Münchener betriebswirtschaftliche Beiträge

Munich Business Research

Cash Flow and Asset Based Interest Calculation in Cost Accounting

Hans-Ulrich Küpper

Ludwig-Maximilians-Universität München
Fakultät für Betriebswirtschaft

Hans-Ulrich Küpper[1]

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2000-03

Juli 2000

[1] Universität München, Fakultät für Betriebswirtschaft, Institut für Produktionswirtschaft und Controlling, Ludwigstraße 28 RG, D-80539 München, Tel. +49 89 2180 2093, email: kuepper@bwl.uni-muenchen.de.

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Abstract

Interest is an important issue in investment and finance theory. Despite this fact it is seldom analyzed in cost accounting. There the calculation of interest costs follows practical rules. Normally, interest costs are calculated on the basis of average capital and current assets, including inventories, work in progress, finished goods and accounts receivable.

This paper first discusses a new proposition of Kloock and Maltry. It says that traditional interest calculation could be based on the Preinreich/Lücke-theorem. Using an easy example of a production process, we show that this thesis does not hold as the Preinreich/Lücke-theorem can be applied to different residual incomes. The amount of periodical interest depends on the realization principles which must be given in order to use this theorem and not conversely.

Secondly, we show that interest calculation in cost accounting can be based on cash flows. Comparing this method of interest calculation with asset based interest calculation indicates two errors of the traditional interest calculation, the lack of interest yields for gain on sale and the interest on accounts receivable. To avoid these errors the traditional method of interest calculation has to be modified. Then asset based interest calculation can correctly be used in cost accounting.

The analysis of interest calculation in cost accounting is an example for the application of investment theory to cost accounting. It shows that it is useful to connect cost accounting with investment and finance theory. By this way decision oriented cost accounting gets a theoretical fundament which allows to derive practical relevant results.

1. Preface

Calculating interest costs on the basis of assets[2] is quite different from the calculation out of cash flows. An important question in theory and practice is, if both methods get the same results, and which of them can be founded by theory. At first sight the asset based method seems to follow thumb rules instead of a theoretical concept. On the contrary Kloock and Maltry[3] claim, that the theorem of Preinreich/Lücke, which is used to calculate the residual income, gives a theoretical foundation of the traditional method. Furthermore, their thesis is in contrast to the thesis, that calculation of interest in cost accounting has to be based on cash flows.

Therefore, the first issue in chapter 2 is to show the meaning of the Preinreich/Lücke-theorem (2.1). It does not give a foundation of traditional interest calculation, as this theorem presumes a profit realization principle and not conversely (2.2). In chapter 3 cash flow and asset based interest calculations are compared (3.1 and 3.2). Traditional calculation does not equal the cash flow based method, unless it is modified in two aspects. The modified method of asset based interest calculation is based on present or future value. Therefore it is an element to connect cost accounting with investment theory. The asset based method holds for full and direct costing (3.3).

The results of this paper show, that decision oriented cost accounting has to be developed as a part of investment theory. This concept is a way to connect short-term (cost and revenue) planning with long-term (investment) planning.

2. Theoretical Foundation of Interest Costs by the Preinreich-Lücke-Theorem?

2.1. Conditions and Proposition of the Preinreich-Lücke-Theorem

In a recent paper, Kloock and Maltry[4] justify the calculation method of traditional cost accounting by the theorem of Preinreich/Lücke[5]. This theorem shows the calculation of the residual income. It says ”that the present value of future cash flows equals to the present value of future residual incomes”[6] if two conditions are fullfilled[7]:

(1) The sum of cash flows CF_t equals the sum of gross incomes before interest costs G_t

$$\sum_{t=0}^{T} G_t = \sum_{t=0}^{T} CF_s$$

(2) The capital stocks at the beginning of each period equal the difference between the accumulated gross incomes and the accumulated cash flows:

$$V_{t-1} = \sum_{s=0}^{t-1} G_s - \sum_{s=0}^{t-1} CF_s \qquad \text{where } V_{-1} = 0 \text{ and } V_T = 0 .$$

[2] Kilger (1988); Kloock/Sieben/Schildbach (1993); Schweitzer/Küpper (1998); Hummel/Männel (1986); Franz (1984).
[3] Kloock/Maltry (1998).
[4] Kloock/Maltry (1998).
[5] Preinreich (1937); Lücke (1955).
[6] Reichelstein (1997), p. 178.
[7] Lücke (1955), pp. 313-317.; Lücke (1965); Kloock (1981).

This implies, that the capital stock V_{t-1} at the end of each period must be identical to the capital stock V_t at the beginning of the next period. Therefore this prerequisite corresponds to a condition of balance sheet identity:[8]

$$V_t = G_t - CF_t + V_{t-1}$$

To get the residual incomes G_t^*, gross incomes G_t have to be diminished by interest costs on the capital stock V_{t-1} at the beginning of each period. Then the present and the future value K_T of residual incomes equals the present and the future value of cash flows:

$$K_0 = \sum_{t=0}^{T} CF_t (1+i)^{-t} = \sum_{t=0}^{T} (G_t - iV_{t-1})(1+i)^{-t} = \sum_{t=0}^{T} G_t^* (1+i)^{-t}$$

$$K_T = \sum_{t=0}^{T} CF_t (1+i)^{T-t} = \sum_{t=0}^{T} (G_t - iV_{t-1})(1+i)^{T-t} = \sum_{t=0}^{T} G_t^* (1+i)^{T-t}$$

2.2. Interest Calculation in Traditional Cost Accounting and Influence of Income Realization on Periodical Interest

In contrast to investment theory, interest costs in cost accounting are usually calculated on the basis of assets instead of cash flows, e. g. on the basis of average capital and current assets,

Time	0	1	2	3	4	5
Cash flows						
Outflows for material		2400				
Inflows from sold products					1700	1700
Assets						
Material	2400	1200				
Products (finished goods)		1200	1200			
Sales			1700	1700		

Fig. 1: Example of a production process

including inventories, work in progress, finished goods and accounts receivable. It is said that cost accounting looks at the input of the different input factors as material, labour and maschines as well as the production process of goods.

Asset	Traditional Asset Based Interest Calculation	
Material	(2400+1200)/2*2*0,01 =	36
Products	1200*2*0,01 =	24
Accounts receivable	1700*2*2*0,01 =	68
Capital items deducted from total	(-2400)*1*0,01 =	-24
Sum of interest		104

Fig. 2: Traditional asset based interest calculation

[8] Laux (1995), pp164-166.

Time	0	1	2	3	4	5	Sum
Revenues	0	1200	2900	1700	0	0	
Costs	0	1200	2400	1200	0	0	
Gross income G(t)	0	0	500	500	0	0	1000
Outflows for material		2400					
Inflows for sold products					1700	1700	
Total cash flow CF(t)	0	-2400	0	0	1700	1700	1000
Capital stock V(t)	0	0	2400	2900	3400	1700	
Interest on capital stock V(t)	0	0	24	29	34	17	104
Residual income G*(t)	0	0	476	471	-34	-17	896

Fig. 3: Calculation of interest costs according to Preinreich/Lücke (case A)

The difference can be illustrated with the example given in figure 1. This example shows a one stage production process which is repeated once. In this process, material is purchased at the beginning and used for the production of 100 units in each period (e. g. each month). The production process lasts one period (carried out twice). To see the key points we neglect labour, depreciations and other costs. The material is paid one period later and the sold products are paid two periods after sale. To calculate the interest costs we have to determine the assets and the tied up capital. Figure 2 shows the average assets of material, finished goods, and accounts receivable and the traditional calculation of interest costs (interest rate i=0,01).

This calculation differs from financial accounting. There we have to specify the paid and the received interest which may include different interest rates. In cost accounting we use one single interest rate and average assets.

Kloock and Maltry[9] claim, that the traditionally calculated interest costs exactly equal the interest costs, if we apply the conditions of this theorem. Figure 3 illustrates an example. Therefore they argue, that traditional interest costs seem to be theoretical founded by this theorem.

To analyze their thesis we change the realization principle. In financial as well as in cost accounting one assumes, that income (profit) is realized at the moment, when products are sold (case A, figure 3)[10]. In order to see the logic of the Preinreich/Lücke-Theorem, we calculate the residual incomes of our example in two different cases: In case B (figure 4) it is assumed that income is realized half by production and half by selling, thus the values of the finished goods include half of the gains. Figure 5 shows an example, where income is realized only by production (case C). Hence the values of the finished goods include the whole gain.

Time	0	1	2	3	4	5	Sum
Revenues	0	1450	3150	1700	0	0	
Costs	0	1200	2650	1450	0	0	
Gross income	0	250	500	250	0	0	1000

Fig. 4: Realization of income partly by production, partly by selling (case B)

[9] Kloock/Maltry (1998).

[10] According to traditional bookkeeping and cost accounting, revenues result from sales and an increase in product inventories.

Time	0	1	2	3	4	5	Sum
Revenues	0	1700	3400	1700	0	0	
Costs	0	1200	2900	1700	0	0	
Gross income	0	500	500	0	0	0	1000

Fig. 5: Realization of income by production (case C)

Now, we calculate the interest costs, the residual incomes and the present as well as the future values of the three cases. As figure 6 shows, the present and the future values of the residual incomes equal the present and the future value of the cash flows for each case. The Preinreich/Lücke-Theorem is allways fulfilled. The sum of periodical interest costs differs, as it depends on the income realization.

Time	0	1	2	3	4	5	present value	future value	periodical interest costs
Total cash flow	0	-2400	0	0	1700	1700	874,9	919,6	
Gross income	0	0	500	500	0	0			
Interest on capital stock	0	0	24	29	34	17			104
Residual income (case A)	0	0	476	471	-34	-17	874,9	919,6	
Gross income	0	250	500	250	0	0			
Interest on capital stock	0	0	26,5	31,5	34	17			109
Residual income (case B)	0	250	473,5	218,5	-34	-17	874,9	919,6	
Gross income	0	500	500	0	0	0			
Interest on capital stock	0	0	29	34	34	17			114
Residual income (case C)	0	500	471	-34	-34	-17	874,9	919,6	

Fig. 6: Comparison of present and future values and periodical interest costs

The results show different facts:

The correspondence of the present and the future values in the different cases does not depend on the income realization and the interest costs *within* every period. This correspondence is only guaranteed if we calculate *two* types of interest: periodical interest costs *and* interest on the residual incomes.

The Preinreich/Lücke-Theorem is not a principle which tells us how to calculate periodical interest costs. Rather it shows how periodical accounting has to be modified in order to equal the results of cash flow oriented accounting. It helps to lead back periodical accounting, including costs or expenditures and revenues, to present value accounting on the basis of cash flows. Therefore it gives no theoretical arguments for the calculation of periodical interest costs.

3. Principles and Methods of Cash Flow Oriented Periodical Interest Calculation

3.1. Cash Flow Based Interest Costs

A company must pay interest on capital for the money, it needs to finance its investments. Therefore interest depends on payments, i. e. cash inflows and cash outflows. There is every indication, that the calculation of interest in cost accounting has to be oriented on cash flows even if it is calculated on the basis of assets. Using the Preinreich/Lücke-theorem Kloock and Maltry accept this in principle, too. Another argument underlines this position: The long-term objective net present value has to be relevant for periodical accounting. That means, that in planning at the end one profit goal is relevant for all decisions. Short-term decisions and objectives have to be derived from this goal.

Usually, periodical cost accounting only contains interest without compound interest. In order to compare traditional with cash flow based calculation of interest cost we neglect compound interest. Using the example of figure 1, we then get the future value without compound interest at T=5 as

$$K_T = (-2400+1700+1700) - 2400 \cdot 0{,}01 \cdot 4 + 1700 \cdot 0{,}01 \cdot 1 = 1000 - 96 + 17 = 921$$

If we consider the periods of this example as parts of a longer period, e. g. two months of a whole year, this total period contains interest charges of 96 and interest yields of 17, in sum interest costs of 79. This amount differs from the traditional result of interest costs, which equal 104. The interest costs of the traditional method exceed the cash flow based interest heavily. This leads to a smaller periodical income.

The Preinreich/Lücke-Theorem tells us, that we have to calculate interest on the residual incomes to get the future value. Taking the traditional calculation of figure 2 this results (without compound interest) in interest yields of $500 \cdot 0{,}01 \cdot (3+2) = 25$. Together with the traditional interest costs of 104, we get 104-25=79 as the result of cash flow based calculation.

3.2. Modified Asset Based Interest Calculation

Traditional interest calculation therefore seems to be incomplete. In an asset based calculation we have to change two points:

(1) As the company gets revenues including profits all over the year one has to consider interest yields on incoming profits.
(2) If the sales are not paid directly, one usually calculates interest costs based on the amount of the accounts receivables. This is not correct. The invested capital equals only the product costs before adding a profit margin.

Both aspects make sense. The revenues reduce the invested capital not only up to the amount of the costs. Instead, they are distributed over the whole period. Differently from financial accounting traditional cost accounting seems to assume, that the capital invested in the products flows back during the whole period corresponding to the dates of the revenues, whereas the included profits accrue at the end. This is inconsistent.

A similar argument holds for the second point. A company invests capital for the manufacturing of its products. Purchasing the needed input factors causes expenditures. The amount of invested capital does not depend on selling prices and it does not increase by their sale. If selling prices exceed full costs per unit, the amount of invested capital equals the costs as well as if costs per unit are higher than the selling prices.

If we alter the traditional calculation in this sense it leads us to a modified asset based method. As figure 7 illustrates, now the asset based calculation of interest equals the cash flow based calculation. By this way we get a method to calculate interest costs on the basis of assets which corresponds to cash flow calculation.

Asset	Modified Asset Based Interest Calculation	
Material	1800*2*0,01 =	36
Products	1200*2*0,01 =	24
Accounts receivable	1200*2*2*0,01 =	48
Capital items deducted from total	(-2400)*1*0,01 =	-24
Interest gains	(-500)*1*0,01 =	-5
Sum of interest		79

Fig. 7: Modified asset based interest calculation

3.3. Asset Based Interest Calculation in Full and Direct Cost Accounting

The analysis can be extended to different production processes and may include other costs, e. g. depreciation[11]. It is also possible to further include compound interest on the assets. The central result in modifying the traditional interest calculation does not change.

One problem seems to arise with overhead costs, as the interest yields and the invested capital of the sold products depend on the allocation of fixed costs. To analyze this problem, we have to look at the relations between assets and costs, too[12]. But there is a compensating effect. If fixed costs are allocated on the products, the interest costs on the assets become higher as in direct costing. On the other side, interest yields on incoming gains on sales are lower. Therefore the sum of interest costs and interest yields is the same, if the transformations from the actual payments to the assets are correct.

This can be illustrated in an extended example. In figure 8 we assume that the production process is repeated continuously. In addition to material one has to pay direct wages, machinery and other overhead costs. The profit of one year, consisting e. g. of 6 periods from t=2 until t=7,

Time	0	1	2	3	4	5	6	7	8	9
Cash flows										
Material		-2400		-2400		-2400				
Wages		-300	-300	-300	-300	-300	-300			
Machinery	-6000									
Overhead	-200	-200	-200	-200	-200	-200				
Inflows from sold products					3200	3200	3200	3200	3200	3200
Sales			**3200**	**3200**	**3200**	**3200**	**3200**	**3200**		

Fig. 8: Extended example of a production process

[11] Küpper (1991); Küpper (1997).
[12] Küpper (1997).

	Asset based calculation	
	Full costing	Direct costing
Material	-1800*0,01*6 = -108	-1800*0,01*6 = -108
Machinery	-(6000+5000+...+1000)*0,01 = -210	-(6000+5500+...+3500)*0,01 = -285
Overhead	-200*0,01*6 = -12	-(200+400+...+1200)*0,01 = -42
Products	-2700*0,01*6 = -162	-2000*0,01*6 = -120
Acc. receiv.	-2700*0,01*2*6 = -324	-2000*0,01*2*6 = -240
Cap. deducted	2400*0,01*3 = 72	2400*0,01*3 = 72
Interest gain	500*0,01*(2+1+0-1-2-3) = -15	1200*0,01*(2+1+0-1-2-3) = -36
Sum of interest	-759	-759

Fig. 9: Asset based interest calculation

is determined by the products which are sold in this year. According to the accrual (realization) principle, all cash inflows and outflows as well as costs and revenues have to be taken into account, which belong to the sales of these products.

To calculate the interest costs of this year, we have to analyze the cash flows and assets, which belong to the production process of these products. In full (absorption) costing, depreciations and other overhead costs are totally distributed to the product units, in direct costing only the variable costs. The values of the assets in full and direct costing are shown in figure 9. We assume that half of the acquisition costs of the machinery is variable. Therefore we get assets for products and accounts receivable per period worth [1200 (material) + 300 (wages) + 500 (variable depreciation) =] 2000 in direct costing and [1200 + 300 + 500 + 200 (overhead) + 500(fixed depreciation) =] 2700 in full costing. They include assets which are caused by the payments (investments) for overhead.
The cash flow based interest calculation is shown in figure 10. Both methods result in identical values of interest costs if we calculate the interests on accounts receivables on their costs and take into account the gains on sales in full costing as well as the gains on contribution margins in direct costing.

	Cash flow based calculation
Material	(-2400)*0,01*(5+3+1) = -216
Wages	(-300)*0,01*(5+4+3+2+1) = -45
Machinery	-6000*0,01*6 = -360
Overhead	-200*0,01*(6+5+4+3+2+1) = -42
Revenues	3200*0,01*(2+1+0-1-2-3) = -96
Sum of interest	-759

Fig. 10: Cash flow based interest calculation

4. Interpretation of the Results

Analyzing interest costs in cost accounting yields several insights, which seem to be important not only for the calculation of interest costs.

The Preinreich/Lücke-theorem is useful to connect periodical calculations in cost or financial accounting with net present value. It is the basic theorem to account residual income as an element of performance measure, which are oriented towards shareholder values, market values and net present values. Although this theorem connects the profits of individual periods with a multi-period profit goal, it does not show how to calculate the periodical profits. It rather requires principles to determine periodical profits. It is only important to pay attention to its conditions.

Expenditures and revenues are observable data, whereas costs are theoretical terms. The latter have to be derived from cash flows within a clear theoretical based concept. In consequence, cash flows must be the basis for interest calculation in cost accounting, too.

Interest costs arise and interest yields accrue from the investment of capital. Investments are reflected in cash flows. This is another reason why interest calculation has to be based on cash flows.

That does not mean that it is impossible to calculate interest in cost accounting out of the average values of assets. But cash flow based calculation forms the norm, according to which other methods of interest calculation must be judged. Asset based interest calculation can be derived from cash flow based calculation. For this, traditional interest calculation in cost accounting has to be modified. It must include interest yields for gain on sales and it must take into consideration, that invested capital does not include gains.

Net (future) present value is a useful profit goal to judge different methods of interest calculation. Interest calculation is only one example which shows the connection between cost accounting and investment. In the end, cost accounting has to be embedded in investment theory, as there seems to be no exact principle to separate cost and investment accounting[13]. Then we get a theoretical concept for decision oriented cost accounting. It helps to connect short-term with long-term planning.

Furthermore, interest calculation in cost accounting has also to be founded by theory of finance. It must be analyzed how to take into account uncertainty and its influence on the interest rate. Whereas there are some concepts to handle this problem in theory of finance, e.g. CAPM and APT, cost accounting only contains some practical oriented considerations and rules. This seems to me to be a deficiency, that could be removed.

[13] Küpper (1985); Küpper (1993).

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Hans-Ulrich Küpper

Universität München

Institut für Produktionswirtschaft und Controlling

Ludwigstr. 28/RG

Tel.: +49-89-2180-2093

Fax.: +49-89-344054

E-mail: kuepper@bwl.uni-muenchen.de

http://www.bwl.uni-muenchen.de