) between two payment transactions (inpayment/outpayment). If the period between two payment transactions is designated a(i), the total of bound funds for the typical course of an investment is as follows:

$$\mathbf{M * t = M(1) * a(1) + M(2) * a(2) + ... + M(i) * a(i) + ... + M(n) * a(n)}$$

or in a shorthand way to write:

$$\mathbf{M * t} = \sum_{\mathbf{i=1}}^{\mathbf{n}} \mathbf{M(i) * a(i)}$$

Since the timing of outgoings and incomings are known either from accounting or from planning departments, bound funds can easily be calculated as a total of the partially bound funds M(i) * a(i). As long as M(i) is negative due to outgoings, the bound funds have not yet flown back in full. If M(i) turns positive due to further receipts, released funds become available to the investor for other uses. He may invest them on the capital market, keep them as liquidity reserve or may move them to other areas (e.g. consumption). Graphically, bound funds are the area below the time axis between the points of time t(o) and t(p) and free funds are that area above the time axis between t(p) and t(n).

Mathematically, bound funds are a function of time: M = f(t). For example, in the case of mortgages, the bound funds are a straight line which is determined by the function

$$\mathbf{M = - C(o) + A * t(i).}$$

In this case, -C(o) is the nominal value of the mortgage and A the annuity per period (t). The payback date with M(p) = 0 is at

$$\mathbf{t(p)} = \frac{\mathbf{C(o)}}{\mathbf{A}}$$

Investment-mathematically, this is the decursive present value factor a(p) #12

In very long or very profitable investments, released funds will reach the amount of bound capital, and binding of funds will assume the

amount of zero or will become positive. Therefore, bound funds alone are no adequate criterion for assessing an investment. Additionally, a statement of the profit factor of an investment must also take into account the time value of profit (profit * time).

f) Allocation profits and profit volume over time

Fundamentally, there are two possibilities for distributing the surplus of an investment over the period of the investment:

1. Spreading the surplus evenly over the entire period of the investment or

2. Allocating the surplus to at least two sectors, i.e., to bound capital period and to release of funds period.

Basically, in both cases distribution may be made according to linear, progressive, degressive, or other courses. Since the surplus is to be attributed in relation of time, the distribution must reflect the accrual of individual profits, i.e. correlate to the course of the bound funds. Assuming that binding of funds will progress linearly and that the surplus of an investment is accruing evenly during the complete period the following correlations will appear:

If the proportionate surplus per period is generally denoted as E(i) and the period as t(i), the profit volume (E * t) will be calculated as the sum of time-related commitments of profits for the period between t(2) and t(n) as follows:

$$\mathbf{E * t = E(2) * t(2) + E(3) * t(3) + .. + E(i) * t(i) + .. + E(n) * t(n)}$$

or in a shorthand way to write:

$$\mathbf{E * t = \sum_{i=2}^{n} E(i) * t(i)}$$

The apportionment must be made to the time between t(2) and t(n) as, in decursive reflection, no proportionate profits can yet be accrued during the time unit t(1).

As a result of the even distribution of the surplus C(n), to be apportionable to the bound capital, the following applies:

$$\mathbf{E(2) = 1 * E(i),\ E(3) = 2 * E(i),\ E(i) = (i\text{-}1) * E(i),\ E(n) = (n\text{-}1) * E(i)}$$
$$\mathbf{t(2) = t(i),\quad t(3) = t(i),\quad t(i) = t(i),\qquad t(n) = t(i)}$$

The result for the profit volume is:

$$\mathbf{E * t = t(i) * E(i) + 2 * t(i) * E(i) + .. + (i\text{-}1) * t(i) * E(i) + .. + .. + (n\text{-}1) * t(i) * E(i)}$$

and by applying the arithmetic summation formula:

$$\mathbf{E * t = \frac{(n\text{-}1) * t(i) * n * t(i)}{2} * E(i)}$$

If the surplus of the investment per time unit is quoted for E(i) as:

$$E(i) = \frac{C(n)}{n * t(i)}$$

the result for the profit volume will be:

$$E * t = \frac{(n-1) * t(i) * n * t(i)}{2} * \frac{C(n)}{n * t(i)}$$

and after restating:

$$E * t = \frac{n * t(i) - t(i)}{2} * C(n)$$

For investments, where the payback date coincides with the end of the investment (or the period of analysis), only an undivided attribution of the surplus can be effected as there will be no release of funds. All other require analysis as to external factors influencing the investment of free funds for the period of fund release.

The actual flow of free funds (F * t[n-p]) is relevant for the time following a payback date. If free funds are reinvested then they establish an additional investment (supplementary investment). The invested released funds increase the bound funds and balanced the free funds to zero. The supplementary bound funds do not flow back in the full amount until t(n). As only released funds were reinvested the bound capital of the original investment is not changed. Only the profits of the supplementary investment influence the final surplus of the investment and, thus the profit factor of the investment. A comparable influence on the surplus and by that on the profit factor occurs if the invested capital is refinanced. For the development of funds one has to include the inflows from obtained credits and the outflows for interest to be paid.

These facts are obviously influencing the profit factor of an investment. However, they will be excluded for the ongoing analysis. Their effect on the normal course of an investment will be investigated in a further analysis. The bound capital method seems to have the same problems as the internal rate of return method: raised external funds and reinvested released funds are both based on the internal rate of return (#13). In practical operations this problems can be avoided by appropriate use of the bound capital method (see part III. at the end of this article).

When determining bound funds, the released funds will be calculated as a result of receipts and their timing (F * t[n-p]). Receipts which, in respect of time, lead to a surplus of the investment after the payback date, are already included in the release of funds. Therefore, they cannot also be part of the profit volume, proportionally apportionable to the bound capital. In this respect, only the profit volume, reduced by the released funds, is apportionable to the bound capital (E * t) - (F * t[n-p]).

This conclusion is also shown in the graphical illustration. If

total profit volume (area between the points t(o)/ t(n)/ C(n)) is added to bound capital (area t(o)/-C(o)/t(p)), a negative sum in the amount of C(n) would result at point t(n). However, if free funds are subtracted from the profit volume, the area t(o)/-C(o)/t(n) will result as capital volume below the time axis.

g) Capital volume and derivation of linear profit factor as an approximate solution

For the purpose of further analysis, bound funds (M * t), bound capital (C * p) and profit volume (E * t) - (F * t[n-p]), corresponding to the bound capital, are known up to now. As in the case of a loan where, to calculate the interest rate, interest payments cannot be substracted from the capital amount (like here the bound capital), but relate to the capital invested initially, a way must be found to determine those capital, invested during the bound capital period prior to the outflow of receipts. Because of the irregular timing profits and the fact that individual incoming payments cannot be split up into a profit part and a redemption part, only a global solution is possible. This can be achieved by adding the proportionable profit volume (apportionable to the bound capital) to the bound capital. The total will then show the initial capital (C * p) + (E * t) which has not been reduced by the outflowing profits yet.

Graphically, the area t(o)/t(p)/C(n) above the time axis and the area t(o)/-C(o)/t(p) below the time axis are both added up. The total of both areas between the points of time t(o) and t(n) will then show the invested capital in its initial volume (capital volume).

The capital volume is thus calculated from the bound capital (C * p), plus profit volume (E * t) and minus released funds volume (F * t[n-p]):

$$\textbf{Capital volume} = (C * p) + (E * t) - (F * t\,[n\text{-}p])$$

However, since the difference between bound capital and release of funds corresponds with the absolute value of the bound funds

$$(C * p) - (F * t\,[n\text{-}p]) = M * t$$

the absolute capital volume results from the sum of bound funds and profit volume:

$$\textbf{Capital volume} = (M * t) + (E * t)$$

Applying the simple interest formula, modified for the rate of interest, the linear profit factor of an investment will result under the quoted conditions as follows:

$$\frac{r}{100} = \frac{C(n)}{(M * t) + (E * t)}$$

h) Iteration to establish the effective profit factor

Calculation of the linear profit factor is based on an even distribution of an investment surplus over a given period. But this course will only

occur if a constant amount of capital is yielding a return in equal intervals and if the capital is flowing back in one amount at the end of the investment. However, in practice the majority of investments is running at a completely irregular course, so that the linear profit factor of an investment only offers an approximate solution. The actual profit factor of an investment may be higher than the linear profit factor, may correspond whith it or may be lower. The actual course of the bound funds will be the determining factor. However, since not all conceivable courses can be framed into general mathematical formulas, iteration of its influencing values remains the only tool for an exact determination of the effective profit factor of an investment.

Based on the linear profit factor as approximate solution, the determining factors for the profit volume will be adjusted by EDP until the final condition is reached (sum of the profits, calculated with the internal profit factor Var(r), equals the surplus of the investment C(n)).

$$C(n) = \sum_{i=1}^{n} [\,(M(i) * t(i)) + (E(i-1) * t(i))\,] * \frac{Var(r)}{100}$$

Hereafter, the profit factors of two different investments will be calculated as examples of the above correlations.

2. Two case studies

a) Management of a portfolio of shares

The development of an investment portfolio, with all inpayments and outpayments, including drawdown of a loan, during the period January 1, 1995 to December 31, 1995, is shown in Table 1 (#14). Although the invested capital has not yet flown back in the full amount by the end of the period it is possible, to quote the market value of the shares, minus loan, as notional income on the target date.

Table 1

Investment Analysis / Bound Capital Method

Date	Days	Event	Payment	Amount	Bound Funds
01/01/95	0	shares (as stated)	(-)	375,281.00-	0
01/07/95	6	deposit fee	(-)	750.00-	2'251'686-
04/13/95	96	net dividend	(+)	9,000.00	36'098'976-
05/27/95	44	trade journal	(-)	180.00-	16'149'364-
06/30/95	33	purchase shares	(-)	100,000.00-	12'117'963-
07/03/95	3	loan for purchase	(+)	100,000.00	1'401'633-
07/10/95	7	commissions	(-)	1,375.00-	2'570'477-
09/30/95	80	debt service	(-)	6,264.00-	29'486'880-
10/27/95	27	net dividend	(+)	12,000.00	10'120'950-
11/15/95	18	selling shares	(+)	126,500.00	6'531'300-
11/17/95	2	commissions	(-)	1,740.00-	472'700-
12/06/95	19	withholding tax credit	(+)	7,000.00	4'523'710-
12/06/95	0	tax imputation	(+)	15,750.00	0
12/30/95	24	debt service	(-)	6,264.00-	5'168'160-
12/31/95	1	stock value (as stated)	(+)	348,781.00	221'604-
12/31/95	0	value of loan	(-)	91,881.00-	0

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Surplus realized by the investment                (+)      35,296.00
                                                  ------------------
Total Outgoings:                                  (-)     583,735.00-
Total Incomings:                                  (+)     619,031.00
                                                  ==================

Bound Funds: (01/01/1995 to 12/31/1995 = 360 days):                    127'115'403-
Bound Capital: (01/01/1995 to 12/31/1995 = 360 days):                  127'115'403-
Released Funds: (12/31/1995 to 12/31/1995 = 0 days):                             0
                                                                      -----------------
Profit volume (35,296.00 * (360-1)/2):                                   6'335'632
Capital volume (6'335'632 + 127'115'403):                              133'451'035
                                                                      -----------------
average Funds employed during investment:                                353,098.34-
average Capital linear employed during investment:                       370,697.32-
average Capital effective employed during investment:                    385,748.63-
                                                                      -----------------
The profit factor (interest) is calculated per day.
Approximate linear profit factor from investment:                          9.522% p.A
Effective rate of investment (profits and capital gain):                   9.15% p.A
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The period of the investment covers 360 days which, in this case corresponds with the bound capital period. The payback date coincides with the end of the period of analysis as a coverage of the invested capital and thus a surplus of the investment is only achieved by the market value of the shares, minus the amount of the outstanding loan.

The total surplus accrues during the period that capital is bound, and an attribution to free funds after the payback date is not necessary. The surplus of the investment as profit C(n) is $ 35,296.00. The linear profit factor is calculated for the time unit "days" so that the profit volume is calculated as follows:

$$\textbf{Profit volume} = \frac{(360 - 1) * 360}{2} * \frac{35{,}296}{360} = \textbf{6'335'632}$$

The PC program shows the bound funds and the bound capital as 127'115'403. As no free funds are accruing the profit volume is not to be reduced and the capital volume will then be:

Bound funds	**127'115'403**
+ Profit volume	**6'335'632**
Capital volume	**133'451'035**

The linear profit factor is now calculated with the interest formula (#16) as follows:

$$\textbf{Profit factor} = \frac{35{,}296 * 360}{133'451'035} = \textbf{0.09522}$$

For the average capital investment of 370,697.32 (quotient of capital volume and period), the result is confirmed as follows (#17):

$$\textbf{Surplus} = \frac{370{,}697.32 * 360 * 0.09522}{360} = \textbf{35,297.80}$$

The assumption that the profit accrues evenly during the period will be set aside for the determination of the effective profit factor. The profit factor will be varied by iteration until the sum of the actual profits will correspond with the surplus of the investment.

Running the PC program this is the case with the profit factor 0.0915. The share deposit thus yields an effective interest in 1995 of

9.15% p.a.

b) Participation in a property company

The development of the participation is shown in Table 2 (#14). The payments for acquiring the participation in two instalments of $ 100,000 each and a repayment of tax credit of $ 15,000 are faced with a tax reduction of $ 50,000 and, up to Sep. 30, 2000 profits of $ 225,000 at different points of time. The participation in the company is then increased by an additional instalment of $ 150,000 which leads to a further tax relief of $ 37,500.

On May 23, 2002 the investment company requests a payment for roof repairs in the amount of $ 20,000. The further profits up to 2004 amount to a total of $ 170,000. At the end of the period of analysis, on Dec. 31, 2004 the market value of the participation is appraised as $ 327,000.

Table 2

Investment Analysis / Bound Capital Method

Date	Days	Event	Payment	Amount	Bound Funds
04/13/95	0	1st instalment	(-)	100,000.00-	0
12/06/95	233	2nd instalment	(-)	100,000.00-	23'300'000-
06/30/96	204	tax reduction 1995	(+)	50,000.00	40'800'000-
01/15/97	195	earnings 1996	(+)	30,000.00	29'250'000-
02/27/98	402	earnings 1997	(+)	45,000.00	48'240'000-
11/17/98	260	payment of tax arrears	(-)	15,000.00-	19'500'000-
02/07/99	80	earnings 1998	(+)	65,000.00	7'200'000-
06/30/99	143	special dividend	(+)	75,000.00	3'575'000-
01/14/00	194	earnings 1999	(+)	10,000.00	9'700'000+
09/30/00	256	additional instalment	(-)	150,000.00-	15'360'000+
01/07/01	97	earnings 2000	(+)	43,000.00	8'730'000-
06/30/01	173	tax reduction 2000	(+)	37,500.00	8'131'000-
02/13/02	223	earnings 2001	(+)	57,000.00	2'118'500-
05/23/02	100	payment for roof repair	(-)	20,000.00-	4'750'000+
03/15/03	292	earnings 2002	(+)	23,000.00	8'030'000+
02/10/04	325	earnings 2003	(+)	47,000.00	16'412'500+
12/31/04	321	estimated value	(+)	327,000.00	31'297'500+
Surplus realized by the investment			(+)	424,500.00	
Total Outgoings:			(-)	385,000.00-	
Total Incomings:			(+)	809,500.00	
Bound Funds: (Duration = 3498 days):					105'294'500-
Bound Capital: (Duration = 2010 days):					190'844'500-
Released Funds: (Duration = 1488 days):					85'550'000+

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Profit volume (424,500.00 * (3498-1)/2):                    742'238'250
Capital volume (742'238'250 + 105'294'500):                 847'532'750
                                                           ----------------
average Funds employed during investment:                     30,101.34-
average Capital linear employed during investment:           242,290.67-
average Capital effective employed during investment:        203,076.38-
                                                           ----------------
The profit factor (interest) is calculated per year.
Approximate linear profit factor from investment:              18.031% p.A
Effective rate of investment (profits and capital gain):       21.513% p.A
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By processing these data in the PC program of the author, the following determining factors result:

The period of the investment is 3498 days, of which 2010 days apply to the bound capital period and 1488 days to the release of funds. Point of coverages (payback dates) are June 30, 1999, September 30, 2000 and on February 13, 2002. The PC program computes the bound funds (M * t) as total of the individual bindings of funds as 105'294'500. The bound capital (C * p) is 190'844'500 so that 85'550'000 are apportionable to free funds.

The profit volume of the total investment is as follows:

$$\mathbf{E * t = \frac{(3498 - 1)}{2} * 424{,}500 = 742'238'250}$$

The capital volume (M * t) + (E * t) will then be:

Bound funds	**105'294'500**
+ Profit volume	**742'238'250**

Capital volume	**847'532'750**

and, derived from this, the linear profit factor of the investment:

$$\mathbf{Profit\ factor = \frac{424{,}500 * 360}{847'532'750} = 0.18031}$$

On the basis of the linear profit factor as approximate solution, the PC program calculates the effective profit factor, relevant for the course of the bound funds, as 0.21513. The participation in the property company thus yields an effective interest of

21.513 % p.a.

The effective profit factor of 0.21513 is confirmed by the following interest statement in Table 3. In this case, the effective profit factor will yield interest on the respective amount of the investment, and interest is added to the amount of the funds. This way, the result will be the initial capital volume as it is bound up prior to the outflow of interest. Disregarding the rounding difference of $ 11.77, the interest table shows a sum of interest of $ 424,500 equal to the investment surplus of the same amount. The remaining capital is reduced to zero. Therefore, the effective profit factor will yield interest on the capital, bound in the investment, which will be fully redeemed in the course of the period.

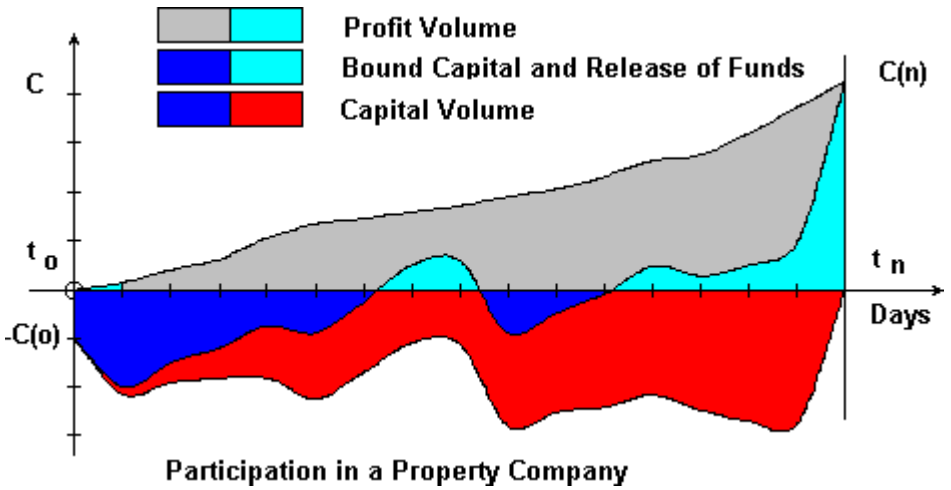
Table 3

Interest Table from 04/13/1995 to 12/31/2004

Date/Days	Amount	Rate	Interest	Total Interest
04/13/1995	100,000.00-	21.513%		
233 days	100,000.00-	21.513%	13,923.69-	13,923.69-
12/06/1995	100,000.00-			
0 days	200,000.00-	21.513%	0.00	13,923.69-
12/06/1995	13,923.69-			
204 days	213,923.69-	21.513%	26,078.80-	40,002.49-
06/30/1996	50,000.00			
0 days	163,923.69-	21.513%	0.00	40,002.49-
06/30/1996	26,078.80-			
195 days	190,002.49-	21.513%	22,140.75-	62,143.24-
01/15/1997	30,000.00			
0 days	160,002.49-	21.513%	0.00	62,143.24-
01/15/1997	22,140.75-			
402 days	182,143.24-	21.513%	43,756.00-	105,899.24-
02/27/1998	45,000.00			
0 days	137,143.24-	21.513%	0.00	105,899.24-
02/27/1998	43,756.00-			
260 days	180,899.24-	21.513%	28,106.62-	134,005.86-
11/17/1998	15,000.00-			
0 days	195,899.24-	21.513%	0.00	134,005.86-
11/17/1998	28,106.62-			
80 days	224,005.86-	21.513%	10,708.97-	144,714.83-
02/07/1999	65,000.00			
0 days	159,005.86-	21.513%	0.00	144,714.83-
02/07/1999	10,708.97-			
143 days	169,714.83-	21.513%	14,502.88-	159,217.71-
06/30/1999	75,000.00			
0 days	94,714.83-	21.513%	0.00	159,217.71-
06/30/1999	14,502.88-			
194 days	109,217.71-	21.513%	12,661.74-	171,879.45-
01/14/2000	10,000.00			
0 days	99,217.71-	21.513%	0.00	171,879.45-
01/14/2000	12,661.74-			
256 days	111,879.45-	21.513%	17,115.47-	188,994.92-
09/30/2000	150,000.00-			
0 days	261,879.45-	21.513%	0.00	188,994.92-
09/30/2000	17,115.47-			
97 days	278,994.92-	21.513%	16,172.10-	205,167.02-
01/07/2001	43,000.00			

0 days	235,994.92-	21.513%	0.00	205,167.02-
01/07/2001	16,172.10-			
173 days	252,167.02-	21.513%	26,069.51-	231,236.53-
06/30/2001	37,500.00			
0 days	214,667.02-	21.513%	0.00	231,236.53-
06/30/2001	26,069.51-			
223 days	240,736.53-	21.513%	32,080.81-	263,317.34-
02/13/2002	57,000.00			
0 days	183,736.53-	21.513%	0.00	263,317.34-
02/13/2002	32,080.81-			
100 days	215,817.34-	21.513%	12,896.88-	276,214.22-
05/23/2002	20,000.00-			
0 days	235,817.34-	21.513%	0.00	276,214.22-
05/23/2002	12,896.88-			
292 days	248,714.22-	21.513%	43,399.22-	319,613.44-
03/15/2003	23,000.00			
0 days	225,714.22-	21.513%	0.00	319,613.44-
03/15/2003	43,399.22-			
325 days	269,113.44-	21.513%	52,265.75-	371,879.19-
02/10/2004	47,000.00			
0 days	222,113.44-	21.513%	0.00	371,879.19-
02/10/2004	52,265.75-			
321 days	274,379.19-	21.513%	52,632.58-	424,511.77-
12/31/2004	327,000.00			
0 days	52,620.81	21.513%	0.00	424,511.77-
12/31/2004	52,632.58-	+ rounding difference		11.77
	11,77-			424,500.00

The development of the foregoing example in a graphical manner (#18) is as follows:



Participation in a Property Company

Once more, the graphical illustration shows the basic correlation of the determinant dimensions:

Bound Funds = Bound Capital + Release of Funds

Capital Volume = Bound Capital + Profit Volume - Release of Funds

$$\text{Profit Factor} = \frac{\text{Surplus C(n)}}{\text{Capital Volume}}$$

When calculating one has to care of the negative or positive sign depending on the fact the value of capital is below or above the time axis.

3. Comparison with the Internal Rate of Return Method (IRR)

a) Comparison of examples

Of the traditional methods of investment analyses, the internal rate of return method is directly comparable with the bound capital method. Both calculations aim at the establishment of an internal interest yield of the investment. Using modern PC programs, it is possible to calculate the interest rate according to the internal rate of return method even for completely irregular developments.

In the following, the above results of the bound capital method will be compared with the calculations according to the internal rate of return method (Tables 4 and 5). (#19)

Table 4

Investment Analysis / Internal Rate of Return

Date	Event	Payment	Amount	Present Value
01/01/95	shares (as stated)	(-)	375,281.00	375,281.00-
01/07/95	deposit fee	(-)	750.00	748.83-
04/13/95	net dividend	(+)	9,000.00	8,763.50
05/27/95	trade journal	(-)	180.00	173.27-
06/30/95	purchase shares	(-)	100,000.00	95,409.52-
07/03/95	loan for purchase	(+)	100,000.00	95,334.82
07/10/95	commissions	(-)	1,375.00	1,308.46-
09/30/95	debt service	(-)	6,264.00	5,834.62-
10/27/95	net dividend	(+)	12,000.00	11,098.92
11/15/95	selling shares	(+)	126,500.00	116,422.21
11/17/95	commissions	(-)	1,740.00	1,600.54-
12/06/95	withholding tax credit	(+)	7,000.00	6,407.11
12/06/95	tax imputation	(+)	15,750.00	14,416.00
12/30/95	debt service	(-)	6,264.00	5,697.64-
12/31/95	stock value (as stated)	(+)	348,781.00	317,163.12
12/31/95	value of loan	(-)	91,881.00	83,551.76-
Surplus realized by the investment		(+)	35,296.00	

The Rate of Return is calculated daily.	
Present Value of Outgoings:	569,605.63-
Present Value of Incomings:	569,605.70
Present Value of the Investment at 01/01/1995:	0.07
Internal Rate of Return of the Investment (IRR):	9.4% p.A.

The internal rate of return method calculates a yield of 9.4% p.a. for

the management of a share portfolio in 1995 on the basis of a daily interest accrual.

Table 5

Investment Analysis / Internal Rate of Return

Date	Event	Payment	Amount	Present Value
04/13/95	1st instalment	(-)	100,000.00	100,000.00-
12/06/95	2nd instalment	(-)	100,000.00	87,795.67-
06/30/96	tax reduction 1995	(+)	50,000.00	39,180.64
01/15/97	earnings 1996	(+)	30,000.00	21,086.17
02/27/98	earnings 1997	(+)	45,000.00	25,279.99
11/17/98	payment of tax arreas	(-)	15,000.00	7,293.36-
02/07/99	earnings 1998	(+)	65,000.00	30,212.85
06/30/99	special dividend	(+)	75,000.00	32,227.94
01/14/00	earnings 1999	(+)	10,000.00	3,854.31
09/30/00	additional instalment	(-)	150,000.00	50,121.60-
01/07/01	earnings 2000	(+)	43,000.00	13,615.33
06/30/01	tax reduction 2000	(+)	37,500.00	10,791.71
02/13/02	earnings 2001	(+)	57,000.00	14,472.83
05/23/02	payment for roof repair	(-)	20,000.00	4,809.46-
03/15/03	earnings 2002	(+)	23,000.00	4,701.05
02/10/04	earnings 2003	(+)	47,000.00	8,005.34
12/31/04	estimated value	(+)	327,000.00	46,592.24
Surplus realized by the investment		(+)	424,500.00	

The Rate of Return is calculated annually.

Present Value of Outgoings:	250,020.08-
Present Value of Incomings:	250,020.38
Present Value of the Investment at 04/13/1995:	0.30
Internal Rate of Return of the Investment (IRR):	21.861% p.A.

For the participation in a property company, the internal rate of return method results in a yield of 21.861% p.a..

From further comparative calculations with both methods for the above examples, the following profit factors are calculated for the different time units and interest apportionments:

1) Management of a portfolio of shares

Period	Bound Capital	Internal Rate of Return	Difference
Day	9.150 %	9.400 %	0.250 %
Month	9.185 %	9.436 %	0.251 %
Quarter	9.255 %	9.510 %	0.255 %
Half-year	9.362 %	9.623 %	0.261 %
Year	9.581 %	9.873 %	0.292 %

2) Participation in a property company

Period	Bound Capital	Internal Rate of Return	Difference

Day	19.490 %	19.776 %	0.286 %
Month	19.644 %	19.935 %	0.291 %
Quarter	19.967 %	20.268 %	0.301 %
Half-year	20.466 %	20.781 %	0.315 %
Year	21.513 %	21.861 %	0.348 %

b) Different profit developments as cause

The differences in the results are due to the fact that the internal rate of return method is discounting all amounts (inpayments and outpayments) to the beginning of the investment, irrespective of whether they accrue prior to the payback date or thereafter. (#20) By thus, profits are degressively distributed over the complete period of the investment in accordance with the investment-mathematical course of discounting. For funds released in the meantime, an investment at the internal interest rate is thus inevitably presumed (#21).

On the other hand, the bound capital method distributes the actual surplus of the investment evenly over the period and determines a linear profit factor as approximation solution. Since release of funds is subtracted from the profit volume, only that portion of the profits will form the basis for calculating the linear profit factor which is actually apportionable to the bound capital. Based on the linear profit factor as approximate solution it is then possible to determine the effective profit factor by iteration (variation of the determining values).

III. Practical applications of Bound Capital Method

The bound capital method can be applied to all economic processes where the time value of receipts and expenses, profits and expenditures or services and costs are to be analyzed as to their consequences. At the start and the end-dates of the period it is only necessary to insert the original values corresponding with the appropriate data (capital, balance values or capacities).

It is not necessary, as for instance in the case of the traditional internal rate of return method, that receipts and expenses accrue at periodic intervals or to transform them into constant cash flows. The times when these amounts accrue, need not be at regular intervals at all. The time differences between the individual payments (commitment period) is the sole decisive factor.

The disadvantage of the internal rate of return method which calculates interest on raised external funds, as well as on reinvested free funds with the same rate can easily be avoided by the bound capital method. Only additional receipts (inflows from raised external funds and yields from supplementary investments) and additional expenses (interest to be paid on external funds, as well as investment of free funds) have to be entered into the course of bound funds in the chronologically correct order.

This is shown by the following example: A loan of $ 100,000.00 is granted at an interest rate of 15% p.a. and amortized in 10 annually payments of $ 19,925.20. The loan is refinanced by credit in the same amount (interest rate 10%, redemption by the annually repayment of the loan). The credit is paid off after 5 years. The thereafter incoming annually payments on the loan are then invested at an interest rate of

7% p.a.. The bound capital method calculates the effective profit factor as follows:

Investment Analysis / Bound Capital Method

Date	Days	Event	Payment	Amount	Bound Funds
01/31/90	0	grant of loan	(-)	100,000.00-	0
01/31/90	0	credit uptake	(+)	100,000.00	0
01/31/91	0	interest loan	(-)	10,000.00-	0
01/31/91	0	pay off loan	(+)	19,925.20	0
01/31/91	0	repayment credit	(-)	19,925.20-	0
01/31/92	360	interest credit	(-)	8,007.48-	3'600'000-
01/31/92	0	pay off loan	(+)	19,925.20	0
01/31/92	0	repayment credit	(-)	19,925.20-	0
01/31/93	360	interest credit	(-)	6,014.96-	6'482'693-
01/31/93	0	pay off loan	(+)	19,925.20	0
01/31/93	0	repayment credit	(-)	19,925.20-	0
01/31/94	360	interest credit	(-)	4,022.44-	8'648'078-
01/31/94	0	pay off loan	(+)	19,925.20	0
01/31/94	0	repayment credit	(-)	19,925.20-	0
01/31/95	360	interest credit	(-)	2,029.44-	10'096'157-
01/31/95	0	pay off loan	(+)	19,925.20	0
01/31/95	0	repayment credit	(-)	19,925.20-	0
01/31/96	360	interest credit	(-)	37.40-	10'826'755-
01/31/96	0	repay credit (remainder)	(-)	374.00-	0
01/31/96	0	pay off loan	(+)	19,925.20	0
01/31/96	0	free funds invested	(-)	19,551.20-	0
01/31/97	360	pay off loan	(+)	19,925.20	10'840'219-
01/31/97	0	interest on free funds	(+)	1,368.58	0
01/31/97	0	free funds invested	(-)	21,293.78-	0
01/31/98	360	pay off loan	(+)	19,925.20	10'840'219-
01/31/98	0	interest on free funds	(+)	2,859.15	0
01/31/98	0	free funds invested	(-)	22,784.35-	0
01/31/99	360	pay off loan	(+)	19,925.20	10'840'219-
01/31/99	0	interest on free funds	(+)	4,454.05	0
01/31/99	0	free funds invested	(-)	24,379.25-	0
01/31/00	360	pay off loan	(+)	19,925.20	10'840'219-
01/31/00	0	interest on free funds	(+)	6,160.60	0
01/31/00	0	repayment invested funds	(+)	88,008.58	0
Surplus realized by the investment			(+)	83,982.66	
Total Outgoings:			(-)	318,120.30-	
Total Incomings:			(+)	402,102.96	

Bound Funds: (Duration = 3240 days):	83'014'560-
Bound Capital: (Duration = 3240 days):	83'014'560-
Released Funds: (Duration = 0 days):	0
Profit volume (83,982.66 * (3240-1)/2):	136'009'918
Capital volume (136'009'918 + 83'014'560):	219'024'478
average Funds employed during investment:	25,621.78-
average Capital linear employed during investment:	67,600.15-
average Capital effective employed during investment:	50,012.90-
The profit factor (interest) is calculated per years	
Approximate linear profit factor from investment:	13.804% p.A.
Effective rate from investment (profits and capital gain):	18.658% p.A.

Equity capital is invested only to pay interest on the obtained credit in an amount of $ 30,112.20. This leads to a surplus of $ 83,982.18

after 10 years and to an effective profit factor of 18.658% p.A.

Practical applications for the bound capital method are the analysis of participations, property investments, share portfolios and all types of operating investments. The calculations can be carried out with appropriate PC programs without any particular difficulties.

Munich, December 1995
Diplomkaufmann
Ernst Erich Schnoor

#1) Kretschmer, H.-J., in: WP-Handbuch 1985/86, 9.Edition, Düsseldorf 1985, Vol.I, p. 1184

#2) Däumler,K.-D., Leitfaden zur Investitionsrechnung, Herne/Berlin 1990, p. 23

#3) Däumler, K.-D., as stated above (a.st.a.), p. 16

#4) Brealey, Richard A. and Myers, Stewart C., Priciples of Corporate Finance, 4th ed., New York 1991, p. 79 - 88, Weinrich, G. and Hoffmann, U., Investitionsanalyse, München/Wien 1989, p. 52 ff.

#5) In this connection the term 'Bound Capital' seems to be new. The respective value does not equal the term 'Capital tie-up' or 'Tied Capital', because the total invested capital still includes the outflowing interest. Contrary to this, the bound capital expresses the net invested capital after deducting the outflowing interest. Therefore this systematic research defines bound capital as the result of capital and time (C * t), i.e. as funds tied for a specific time in an investment.

#6 The basic correlations have been published in an article by the author in the journal DER STEUERBERATER, Heidelberg, issue 9/1995. The continuation of the analysis of correlations, especially also the conditions concerning investments with more than one payback date, has led to other findings in parts, which are now taken into consideration in this article, as well as in the latest version of the author's PC program, CALCULATION of INTEREST with the PC.

#7) Hax, H., Investitionstheorie, 5th ed., Heidelberg 1993, p. 12.

#8) Also "Amortisationsdauer" (cutoff period): Weinrich, G., Der Betrieb 1989, p. 989,
Weinrich, G. and Hoffmann, U., a.st.a., p. 45 and
Kretschmer, H.-J., a.st.a., p. 1183.

#9) The term "profit" is used alternatively for the terms interest yield, surplus of receipts over expenses and surplus of the investment.

#10) Hax, H., a.st.a., p. 36, Weinrich, G. and Hoffmann, U., a.st.a., p. 2 and Kretschmer, H.-J., a.st.a., p. 1189.

#11) Kretschmer, H.-J., a.st.a., p. 1182.

#12) decursive present value factor: a(n) = 1/r - 1/[r * (1 + r)^t]
See also Hax, H., a.st.a., p. 14.

#13) Schneider, D., Investition, Finanzierung und Besteuerung, 7th ed., Wiesbaden 1992, p.87 and p.91

#14) Calculated with the PC-program of the author: CALCULATION of INTEREST with the PC.

#15) Because the arithmetic summation formula delivers different results in the expression (n - 1) * t(i), if the time unit for the interest apportionments is 360 days for a year, 90 days for a quarter, 30 days for a month or 1 day, the profit volume is basically dependent upon the selection of the time unit (year, half-year, quarter, month or day).

#16) The calculation of time in days requires an additional factor of 360

#17) The calculation of time in days requires an additional division by 360

#18) Created with pc programs MS-Excel and MS-paintbrush.

#19) Calculated with the PC-program of the author: CALCULATION of INTEREST with the PC, according to a suggestion of Hax, H., a.st.a., p. 24.

#20) Hax, H., a.st.a., p. 15 ff.

#21) Weinrich, G. and Hoffmann, U., a.st.a., p. 54.

#22) Compare Kretschmer, H.-J., a.st.a., p. 1192.