Cost estimating in sawmilling industries:

guidelines

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PREFACE

This paper deals with managerial decisions on profitability assessments in sawmills. The target group is primarily sawmill managers in medium-sized and large companies in different developing countries.

Costing is a difficult field of study. Even introductory textbooks consist of many hundreds of pages. This paper explains the very core of managerial models for costing and profitability assessments.

These models are valid for all kinds of companies. The main difference between this booklet and an ordinary textbook is that almost all examples deal with sawmill problems. Although theoretical models are general in nature, the sawmill manager has problems that are very specific to his industry. Above all, the sawmill's raw material - the log - creates difficult problems. But there are also other problems more or less typical for sawmills. A few of them are covered in this paper.

As this paper presumably will be used in many countries, a fictitious currency called the monetary unit (MU) has been used. Any real currency would most likely have diverted the readers' attention from the analyses to the realism in chosen figures.

With one exception - a cash flow budget - taxes have not been included in the text. The reason is that tax rules are specific to different countries and, thereby, impossible to treat in a common way.

In Chapter 6 on capital budgeting, the inflation problems might have been discussed, but inflation rates vary between countries and also differ over time within any one country. Thus it is difficult to treat the problem in a manner suitable for all readers and it has accordingly been excluded from this study.

The models - and the subsequent analyses - presented in this paper might look difficult, especially for the first time reader. The model concept is often defined as "a simplified picture of reality". The models of this paper are also "simplified" as compared to reality. However, it is possible to simplify them still further, but then there is a great risk that they will not contribute at all - or even negatively - to the sawmill manager's endeavour in improving his profitability assessments and costing systems.

This paper is based on the work of Mr. Bo L. Eklund, Senior Lecturer in Business Administration, University of Karlstad, Sweden in collaboration with the Forestry Department.

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1. COSTING AS A MANAGERIAL TOOL

1.1 The overall framework

Managers are decision-makers, i.e. their main role is to make sound decisions in order for their companies to become - or remain - prosperous. To do this the manager needs information about operational aspects of his company as well as the environment in which his company operates. This paper deals with internal aspects of the company's costing systems with special reference to costing problems in sawmills.

The term 'costing' can be used in several ways. As it is used here, it is fairly closely related to the modern aspect of cost accounting, which should be separated from financial accounting (bookkeeping, etc.). Cost accounting can be described in the following way:

> COST ACCOUNTING. Quantitative method that accumulates, classifies, summarizes and interprets information for three major purposes: (1) operational planning and control; (2) special decisions, and (3) product costing. (Horngren, Charles T., ed., Cost Accounting. A Managerial Emphasis, Prentice/Hall International editions, Englewood Cliffs, N.J., 1982, p. 967.)

The overall cost accounting system of the company is described in Exhibit 1.1. The system is based on three cornerstones - the financial accounting system, the profitability judgement system, and the budget system. The dashed line indicates that these three cornerstones are internally connected and mutually supporting each other. In compiling the yearly, short-term budget of the company, one must rely on information from the financial system. The budget, in its turn, is an important source of information. At the same time product costing and product performance reports will constitute sources of information in the budget work. In the same way there are connections between the financial accounting system and the profitability judgement system.

In this paper we will concentrate on the budget and the profitability judgements of the company. Financial accounting will be regarded only as a possible source of information. We focus on the following three aspects of cost accounting:

1. The need for a budget, budgetary control and active use of the budget for various costing purposes.

2. How to estimate the cost of sawn timber, i.e. how to measure the performance of the sawmill.

3. How to carry out capital budgeting and how to use the information from the budget system.

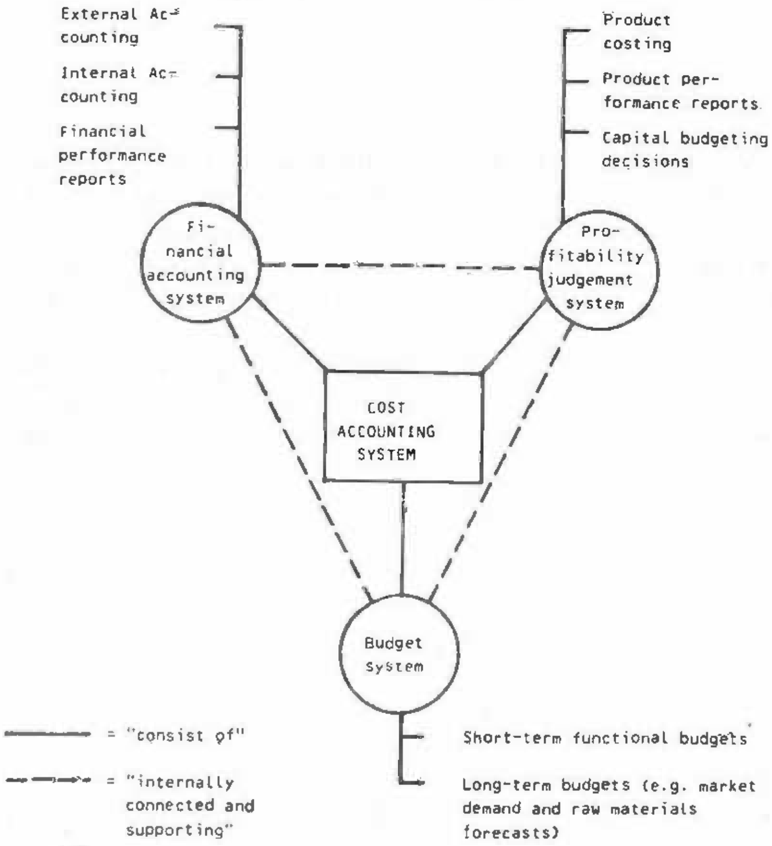


Exhibit 1.1 - The Cost Accounting System and its three cornerstones.

1.2 The cost concept

In practice, the cost used for various decisions is often taken for granted. Managers use, uncritically, costs taken from the company's financial accounting system. In costing, however, we need a clear definition of what is meant by the term 'cost'. Let us, therefore, define the cost concept in the following way:

> A cost is a <u>genuine sacrifice</u> made for the goods and/or services provided by a company to its customers.

In this definition we have underlined the expression "genuine sacrifice". In order to produce a product or to provide a service to somebody, the company has to sacrifice something. This sacrifice can be <u>measured</u> in different ways. This means that we will most probably get different evaluations of the cost. We can measure a cost as either what we have <u>paid</u> to somebody or what we have refrained from by using our resources in a certain way. (By using our money to produce a product, we refrain from the bank interest that we would have got, if we had put it in a savings account.) In the first case we talk about the sacrifice as an "outlay cost", in the latter case we call the cost an "opportunity cost". This will be explained thoroughly in Chapter 2. Suffice it to say here that the size of a cost is obviously a <u>matter of evaluation</u> and not merely grabbing a figure from the financial accounting system.

In a company's financial accounting there might be sacrifices that will not be considered sacrifices in the costing procedures. A fire in the sawmill does not mean increased genuine sacrifices for the production of sawn timber, even if purchases of new machines, etc. are "costs" from the accountant's point of view. At the same time, there are genuine sacrifices made in producing and distributing the sawn timber that the accountant does not consider "costs" in his system. Storing a m^3 of sawn timber during a year is a genuine sacrifice from the costing point of view. In this paper, when referring to "costs", we mean those sacrifices recognized in the sawmill's costing procedures.

The difference between various aspects of the cost concept in this respect is illustrated in Exhibit 1.2. There, costs according to both the financial accounting system and the budget and profitability systems have been "boxed". The dashed lines indicate sacrifices common to all systems. Those sacrifices falling outside the dashed lines are considered as added costs for the financial accounting system and the two other systems respectively.

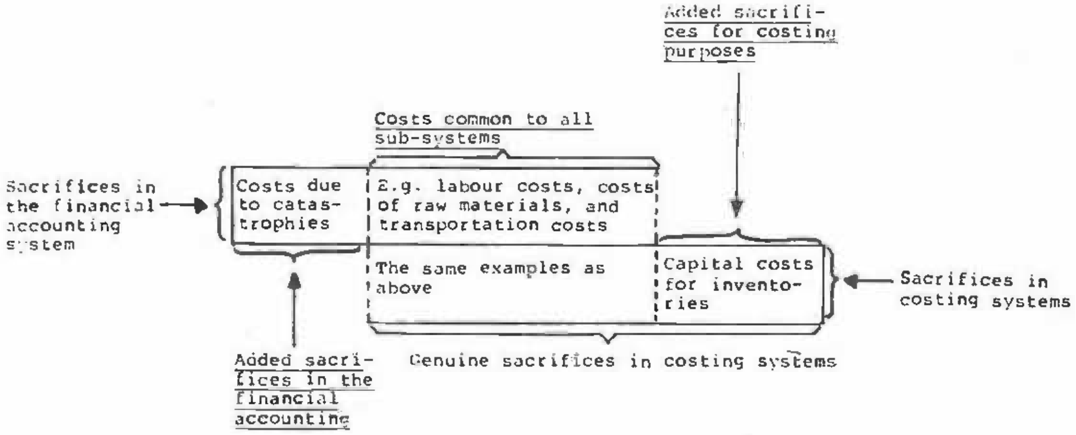


Exhibit 1.2 - Sacrifices in different accounting sub-systems.

Finally, the cost concept is always time-bound. Most expenses of a company will be part of the total costs of the year. Labour costs, rents paid to house-owners, fuel and electricity expenses will accrue during the year. Accrued expenses will then be treated as costs for the year. But, e.g. the electricity bill, will once a year represent electricity consumption for a period that stretches over the end of one year and the beginning of the other year. In such cases, the expenses must be allocated between the years to show each year's cost.

This problem of time-wise allocation of expenses is especially important for capital investments in machinery and buildings. Each year's cost will be measured as the depreciations of machines and buildings. In actual costing the size of the depreciation will reflect estimated useful life of machines and buildings.

1.3 Cost objectives

Now and then we use the expression 'cost objective'. With this term we refer to anything for which a cost estimate may be desired.

There are numerous cost objectives used in the costing procedures of a company. A product, a product mix, or a whole production unit might be considered a cost objective. We can also find the cost objective outside the company. We might be interested in comparing costs accrued as a result of the fact that the company serves different customers or groups of customers.

But cost objectives do not necessarily have to be "physical units". Various kinds of activities can also be used as cost objectives, e.g. comparing one production system with another system or comparing two different transportation routes.

We are not interested only in costs of various cost objectives. The income side must also be taken into account. Therefore, the following definition of a cost objective will be used throughout this paper.

> A cost objective is any physical unit or any activity in the company's operations that can be examined for a profitability assessment.

1.4 Costing purposes

There are many costing purposes in the company. Different purposes might create different needs of costing procedures. This in turn means that the costing systems must be flexible enough to serve different needs. Let us look upon the more important purposes that costing usually serves in a company.

Purpose 1

> Cost estimates for various kinds of price assessments.

In many managerial textbooks one finds that the main purpose of the company's costing procedure is to serve as a basis for price-setting. This is theoretically illogical. Pricing the products should be made from the point of view of the buyer. This will be developed further in Chapter 4.

But still, there are many situations in which the company is faced with a customer bid. In such a situation the costing system should help in judging whether the bid should be accepted or rejected. In some situations the full cost of the product might be a logical measure to use. On other occasions perhaps some kind of "reduced cost" will be used. Price assessments call not only for flexibility in the system as such. They also point to the need for a theoretical understanding of how different costs influence profitability.

Purpose 2

> Cost estimates are used for assessing the profitability of special orders and/or different customers or groups of customers.

Special orders, different customers or customer groups usually give rise to different costs. In order to assess the profitability the costing system must be more detailed than otherwise would have been necessary. Providing a customer with dimensions that normally are not produced will influence costs. If these special orders are produced, the company's buffer stocks before the kiln and the trimmer will have to increase to avoid drying and trimming of series that are too small to be profitably handled.

Purpose 3

> Costing procedures serve the purpose of performance assessments for the company as a whole as well as for various parts.

Performance control is an important task. To be able to exert control, we must create tools, i.e. costing procedures, that are conducive to such a task. In the first place, performance control always calls for some degree of sophistication in the system. All costs that can be influenced should be separated in the budget. Secondly, it is sometimes of utmost importance to clarify where the cost accrues. Who can influence the size of the cost and, thereby, be made responsible - or credited - for the changes that occur?

1.5 The plan of this paper

To build up a costing procedure in a company is a difficult task. There is always a risk that too much is taken for granted. However, when the system has been constructed it should also be possible to use it. To avoid common pitfalls in profitability assessments, a theoretical basis is needed.

Chapter 2 gives a conceptual framework for costing. The larger part of this chapter deals with various cost concepts from a purely theoretical point of view. The concepts studied in this chapter will be used - often with cross references - in later parts of the paper.

Chapter 3 also contains a theoretical basis, as short-term profit planning is discussed. The way basic concepts such as variable and fixed costs are put together in break-even analyses is scrutinized. The most important message in this chapter is that profit planning is a simple task - in theory! In practice, however, problems are much more difficult. Some difficulties of practical profit planning are discussed.

Chapter 4 deals entirely with sawmill budgeting. With Chapters 2 and 3 as a theoretical basis, the short-term budget is compiled. One company serves as a "model company" throughout the whole paper except for one section in Chapter 4. In discussing the sawmill's raw material costs (logs), we use another example for reasons explained later.

Chapter 5 treats the concept of sensibility analysis. In this chapter we return to the budget to illustrate how it can be used for various kinds of decisions.

Chapter 6, finally, introduces the concept of capital budgeting. The chapter starts with a short introduction to the theory of how to estimate the time value of money. Thereafter, we work through five models for capital budgeting. At the end of the chapter we return, for the last time, to our model company. From the budget we analyze a couple of possible decisions for capital investments in the sawmill.

2. CONCEPTUAL FRAMEWORK

2.1 The value of a conceptual basis

The manager of a company is often faced with the problem of making economic decisions affecting the profitability of his company. Such decisions involve both cost and income aspects. The result of the manager's efforts is heavily dependent on how well he can assess the economic consequences involved in decisions such as:

i) Can the company profitably sell the product at the price offered by the customer?

ii) What are the economic effects following a decision to add a new product to the company's production programme?

iii) Which product is preferable - A or B - if available machine time is a bottleneck?

iv) Is it, from an economic point of view, justifiable to repair a machine now or should it be postponed until next year?

v) Does it pay to hire a new production manager?

vi) Should depreciation costs be considered in calculating the costs of the products?

In answering questions of this kind, the manager will meet problems both in assessing the size of the cost as well as in deciding whether or not there is a genuine sacrifice to be evaluated. As a matter of fact, he will find that "the cost of something" is a highly relative matter.

Additionally it will often happen that he will have trouble in finding the size of the cost. The only source of information available - without effort - is, in many cases, the financial accounts. Here costs are measured in the conventional way to serve specific needs. However, the needs in connection with profitability judgements are often of such a nature that other cost concepts and other assessments must be used. Sometimes the manager has a difficult choice between different cost concepts.

> It is better to use a rough approximation of the concept of cost that is correct for a particular decision than to have an accurate estimate of an irrelevant concept. The unsophisticated executive is in danger of taking the easier course of using conventional accounting costs as though they were appropriate for all purposes. Instead, it is better to modify reported costs as necessary to make the best possible guess at the concept theoretically relevant for each decision. (Dean, J., Managerial Economics, Prentice-Hall, Inc., Englewood Cliffs, N.J., 1951.)

Occasionally the income aspect might also create a problem, but in most situations the assessment of the company's income (for a particular decision) will be fairly easy. True, the size of the sales income might be difficult to predict, but in most cases there will be no conceptual confusion involved in forecasting the sales income. However, in estimating costs the conceptual problem almost always turns out to be the key task. That explains why this chapter puts cost concepts in focus.

2.2 Variable and fixed costs

The most common way to describe costs is to study how a certain cost reacts to changes in company activity level. The activity may be measured as production or sales volume, hours worked and so forth. In this paper the activity level will be measured as production of sawn timber in cubic metres (m^3) and referred to - for short - as "volume".

If the total cost changes with volume, the cost is defined as a variable cost. The pattern of such a cost is illustrated in Exhibit 2.1. The graph shows that the total cost changes in direct proportion to changes in volume.

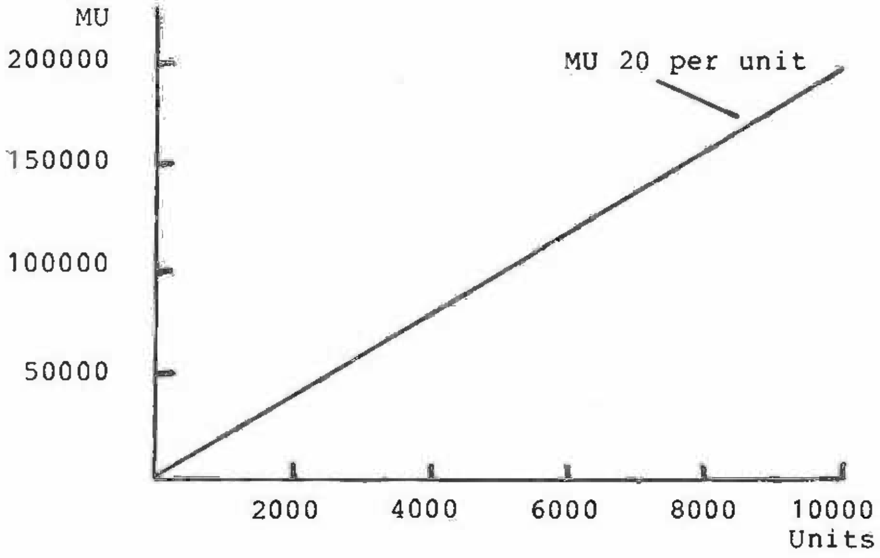


Exhibit 2.1 - The proportional variable cost function.

This means that the unit cost is constant, assumed here as MU 20 per unit. This is the way variable costs are mostly described in textbooks. There are for every company lots of examples of proportional, variable costs. The cost of raw materials used in manufacturing often shows this pattern. Other examples are labour costs, package costs, and sales commissions.

However, a realistic assessment of variable costs is more complicated. Depending on where, along the volume axis, the cost is studied, one finds changes in the behaviour pattern. Besides proportional variable costs, it is also possible to discover both progressive and degressive variable costs. The progressive cost grows at a higher rate than the increase in volume and the degressive at a lower rate. The principle of these two types of variable costs is illustrated in Exhibit 2.2. It is obvious from this graph that the unit cost increases for the progressive (Curve I) and decreases for the degressive (Curve II) variable cost.

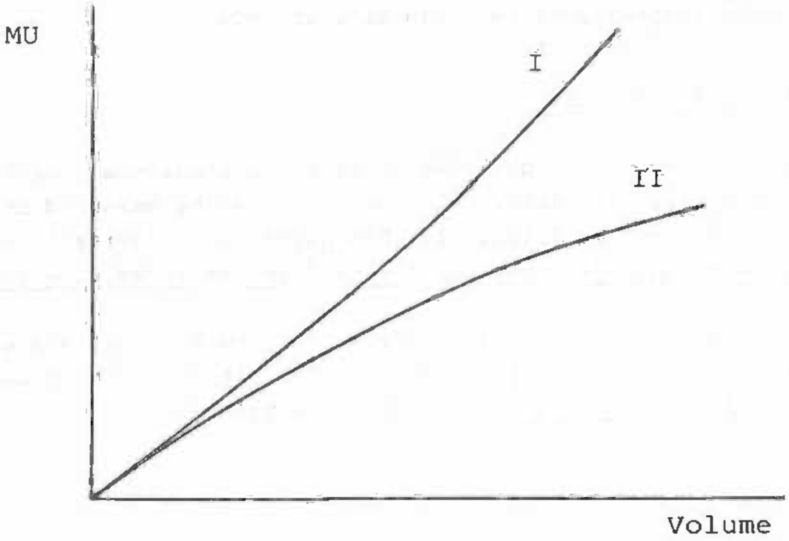


Exhibit 2.2 - Graphical illustration of progressive (I) and degressive (II) variable costs.

Unfortunately one will not always find progressive and degressive variable costs that can be shown as smoothly as in Exhibit 2.2. Instead one usually finds that these costs are composed of a series of proportional variable costs that will show a progressive (degressive) behaviour pattern.

Fixed costs are defined as costs that remain unchanged with changed volumes. As can be seen from Exhibit 2.3, the fixed cost can be shown as a horizontal line parallel to the volume axis. However, for fixed costs also, reality is more complicated.

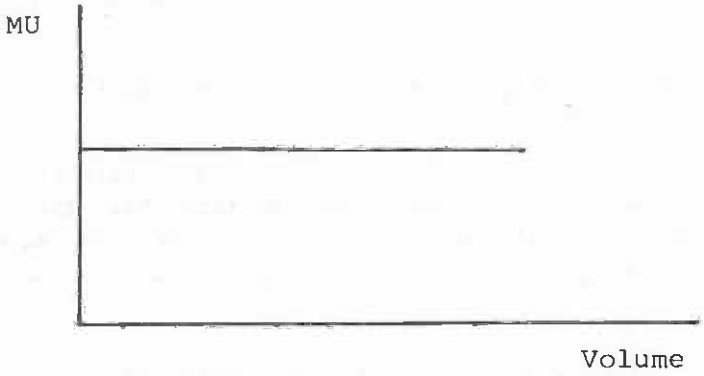


Exhibit 2.3 - The simple, fixed cost curve.

The volume range must always be considered when studying the fixed costs. There are two aspects. Firstly, we must consider where on the volume axis, the cost studies are made. The horizontal cost line presented in Exhibit 2.3 extends indefinitely from zero and along the volume axis. However, no cost can remain fixed regardless of how much the volume changes. Sooner or later a cost increase must occur. Showing a fixed cost as a horizontal line is valid only for a part of the total range. This part is called the relevant range. Secondly, we must consider what happens, when the production volume passes either of the borderlines of the relevant range.

To study the relevant range we can use labour costs of supervisors as an example of a fixed cost. The graph of this cost is shown in Exhibit 2.4. Here we can see that the company can produce up to 10 000 units with one supervisor. In order to increase production from 10 000 to 20 000 units, another supervisor must be employed. Thus, costs for supervisors have been doubled.

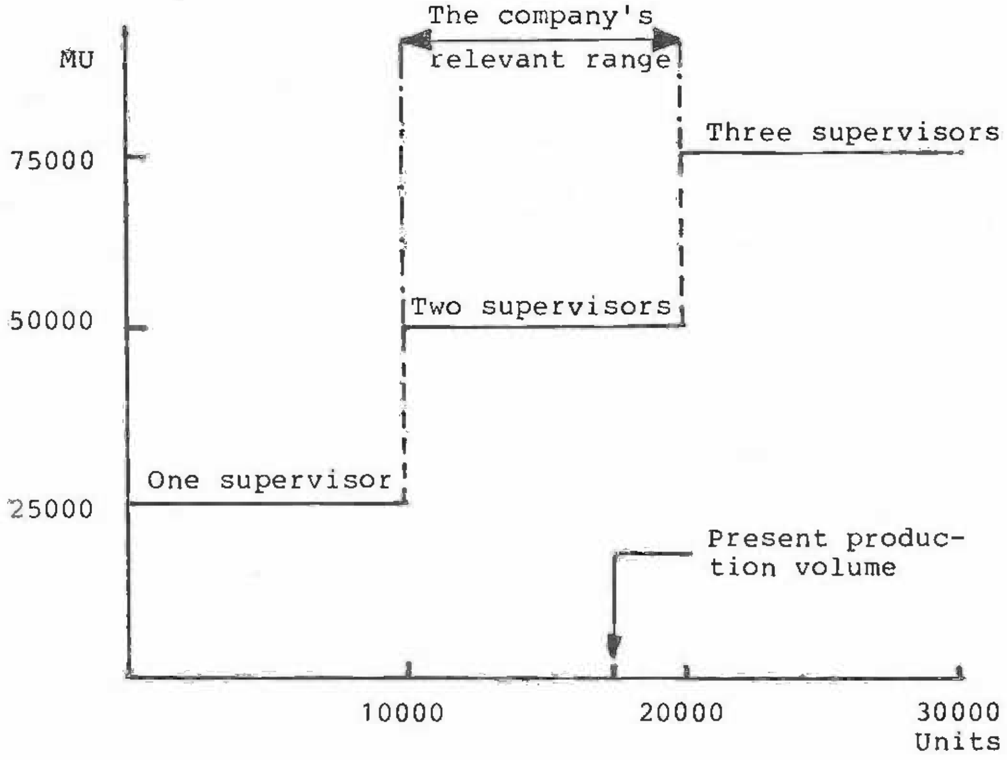


Exhibit 2.4 - Step-fixed cost, supervisory salaries at various production volumes.

This is shown as a jump to a higher level in one single step although present production remains at 17 500 units. If the production increases above 20 000 units, a third supervisor must be employed.

The stepwise increase of certain costs creates some problems. If an increase in demand of some 5 000 units is forecast for the coming year, the company needs to produce 22 500 units. To accomplish this, a new supervisor must be employed. One supervisor can handle up to 20 000 units. The new supervisor is in theory needed for only 2 500 units[1]. Unfortunately, the majority of every company's "fixed costs" are actually step-fixed, i.e. costs being fixed only within certain intervals (relevant ranges).

The second consideration is to see what happens when the production volume passes the borderlines of the relevant range. Increased production volume is followed by increased costs. But what happens to a cost when the production volume <u>decreases</u>? Suppose that the company hired a third supervisor three years ago due to increased demand. What happens with the cost of supervisors if the production volume shrinks to the previous level (17 500 units) or lower? From a principle point of view the last employed supervisor can be fired. If so, labour cost for supervisors will go back to the previous level.

1/ This is a principle analysis. Such objections like "use overtime production" or "hire a part-time supervisor" are of no value. There are always occasions in a company, when the indivisibility of costs creates problems of this kind.

We then talk of a reversible, step-fixed cost. If, for one reason or another, the supervisor cannot be fired, the cost of supervisors will be unchanged in spite of the decrease in volume. A step-fixed cost that tends to remain unchanged with volume decreases is called an irreversible step-fixed cost. Most step-fixed costs are partly or totally irreversible. Workers, supervisors and even managers can, in principle, be fired. Machines and buildings cannot! Too optimistic assumptions about future demand might incur irreversible step-fixed costs that with decreasing demand become devastatingly high.

Before leaving the concepts of variable and fixed costs, a certain mixture of them will be commented on. In some instances a cost can consist of one fixed and one variable element. Such a cost is called a semivariable cost or a mixed cost. It is e.g. common to pay a fixed amount p.a. for electric power installation and a variable fee for the power actually used. Mixed or semivariable costs are generally of little interest, but from a conceptual point of view it is important not to mix these costs with step-fixed costs.

2.3 Traceable costs and common costs

A pair of cost concepts of great practical use in profitability assessments is the constellation of traceable and common costs. A cost that can be indisputably traced to a given cost objective is defined as a traceable cost. Costs lacking this traceability are common costs. A common cost is, therefore, defined as a cost, the burden of which should be shared by at least two different cost objectives.

In using this cost pair the "traceability aspect" is crucial. A cost is traceable to a given cost objective, if the elimination of the cost objective means that the cost disappears completely. In defining "traceability" the starting point can also be the addition of a new cost objective. If a new cost objective is added to a company's current activity, all costs then accruing are traceable costs.

The traceability can be illustrated by a product-costing example. Assume that a company produces and sells five different products, A-E. The company has made cost calculations shown in Exhibit 2.5.

Products Specification	A	B	C	D	E
Total revenues	700	625	740	480	810
Cost of raw materials	435	405	460	320	500
Cost of labour:					
Machine operators	190	180	200	110	265
Supervisors	15	10	20	10	25
Sales commission	14	25	15	10	20
Depreciations	20	30	30	15	35
Net income (loss)	26	(25)	15	15	(35)

Exhibit 2.5 - Simplified example of product-costing for five products.

As can be seen from the figures, two products - B and E - have given a negative net income (loss) during the year. The question now arises, whether these two products should be deleted from the production schedule or not. To answer this question, information is needed on expected future demand, expected prices, the competitive situation in the future, possible alternative actions and so forth. Let us, to begin with, study the figures to see what they tell us.

If we stopped producing these products, the following changes would occur:

i) The revenues from products B and E will disappear.

ii) Costs of raw material will also disappear given that this material is indisputably traceable to the products.

iii) Cost of labour will most probably be reduced. Machine operators can be dismissed. If so, these costs are traceable. Supervisory salaries do not necessarily change. If there is only one supervisor, he is needed for the rest of the production, and his salary is then to be regarded as a common cost.

iv) If the products are deleted, the sales commission will disappear, i.e. this cost is traceable.

v) Depreciation cost is nothing but a time-distributed cost. Years ago machines were bought, the cost of which now shows as a yearly depreciation. If there is no alternative use of the machines, the depreciation must be regarded as a common cost.

With these possible changes in mind, a recosting of products B and E has been made in Exhibit 2.6. From this calculation we can see that both products give a surplus over and above those costs that are traceable to the products. This surplus is called the products' contribution to profit. If there are no other alternatives, it would be unwise to cancel products B and E despite the "obvious loss" according to Exhibit 2.5.

Products Specifications	B		E	
Total revenues		625		810
Traceable costs:				
Raw materials	405		500	
Operators' wages	185		265	
Sales commission	14	599	20	785
Surplus above traceable costs		26		25

Exhibit 2.6 - Recalculations of products B and E from Exhibit 2.5 using only traceable costs.

Let us have a look at the labour cost for supervisors. We found that when products B and E were the cost objectives, supervisory salaries were treated as a common cost. Changing perspective and making the whole department the cost objective would turn the supervisory salaries into a traceable cost. This example highlights a very important characteristic of this cost pair; a certain cost may very well for one cost objective be characterized as a traceable cost, but for another cost objective the same cost may become a common cost. In other words, it is the defining of the cost objective that decides whether a cost is traceable or common. Careful defining of the cost objective becomes a crucial task when using this cost pair.

2.4 Direct and indirect costs

The cost pair of direct and indirect costs will be found in the accounting system. It is of very limited use in profitability decisions. But the problem is how to find valid cost estimates in a particular situation. One source of information is the accounting system. Cost figures, taken from this system, might sometimes be the only way to get a cost estimate even if those are often constructed for highly generalized purposes.

In the accounting system the products usually are cost objectives. All costs that can be directly traced to such a cost objective are direct costs. Examples of direct costs are raw material, labour costs and sales commissions. Direct costs are traceable to the cost objective (Exhibit 2.5). One would expect these two concepts - direct costs and traceable costs - to be synonyms. But this is not the case! Direct costs are all those costs which the accountant has chosen to treat as directly traceable. Obviously, then, indirect costs are those costs which the accountant has chosen to treat as indirect relative to a certain cost objective. Supervisory salaries (Exhibit 2.5) are usually not directly traceable to one product and therefore treated as indirect costs. Rent paid for an office, depreciation of factory buildings, and salaries to the management are other examples of costs that the accountant treats as indirect costs.

It is important to notice the stress that has been put here on the word 'treat'. In the general accounting system it is impossible to identify every single cost in such a way that makes it possible to classify the nature of the cost for different situations. There are thousands of small items used in production and distribution of goods; pencils, erasers, staples, paper clips, lubricating oil, lubricating cans and various minor tools, to mention but a few. There are services required like electric power, heating, telephone calls, transportation, mail services, insurance. It is obvious that it would be too tedious to trace such costs to individual cost objectives. Instead the accounting system is built up in such a way that fairly good estimates will be achieved for each final cost objective. This may be carried out as shown in Exhibit 2.7. Costs that are directly traceable to the cost objective will be directly applied. Indirect costs will first be allocated to different cost centres. Such cost centres may be production or service units. From these cost centres, indirect costs are applied to the cost objectives.

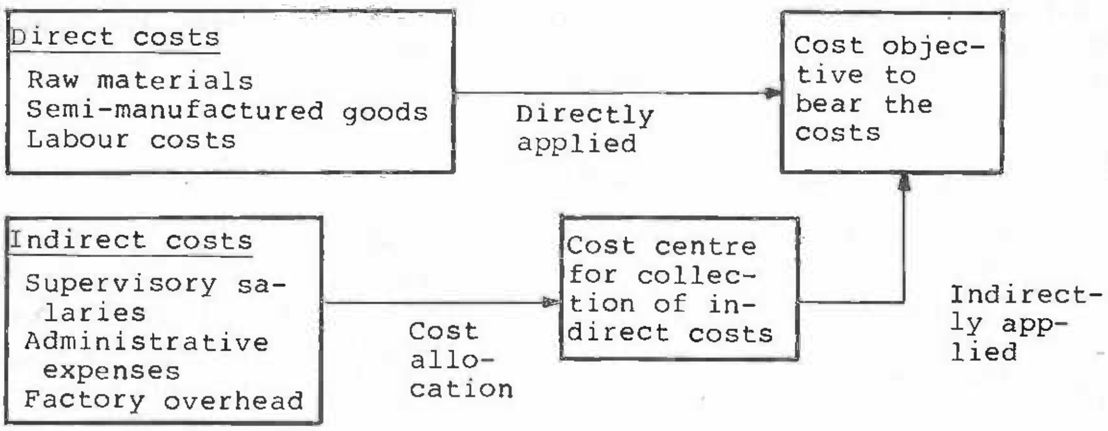


Exhibit 2,7 - Applying direct and indirect costs to cost objectives.

2.5 Opportunity costs and outlay costs

To classify costs as either opportunity costs or outlay costs means focusing the nature of sacrifice. Perhaps the most natural way to measure the sacrifice for a certain activity is to find out how much one has to pay somebody (a worker, another company or an agency of any kind). Wages or salaries, raw materials and services paid are all examples of outlay costs, i.e. costs measured by the amount of money paid.

But there is a different way of measuring the sacrifice made, namely to see what the company has to refrain from by choosing a certain course of action. If a worker is used for activity A, we can often find out how much we have to refrain from, when we do not use him for activity B. Instead of measuring the labour cost of activity A as the wage actually paid to the worker, we can measure the sacrifice in performing activity A as the foregone net earnings by not letting him perform activity B. The cost measured in this way is called the opportunity cost.

A taxi-driver, who owns his car has been requested to drive a customer to a place 500 km away, to wait there while the customer attends a meeting and then drive the customer back again. The total ride will amount to 1 000 km and the trip will take a whole day. The customer wants to have a binding offer before he makes up his mind. For the taxi-owner the problem now is to decide on the price to offer the customer. Let us simplify his problem so that only two types of sacrifices will be involved, namely the cost of gasoline and the cost of his own work. The first cost can easily be estimated as it is an obvious outlay cost. Knowing the price of gasoline, MU 4 per litre, and how much the car consumes, 0.18 litre per km, this cost will be 1 000 x 0.18 x 4, which amounts to MU 720 in total. But how should he estimate the "labour cost", i.e. his own work? Here the opportunity cost concept offers a way out. From records he knows that during this time of the year his average gross earnings amount to MU 804 per day and to achieve this, he drives at an average 183 km per day. In city-driving the average gasoline consumption amounts to 0.22 litres per km. With these figures he can estimate his total, net earnings per day:

+ Gross earnings per day	MU 804
- Cost of gasoline per day 4x183x0.22 =	MU 161
= Net earnings per day	MU 643

This amount, MU 643 per day, is what he, at an average, would refrain from by not driving as usual. This is the opportunity cost. If he demands MU 720 (to cover cost of gasoline) plus 643 (to cover what he otherwise would have earned), i.e. a total of MU 1 343 for this special driving, he will be equally well off as compared to "an average day".

2.6 Incremental costs and sunk costs

Making decisions in a company very often means adding new activities to those previously performed. To perform the new activity, e.g. taking up a new product, means that two types of resources will be used. Perhaps a new machine must be bought and a new operator employed. This means that the decision will incur added costs, and these costs are termed incremental costs. However, the machine also demands space in the factory. If there is free space on the factory floor, and there is no alternative use of this space, the cost of using it is zero. We term this cost a sunk cost. This will be discussed further with a number of examples in later chapters.

2.7 Sawmill problems and solutions

2.7.1 Problems

(a) Give some examples of variable and fixed costs in a sawmill. Comment also on what kind of variability different costs might have and their degree of fixedness and/or reversibility.

(b) In the discussion on "traceable and common costs" an example was given for five products (cf Exhibit 2.5 and 2.6).
Consider the various dimensions of sawn timber as different products.
Carry out a study for a sawmill, similar to the one referred to above, under the assumption that one or more of the products might be unprofitable. The main question is: What costs in this situation will be regarded as traceable costs?

(c) A company is divided into two separate production units - the sawmill and the planing mill. Both units have the same, overall management.
How would you classify the administrative cost for this company?

(d) In our company the raw materials of the planing mill are all taken from the company's own sawmill. The sawmill sells some 70 percent of its production on the open market. The remaining 30 percent is used in the planing mill. The management has to decide on the internal price of the sawn timber. Use the conceptual framework presented in this chapter to discuss different ways of pricing the internally delivered sawn timber.

Hints: The sawmill can sell its total production of sawn timber on the open market because demand is high. From a principle point of view, it is also possible for the planing mill to buy sawn timber from open market suppliers.

2.7.2 Solutions

(a) In scrutinizing the cost structure of a sawmill - or any other industry - one finds very few costs that easily and indisputably can be classified as proportional, variable costs. Either costs are variable, but degree of variability is difficult to assess, or they are fixed.

One example of a proportional, variable cost is the sales commission paid to an outside agent. If the agent's commission is the same regardless of how much he sells, the total commission cost will grow at a constant rate, when the sales volume increases.

In product calculations, the cost of raw materials is often used as an example of a variable cost, but this cost cannot be treated as a proportional, variable cost under all circumstances. For sawmills raw materials cost should in most cases be classified as a progressive, variable cost. As the raw material accounts for a considerable part of the total cost of sawn timber, misjudging this cost can be extremely expensive. A typical cost curve for the sawmill's raw materials is shown in Exhibit 2.8 below.

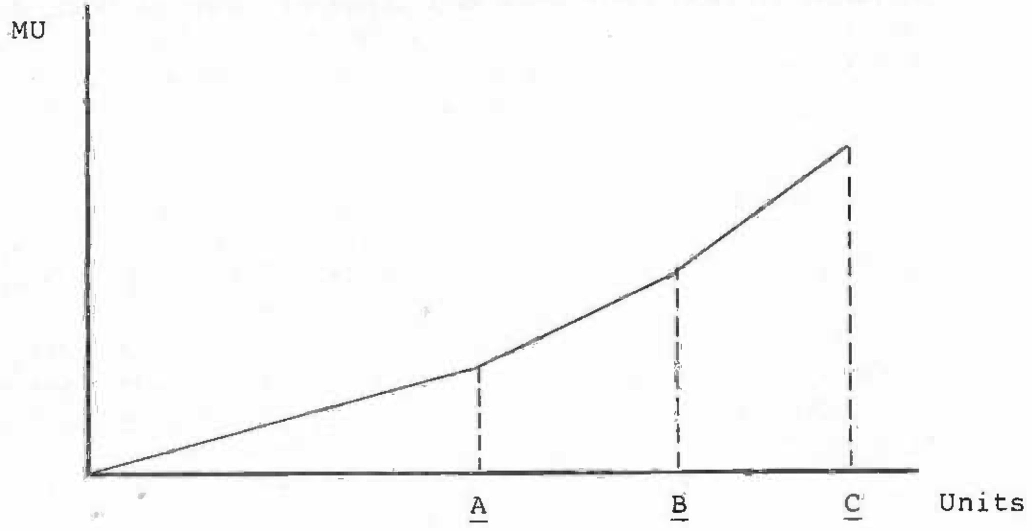


Exhibit 2.8 - A typical log cost curve.

Assume this sawmill has a normal production of A units per year but a total capacity of C units. If the demand should increase during one year to C units, it is tempting to try to meet the demand. However, we will find that the unit cost of logs increases sharply. Reasonable increases in relation to normal activity, let us say up to B units, will perhaps not change the unit cost too much, but marginal quantities always do. The danger is that we never discover the increase in log costs. If we use average figures for the whole period, small, high-priced quantities will not be observed. There are no costs in the sawmill that differ from costs usually found in other industries. As an example of an important cost that is often fixed, let us take labour costs. There are many ways of paying a worker, so we will consider one of these: a fixed monthly wage. With a strong trade union, there are very few possibilities of modifying total labour cost, e.g. in connection with a short recession.

Decreasing sales means in many cases that the labour force will be occupied with repair and maintenance work and labour costs will remain at the same level. The process structure in the sawmill industry also means that either everybody works or they do not. As compared to a mechanical workshop with 10 lathes, the situation is different. It is possible to stop two lathes and temporarily dismiss their operators. In a sawmill it is more difficult to cut down the activity by a certain percentage, even though it is possible, e.g. by stopping the whole production one day a week. Labour costs in the sawmill industry have a tendency to remain unchanged, when the activity level of the company goes down during short periods of time.

(b) The decision to be taken in this kind of problem is to find both traceable revenues and traceable expenses for all products sold. There are many costs that the sawmill incurs whether it sells its products or not. In the short-term planning, machinery, buildings, forklift trucks and administration are examples of costs that the sawmill has under all circumstances. We refer to such costs as common costs, and we do not take them into consideration for single product calculation.

For other industries, such costs as direct labour and raw materials can be classified as traceable costs. If management chooses to stop production for a certain product, these costs will disappear. Cost of labour in a sawmill cannot be reduced that easily. If we decide not to produce certain dimensions, we still need all production operators for the remaining products. This cuts out labour costs as a traceable cost for the sawmill and turns it into a common cost.

Scrutinizing the raw materials cost gives a similar result. Whatever dimensions - profitable or non-profitable - the sawmill produces, the raw materials cost will be approximately the same. If smaller dimensions like 19x75 or 19x100 turn out to be unprofitable, the sawmill still has to buy the whole log in order to get hold of the material for the profitable part of the production. It is impossible to buy exactly what is needed for each and every single product (dimension). This turns the raw materials cost into a variable, common cost. The sawmill's situation is not unique but fairly unusual. For all industries facing this situation, profitability assessment for single products is a difficult problem.

(c) There are many possibilities of classifying "administrative costs". In the first place, administrative costs are fixed costs within the relevant range of the whole company. Secondly, these costs should be classified as common costs for both the sawmill and the planing mill. There are few, if any possibilities of allocating these costs between the two units. But, of course, the company will, in its product calculation, allocate these costs to both units, e.g. in relation to their respective sales volume.

(d) In this problem a choice will be made between an outlay cost and an opportunity cost in order to estimate the sacrifice made by the sawmill. After having chosen the cost concept, company management has to estimate the size of the sacrifice.

Choosing an outlay cost means that the company estimates what expenses accrue from producing one cubic metre of sawn timber. The estimate will contain cost of raw materials, labour and a number of indirect production costs.

Most probably this outlay cost will also contain capital costs, e,g. depreciation costs.

Choosing the other option, i.e. the opportunity cost concept, means estimating what the sawmill has to refrain from when delivering one m^3 of sawn timber to the planing mill. Assume the following data to be valid during the period:

Open market price of sawn timber	MU 900 per m^3
Sales commission, 4%	MU 36 per m^3
Transportation cost from the sawmill to the customer	MU 8 per m^3
Total cost (of production and administration, except sales commission and transportation costs)	MU 700 per m^3

Choosing the outlay cost concept means that the sawmill unit will fix the internal price of sawn timber at MU 700 per m^3.

Choosing the opportunity cost concept (cf. the taxi-driver's problem in section 2.5) gives rise to the following calculations:

Market price of sawn timber		MU 900 per m^3
Less: Sales commission	MU 36	
Transportation costs	MU 8	MU 44 per m^3
Opportunity cost		MU 856 per m^3

There is quite a difference between the internal price, as estimated in these two different ways. But <u>if</u> there is a real market demand for sawn timber, large enough to cover the total production, then the opportunity cost concept is the only way to estimate the real sacrifice (cost) made by the sawmill. If, at the same time, there are possibilities for the planing mill to buy whatever it needs of sawn timber from outside suppliers, the opportunity cost will direct the planing mill manager in a correct way. If he can find sawn timber in the open market at a lower price than the sawmill's opportunity cost, the whole company will benefit from buying this timber.

Estimating the breakeven volume is of great importance. We define the company's *breakeven volume as the volume needed to cover total expenses*. Let X be the breakeven volume and let all other variables take on the same values as before. We then get:

$8X$	=	$3X + 2400$
(total sales revenues at the breakeven volume)		(total expenses at the breakeven volume)

Solving for X gives us the breakeven volume as:

$$X = 480 \text{ units}$$

The intersection between the sales revenues and the total expenses is a point in the diagram called the *breakeven point* or the *zero profit point*, and the breakeven volume always corresponds directly to this point.

The importance of the breakeven volume is obvious, as this is the lowest acceptable volume. As is shown in the lower half of Exhibit 3.1, the company runs at a *net loss* to the left of the breakeven volume. To the right of this volume, the company's *net income* starts growing.

3.3 Breakeven assumptions

In some textbooks the breakeven chart is presented in the same way as in the previous section. There are, however, a number of assumptions that underlie the breakeven chart.

First of all, there is a dispute about linearity versus non-linearity. In Exhibit 3.1 both the unit price of the product and the variable expenses were supposed to increase proportionally. However, for the majority of business companies, the sum of variable costs (or expenses) will include components growing progressively and/or degressively. The more such components are included and the higher the values of these components are, the less accurate the breakeven study becomes.

The breakeven chart as presented in Exhibit 3.1 covers the whole range from zero to 900 units. For reasonably short *periods of time* some fixed costs might remain fixed, even with considerable changes in volume, but over the whole range we will get a number of step-fixed costs that will change the fixed cost curve. Over the whole range also the sales revenues and the variable expenses will look different. In order to simplify, when a wide range of volume is studied, it is customary to cut off a part of the chart along the volume axis. This part is called *the relevant range*. (Cf. Section 2.2, supervisory salaries in Exhibit 2.4). The narrower the relevant range is made, the more trustworthy - all other things being equal - the analysis will become.

There are also other assumptions behind the breakeven chart. Volume is considered to be the one and only independent variable, but the *cost efficiency* of the company might vary with other factors also. Different production methods, variations in work hours, fluctuations in sales and production during the year and so on are all examples of possible cost influencers that are usually not considered in the breakeven analysis.

3.4 Breakeven analyses and step-fixed costs

In Exhibit 3.2 fixed and variable expenses of the company have been plotted for the whole volume range. We assume that the volume interval from A to B can be considered the relevant range. In deciding on range limits we have considered production capacity, market demands, the smallest volume that can be accepted without reducing the present labour force and so on.

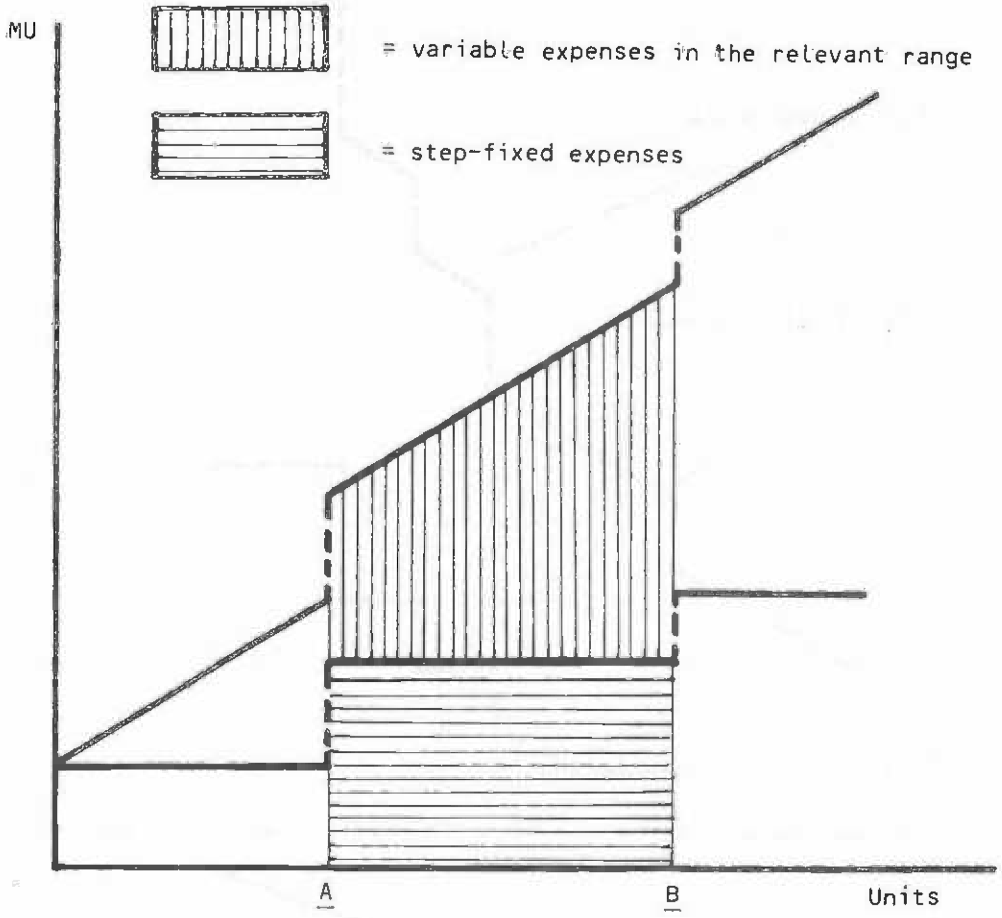


Exhibit 3.2 The breakeven chart for the relevant range from A to B

The relevant range as in Exhibit 3.3 shows a rather complicated cost structure. Most of the so-called "fixed expenses" often turn out to be step-fixed. For limited relevant ranges and during short periods of time, there are always some indisputably fixed expenses. Administrative salaries and depreciations can serve as examples of such fixed expenses.

Although we choose to study a limited volume range, we end up in a fairly complicated situation due to the step-fixed nature of the fixed costs. Showing revenues and expenses in a graph is not a practical way of solving problems. There is a need for a simple, mathematical model that also covers the step-fixed functions. Consider the following example:

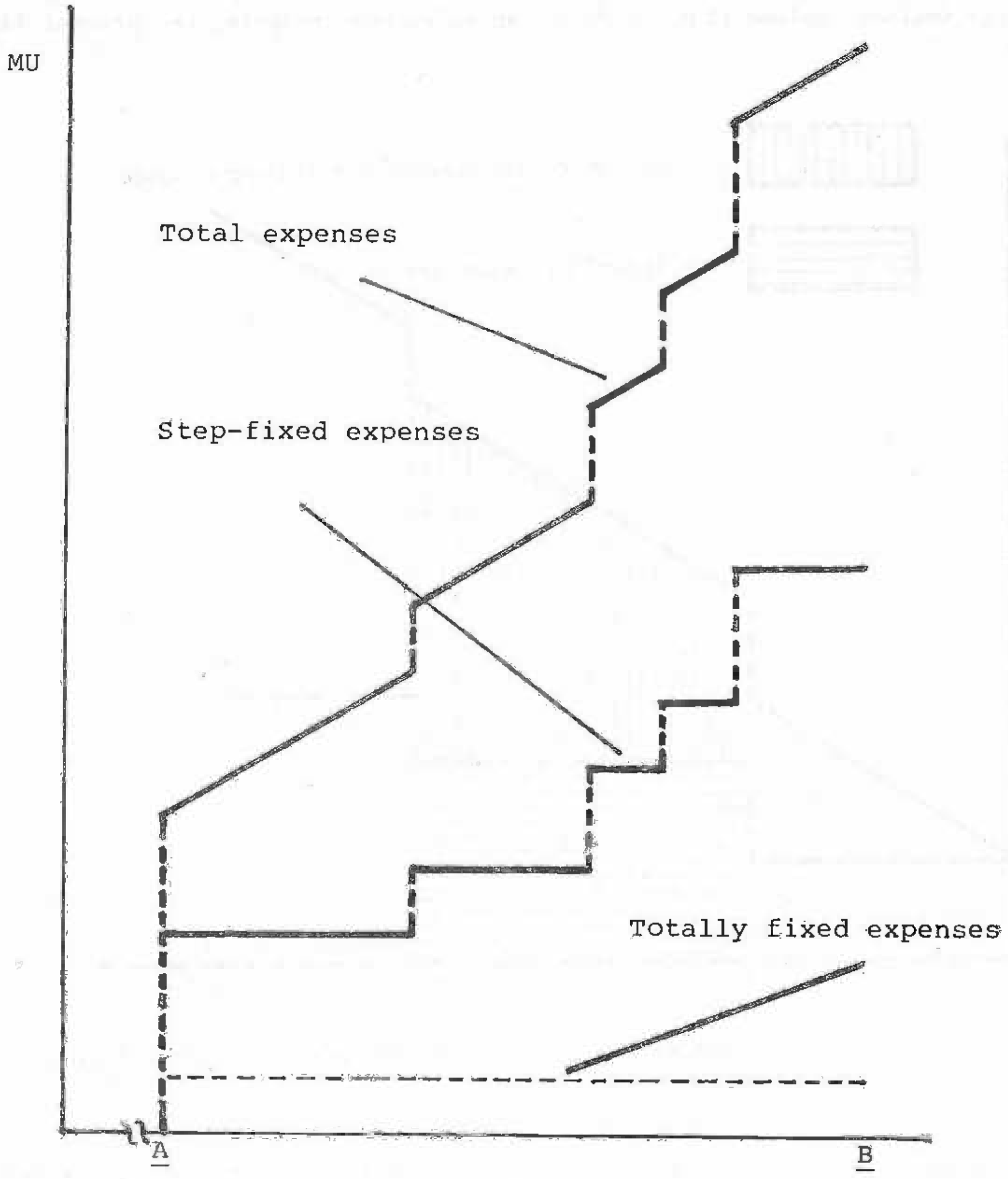


Exhibit 3.3 The relevant range

Cost specification	Volume range, units	Expenses in MU
Production costs	0 - 100000 100001 -	60000 90000
Advertising	0 - 80000 80001 - 140000 140001 -	0 25000 35000
Selling and administrative costs	Over the whole volume range	40000

The cost figures given for this example can be explained in the following way. Costs of production (machine operators' wages, depreciation, etc.) amount to MU 60 000, allowing a production of 100 000 units. Increased production above 100 000 units is followed by a cost increase of MU 30 000, totalling MU 90 000. The production capacity will then exceed the most optimistic forecasts of company demand, which will then become a bottleneck.

It has been considered necessary to support personal selling by advertising. Experience shows that the company can sell up to 80 000 units without extra support. Advertising for MU 25 000 will increase the quantity sold up to 140 000 units. Above that volume another MU 35 000 are needed to stimulate demand.

Selling and administrative costs amount to MU 40 000. These costs are totally fixed for varying production volumes.

It is assumed that both sales revenues and variable expenses are proportional to the volume. The following estimates have been made.

Sales revenues	MU 2.00 per unit
Variable expenses	MU 0.70 per unit
Contribution margin	MU 1.30 per unit

In other words, each unit will contribute MU 1.30 to cover fixed expenses. This unit contribution will remain unchanged regardless of how many products the company sells.

The problem has been shown graphically in Exhibit 3.4. In this example we have refrained from picking out a relevant range. Instead we study the whole range with the aim of choosing a relevant range later. From the graph we can see what might be called the decision-maker's dilemma. Due to the step-fixed nature of some of the company's costs, the sales revenue function intersects with the total expenses function repeatedly giving rise not to one but a series of breakeven volumes. If we are in the net income area No. 3 (NIA/3), advertising for another MU 35 000 means that the increase in sales volume must be large enough to cover not only breakeven volume No. 4 (BEV/4) but also exceed the profit gained in NIA/3. However, if the new sales volume just barely passes 140 000 units, the decision to increase advertising might throw the company from a net income area into a net loss area - in this case from NIA/3 into NLA/4. In fact, every expansion in a company involves such a risk.

There are many ways in which we can use the breakeven analysis. The model helps in answering many questions. To give a few examples:

1. How profitable is the company's present performance?
2. What happens to profit, if another machine is purchased in order to expand production volume?
3. Can company profitability be enhanced by a change - upwards or downwards (!) - in sales volume? If so, which of the two possibilities is the more profitable?

The graphical tool, though, is too awkward. As was pointed out earlier, there is a need for a simple mathematical model. As long as both revenues and variable expenses are proportional to volume changes, only the step-fixed expenses create a calculating problem. These expenses, however, can easily be dealt with. All that is needed is an estimate of the fixed expenses for all possible volumes. First we calculate fixed expenses for different volumes.

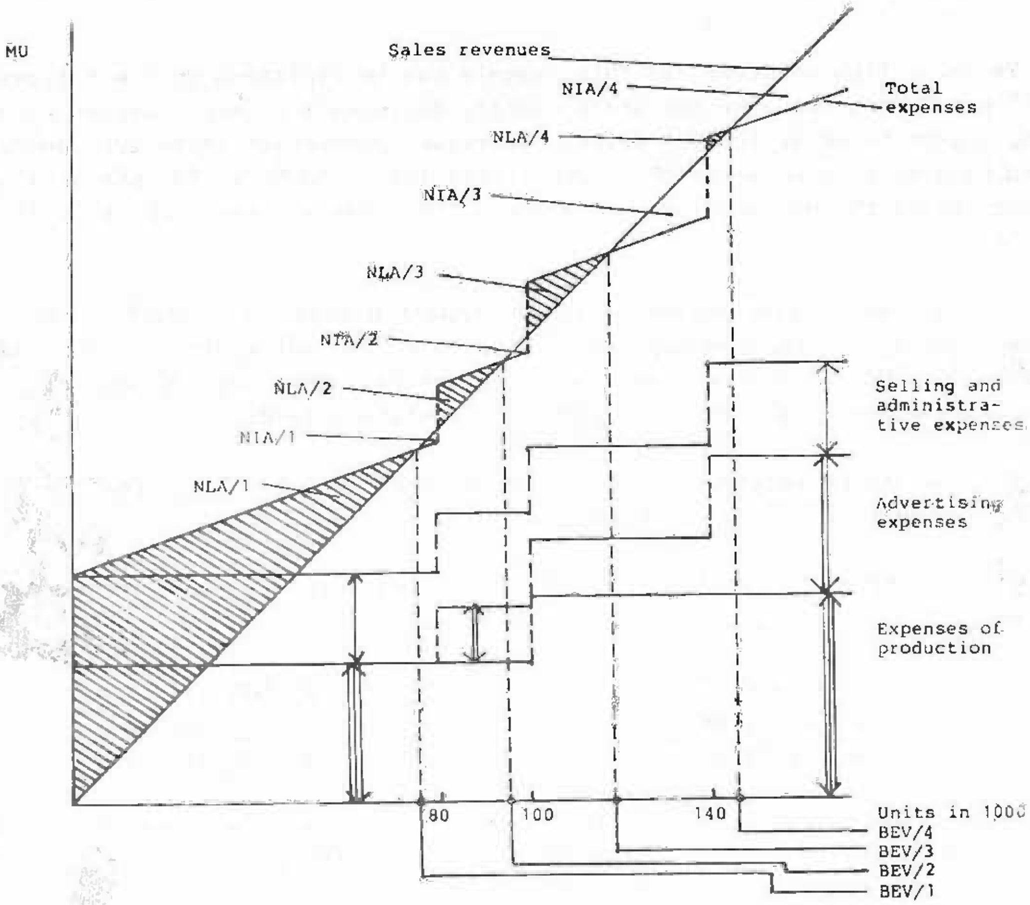


Exhibit 3.4 The breakeven chart with step-fixed expenses

Vol. range No.	Range in units	Fixed expenses in preceding range	Incremental expenses in present range	Total expenses for different ranges
1	- 80000	0	+ 60000 40000	= 100000
2	80001 - 100000	100000	+ 25000	= 125000
3	100001 - 140000	125000	+ 30000	= 155000
4	140001 -	155000	+ 35000	= 190000

Having this cost structure, we can estimate the different breakeven volumes. This might be a breakeven volume in each volume range. From Exhibit 3.4 we know that in this example each range has its own breakeven volume. If we denote the breakeven volume of the i:th range with BEV/i, we find these volumes by equalizing total revenues with total expenses. Using the contribution margin, i.e. unit revenue minus unit variable expenses, we get:

$$(2.00 - 0.70)\ (BEV/1) - 100\ 000 = 0 \qquad (1)$$
$$(2.00 - 0.70)\ (BEV/2) - 125\ 000 = 0 \qquad (2)$$
$$(2.00 - 0.70)\ (BEV/3) - 155\ 000 = 0 \qquad (3)$$
$$(2.00 - 0.70)\ (BEV/4) - 190\ 000 = 0 \qquad (4)$$

Solving (1) through (4) we find the respective breakeven volumes as:

BEV/1 = 76 923 units
BEV/2 = 96 154 units
BEV/3 = 119 231 units
BEV/4 = 146 154 units

Let us also find out how large a volume is needed to get a profit of at least MU 15 000. The only way to solve this problem is to study each volume range separately. If we denote the volume needed to get the desired profit from volume range $\underline{i}$ by $\underline{X}_i$, we get the following expression:

$$(2.00 - 070) \cdot \underline{X}_1 - 100\ 000 = 15\ 000 \qquad (5)$$

This stated in words means: The contribution margin times the volume reduced by fixed expenses gives a profit of MU 15 000. Solving (5) gives $\underline{X}_1 = 88\ 462$ units. But the first volume range covers only up to 80 000 units. Thereafter, fixed expenses take on a higher value. This means that it is impossible to get such a high profit within the first volume range. Instead, we have to try with volume range 2. Denoting the needed volume by $\underline{X}_2$ and changing the fixed expenses value gives:

$$(2.00 - 0.70) \cdot \underline{X}_2 - 125\ 000 = 15\ 000 \qquad (6)$$

Solving (6) gives $\underline{X}_2 = 107\ 692$ units. Once again, we get an answer <u>outside</u> the volume range for which the fixed expenses are valid. Thus, we have to climb one step further on the volume axis, finding volume - $\underline{X}_3$ - that gives the desired profit without violating the constraints.

$$(2.00 - 0.70) \cdot \underline{X}_3 - 155\ 000 = 15\ 000 \qquad (7)$$

Solving (7) gives $\underline{X}_3 = 130\ 769$ units.

3.5 Breakeven analyses and linearity changes

So far we have considered sales revenues and variable expenses as strictly proportional. In practice this assumption often makes the problem too simplified. Both may change with changed volumes. As long as we get a contribution margin that is positive, increased sales volumes should improve company profit. However, there are many pitfalls. We will study two of them.

Usually sales revenues sooner or later start growing degressively and variable expenses start taking on a progressive increase. It is always possible to increase sales by lowering prices. When sales volume increases, production volume must follow. However, an expansion will most probably create increases in variable expenses. Labour costs might change, costs of raw materials may show a progressive increase, transportation costs may increase as a result of higher volume and so on. The effect of expansive thinking might be an increased sales volume but with reduced profit. The economists usually describe this as shown in Exhibit 3.5.

At first, total revenues increase more than total expenses do. But soon the reversed process occurs. The increase in revenues is reduced and the expenses are further increased. This gives us two intersection points and, thereby, two breakeven volumes. As long as production volume is to the left of BEV/L, the company must strive for increased production. Obviously, optimal production volume is where the distance between the sales revenues and the total expenses functions is as large as possible. Every deviation - in either direction - from this volume creates a lower profit. This volume, therefore, is called the optimal production volume. Increasing production (and sales) means that sooner or later the company will pass a new breakeven volume - BEV/U - to the right of which is a net loss area.

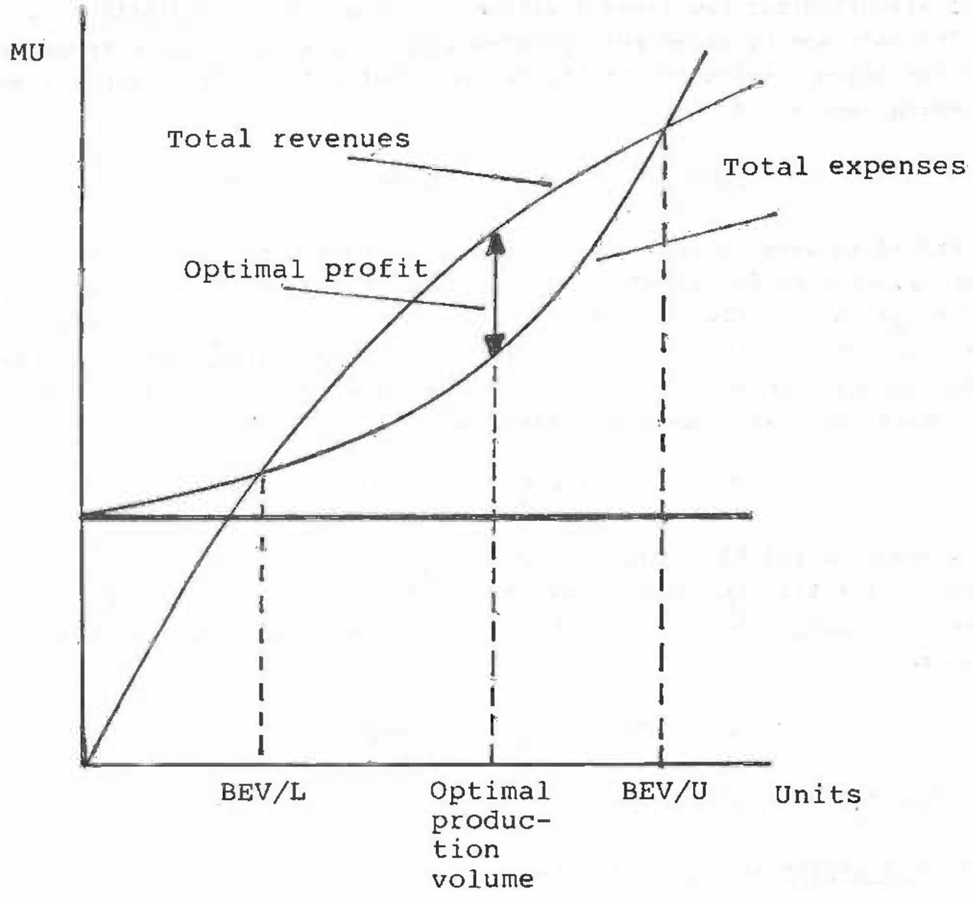


Exhibit 3.5 The economists breakeven chart

In practice we do not believe that we will find the optimal production volume. The model, however, reflects reality and, thereby, also has a certain value. The manager should realize that he cannot expect the same proportional change in revenues and expenses. However, there are no simple tools that can help us analyse the change in profitability that various decisions give rise to. For a running company changes in these functions are interactions of hundreds of more or less important single decisions.

Within the relevant volume range the business manager might find at least approximate shapes of his various functions. Perhaps his revenues and expenses will not take on the smoothed curveshape of the economist's breakeven chart. The manager will rather find that the slopes change frequently as is shown in Exhibit 3.6. Due to the difficulty in finding relevant data, he will be forced to accept approximate estimations of revenues and - above all - expenses. Many managers consider their cost calculation very difficult, but it is better to use a rough estimate than to refrain from even trying.

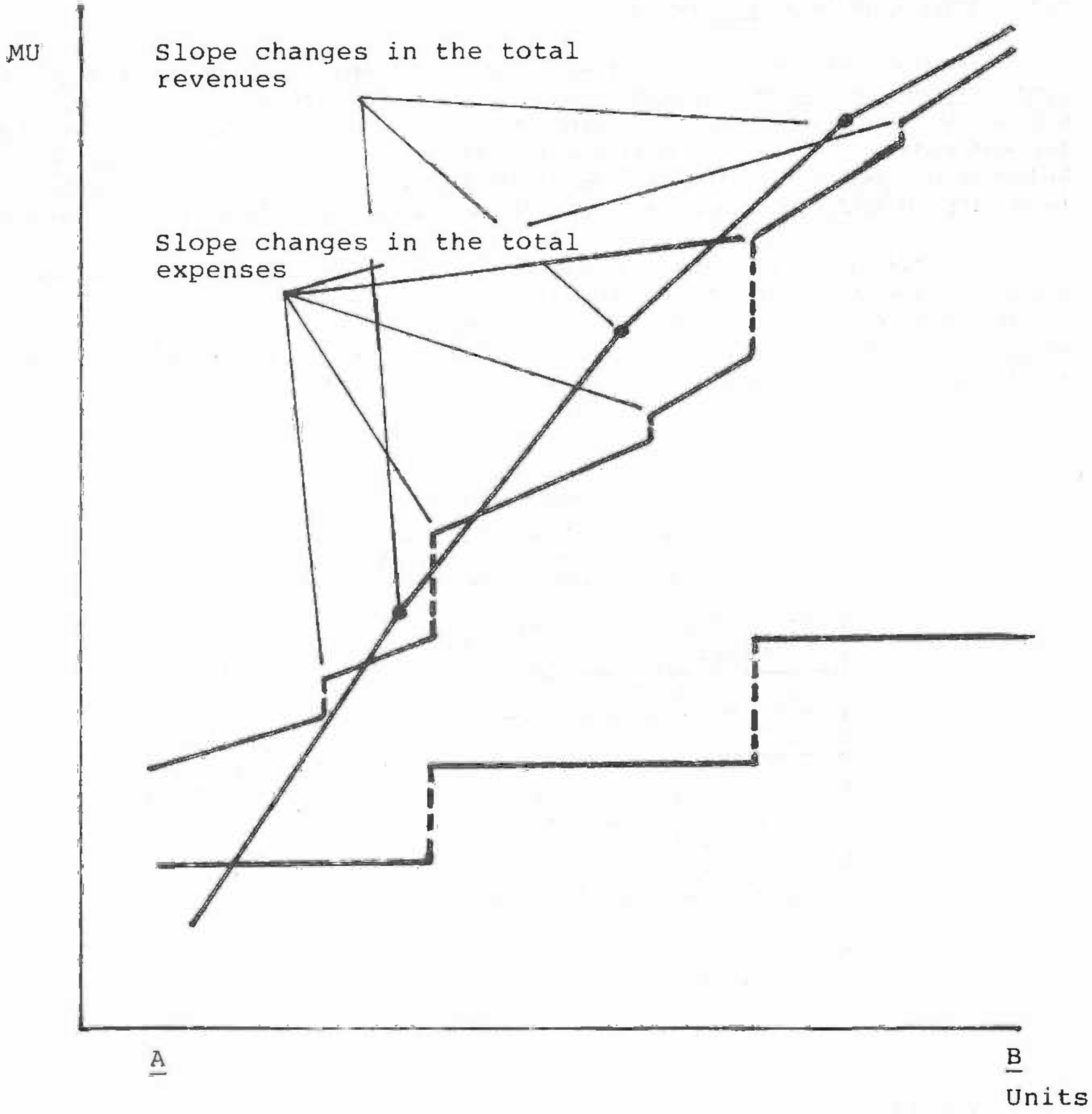


Exhibit 3.6 The business manager's breakeven chart

4. BUDGETING IN SAWMILLS

4.1 Budgets and budgetary control

There are many ways of classifying a budget. A budget can be defined as a quantified compilation of the company's planned actions for the budget period. For every budget period, there are usually a number of plans about what to produce in what quantities and for what markets, staff needed and with what qualifications. The overall aim of the budget is to quantify such plans, to compile all estimations made and to control the feasibility of different plans. The result of these activities will be a master budget.

A master budget will consist of a series of sub-budgets. A simple, annual budgeting system is shown in Exhibit 4.1. The starting point of the work is to forecast the demand for the year. Estimated sales figures will show how much the company needs to produce, which in its turn decides labour and staff needs. The compilation of sub-budgets into a master budget is a rather tedious co-ordination task.

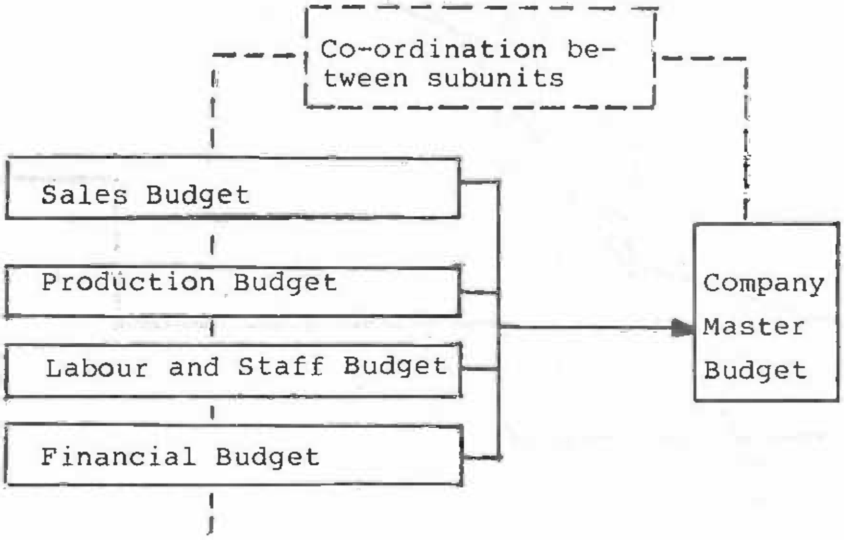


Exhibit 4.1 Example of a simple, annual budgetary system

The budget is an important tool in running the company. The following quotation summarizes some important aspects of budgeting.

> Budgets formulate expected performance; they express managerial targets. Without such targets, operations lack direction, problems are not foreseen, results lack meaning, and the implications for future policies are dwarfed by the pressure of the present. The planning role of all levels of management should be accentuated and enlarged by a budgetary system. Managers will be compelled to look ahead and will be ready for changing conditions. This forced planning is by far the greatest contribution of budgeting to management. (Horngren, Charles T., ed. Cost Accounting. A Managerial Emphasis, Prentice/Hall International editions, Englewood Cliffs, N.J., 1982).

4.2 Budgeting sales revenues

4.2.1 The overall problem

When budgeting sales revenues at least three aspects should be considered:

1. The price-setting system.
2. Market demand for various products.
3. Possible prices that can be achieved.

The price setting system can, roughly speaking, be of two kinds. Either the sawmill works in an environment where price setting is completely free or in some kind of price regulation system.

Prices should be set in such a way that the sawmill will maximize its profit. We no longer believe in finding an optimal price, but, of course, we should pay attention to revenues and expenses in a way that improves the situation. In trying to create as large a profit as possible, we should be aware of two common mistakes.

Firstly, sales volumes or sale revenues as yardsticks for performance cannot be substituted for profit measurements. A look at Exhibit 3.5 proves the statement. At BEV/U both sales volume and sales revenues are higher than at the optimum volume, but the company's profit is lower. True, we will never be able to plot down this curve for our sawmill, but the model still reflects reality.

Secondly, we must stop believing in cost calculations as price-setting tools. The customer does not ask for the supplier's costs. The one and only interest of the customer is how competitive the supplier's price is. All other things being equal, the customer, in choosing between products from different suppliers, buys the one that is cheapest! The view taken here is, therefore, that the aim of product calculations is not to get a basis for product pricing. Instead the reversed process should be emphasized; the primary task is to price the product and then study whether the product is profitable or not.

4.2.2 Forecasting procedures and techniques

If a manager is free to determine product prices, he must consider market prices as the starting point. The prices customers are willing to pay depend, inter alia, on such factors as:

1. The overall competitive situation in different markets.
2. The company's own offerings - quality and special features of its products, terms of delivery, terms of credit and so forth.
3. Price sensitivity of customers.

Judging these and similar factors is always important in pricing. Depending on prices chosen we will get different sales volumes and, thereby, variations in company costs. Our job is to try to find prices that will give an expected profit that is as high as possible. The interaction between prices - and their effects on sales volumes - and costs must be carefully analyzed.

When studying market demand we need a forecasting technique. One or more of the following techniques can then be used.

1. Sales staff judgements

   Using the knowledge of the company's own sales staff is perhaps the most common technique used in sales forecasting. Company salesmen are familiar with both customer wishes and the company's own product assortment.

2. Internal and/or external expert judgements

   This way of forecasting means using knowledge both inside and outside the company. Company executives outside the sales staff might have other views than the sales manager. It might also be valuable to get expert opinions from people in various trade and industry associations.

3. Statistical demand analysis

   Statistical approaches vary from relatively simple trend analyses to a variety of cause-effect studies. These techniques are usually part of the forecasting procedures of large companies.

4.3 The sales revenues of the sawmill

The produce of the sawmill can be studied in different ways. One is to consider, for each species, the output as one, single product - sawn timber - plus two by-products - chips or slabs and sawdust. Another way is to consider the output as an assortment of products. In that case, quality, dimensions, and lengths are put in to split up the assortment into a number of individual products. For a sawmill sawing 3 species of wood in 20 different dimensions, 15 various lengths, and 7 separable qualities, the total number of products will amount to 6 300. The addition of the two by-products does, in this case, not increase the complexity very much.

A look at how sawmills budget sales revenues and expenses indicates that the first method is the most frequently used. One often finds, especially for small sawmills, that one single average estimation is used for both revenues and expenses.

The opposite way, considering all possible products, is not feasible. Most often only a few combinations of dimension and quality, all having the same sales price per m^3 for all lengths are used. To budget sales revenues for all possible combinations would mean considerable extra work but with little or no information of value. At the same time, a simple, overall average figure does not suffice. Therefore, we have to find a compromise taking the following aspects into consideration:

1. The value of added information should exceed the extra cost of data collection.
2. The added information should be of practical use in directing sales efforts and/or production scheduling.

The need for separating various outputs from each other in the sales budget depends on many factors. Most probably, this need differs heavily from one sawmill to another. Small sawmills, perhaps with only local demand, may find that an average estimate of sales revenues per m^3 of sawn timber for all finished goods will suffice. Most often, however, the sawmill will benefit from a more detailed budgeting. Sales prices might vary between different markets, export prices might differ from domestic prices and so forth.

Before compiling the sales budget, we have to study the situation for the budget year. We must answer at least the following questions:

1. How will demand fluctuate during the budget year?
2. With what certainty can demand be predicted?
3. What are the expected prices for:
   a. Different dimensions for each species?
   b. Different qualities for each species?
   c. Different dimensions and qualities for various markets?
4. Does expected log supply meet demand fluctuations?
5. Does expected log supply fluctuate in such a way that the production might be jeopardized?

Before we look more closely into the sales budget, the treatment of the by-products must be commented on. Many sawmills take up sales revenues from their by-products on the budget's revenue side. Nevertheless, barks, chips, slabs, and sawdust are all genuine by-products, i.e. output from the sawing process that cannot be dealt with as separate products. It is not possible to trace all costs of handling these by-products. The handling cost will be part of the overall costs of the sawmill, and only a minor part of these costs can be indisputably traced to the by-products. In such a case the most logical treatment of their sales revenues is to deduct these revenues from the sawmill's expenses. This will be referred to in section 4.4.2.

Let us introduce our model company, which is a sawmill in a tropical country. The production equipment consists of two frame saws. The sawmill has at most produced some 11 200 m^3 (without overtime) during a year. The theoretical capacity of the frames is, according to the manufacturer, some 20 000 m^3. The company saws two species, which we will call Species A and Species B. We will use this sawmill as a model company throughout this paper with one exception only.

For the next year, management has estimated the demand for both species. The market is such that the management has decided to work with single average prices for each species. Management has arrived at the sales budget presented in Exhibit 4.2 For each species, yearly sales have been estimated (first row) to 6 000 m^3 of sawn timber for Species A and 4 000 m^3 for Species B. With an average price of MU 900 and MU 850 respectively for the two species, the company will have a total cash inflow over the year of MU 8 800 000 (5 400 000 + 3 400 000). The cash inflow is also shown month by month, which is important for the company's cash flow planning. As can be seen, the monthly demand fluctuates during the year with a minimum of 400 and 250 m^3 and a maximum of 600 and 400 for Species A and B respectively.

Forecasting sales for various months reduces the risk of not being able to meet demand. If demand is not met the sawmill loses, in principle, sales revenues minus the cost of raw material and some other minor costs. However, almost all othercosts will remain unchanged.

Month No. / Specification	1	2	3	4	5	6	7	8	9	10	11	12	Total 12 months
Species A													
Estimated demand in m3 of sawn timber	600	600	600	400	400	400	400	400	500	500	600	600	6 000
Average price per m3, MU	900	900	900	900	900	900	900	900	900	900	900	900	900
Cash inflow, MU 1 000	540.0	540.0	540.0	360.0	360.0	360.0	360.0	360.0	450.0	450.0	540.0	540.0	5 400
Species B													
Estimated demand in m3 of sawn timber	400	350	350	300	250	250	250	350	350	350	400	400	4 000
Average price per m3, MU	850	850	850	850	850	850	850	850	850	850	850	850	850
Cash inflow, MU 1 000	340.0	297.5	297.5	255.0	212.5	212.5	212.5	297.5	297.5	297.5	340.0	340.0	3 400
Total cash inflow, both species, MU 1 000	880.0	837.5	837.5	615.0	572.5	572.5	572.5	657.5	747.5	747.5	880.0	880.0	8 800

Exhibit 4.2 Sales budget

The sales budget is an important tool in planning the production over the year. It helps the manager in planning things like:

1. Raw material purchases over a period.
2. The size of buffer stocks.
3. The total production schedule taking into account the choice between overtime production and production for stock.
4. The suitable time for repair and maintenance.

The sales budget is a pre-requisite for the cash flow planning. This is especially important for sawmills, as raw material purchases and sales are often unevenly spread over the year.

Finally an annual budget subdivided into months is the manager's tool for control and correction purposes.

4.4 Budgeting short-term expenses

4.4.1 The sawmill's cost centres

In some aspects sawmilling is a fairly simple type of industry. In most manufacturing industries, production flow is divided into departments and sub-departments, and each unit is separately treated in both budgeting and calculating product costs. These separate estimations are then brought together into one overall cost estimation for each product.

The main purpose in this section is to improve the sawmill's budgeting and cost control. For this reason the sawmill's operations will be divided into three functions as described in Exhibit 4.3

Although a common way of sawmill budgeting is to use overall average figures (cost per m^3 of sawn timber), there are a number of reasons for acquiring more detailed information on what kinds of costs the sawmill has and where in production or distribution these costs accrue. Let us look at some of the more important rationales for budgeting and costing.

Studying cost influencing activities helps to discover sacrifices made in production and distribution. The most important sacrifice that is usually overlooked is the cost of storing.

A systematic analysis of where costs accrue is the only way to get a proper cost estimation for various outputs. The need for a systematic approach varies from one sawmill to another. A small sawmill producing only sawn timber has a quite different costing situation as compared to a large sawmill producing sawn timber, planed boards, and various kinds of wood products, perhaps for different markets.

Information is a pre-requisite for managerial control. If somebody is given a certain responsibility, he must also be equipped with proper tools for guidance and performance control. Take as an example costs for repair and maintenance. This can be treated as an overall cost for the whole sawmill. However, not budgeting costs of this kind for different parts of the sawmill means that the manager cannot control where costs accrue. With a proper budget each supervisor should know what is expected of him, how much he has consumed of his budget, and if and when it is time to point out that he can no longer keep costs within the budget. This in turn probably indicates that there is something wrong, thus giving the management the possibility to react in time.

	LOG HANDLING	SAWING PROCESS	STORING, SELLING & GENERAL ADMINISTRATION
Functional costs	Log & log handling costs	+ Processing costs	+ Selling & administration costs
	↓ =	↓ =	↓ =
Combined (accumulated) cost concepts	Log & log handling cost	Manufacturing costs	Full costs
Cost influencing activities	Log purchases Transportations Measuring Sorting Caretaking Storing Internal transports	Debarking Sawing Green trimming Drying Final trimming Work-in-process storing Internal transports	Finished goods storing Selling activities Shipments Overall administration

Exhibit 4.3 Cost concepts and the sawmill's cost influencing activities

4.4.2 Budgeting log costs - integrated company

In this section we will deal with budgeting costs of logs in a sawmill, and thereby we have to decide how to handle the by-products of the sawmill. We will discuss two different methods used in practice. To show why one method is superior to the other, we have to bring a planing mill into the picture. In this section we do not refer to our model company.

Budgeting log costs is a controversial issue. They can be estimated gross, i.e. as the actual cost paid for purchased logs. In this case revenues from by-products are put on the revenue side of the budget. The other way is to estimate log cost net, i.e. as the actual cost paid for logs less revenues from by-products. The following figures are all assumed estimates per m^3 of sawn timber. 1/

Specification	MU/m^3
Sawn timber, average sales price	1 000
Revenues from by-products	200
Log costs	500
Sum of all other costs except direct, traceable selling costs	400

The two types of cost calculations have been shown in Exhibit 4.4. However, the gross method shows total revenues of MU 1 200 while the net method gives MU 1 000. The same difference, MU 200, is also shown on the expenses side of the income statement. Both methods give the same profit per m^3 of sawn timber, i.e. MU 300.

Adding revenues from by-products on one side of the income statement (gross method) or deducting them from the other side (net method) might be viewed as a quarrel about nothing, but, in fact, the choice of method is a matter of avoiding pitfalls in estimating the result of various profit centres within the sawmill. Let us assume that there is also a planing mill within the company. For this profit centre, the following figures are assumed:

Specification	MU/m^3 of planed boards
Planed boards, average sales price	1 500
Revenues from by-products of the planing mill	50
Sum of all other costs accruing in the planing mill	550

If the sawmill and the planing mill are regarded as two different profit centres, we get various profits in these two centres depending on what cost estimating method is used.

1/ Direct, traceable selling costs/m^3 have been excluded for simplification purposes. They will be brought into the picture later on.

Specification	Figures in MU/m3 of sawn timber Gross method	Net method
+ Revenues, sawn timber	1 000	1 000
+ Revenues, by-products	200	0
= Total revenues	1 200	1 000
+ Actual log costs, gross	500	500
- Revenues from by-products		200
= Actual log costs, net		300
+ Sum of all other costs excl. of direct selling costs	400	400
= Total costs excl. of direct selling costs	900	700
Profit analysis		
+ Total revenues	1 200	1 000
- Total costs excl. of direct selling costs	900	700
= Net profit per m3 before deduction of selling costs	300	300

Exhibit 4.4 Comparison between the gross and the net method in estimating log costs per m^3 of sawn timber.

Let us assume the following production figures:

Specification	m^3
Sawmill production:	
Sales of sawn timber on the open market	7 000
Internal deliveries to the company's own planing mill	3 000
Planing mill production of planed boards	2 650

The planing mill's recovery is estimated to 85 percent of sawn timber inputs. Furthermore, we can assume that each m^3 of planed boards gives 1.8 m^3 of by-products (shavings).

Studying the results of the two profit centres, we get the figures given in Exhibit 4.5. Internal deliveries from the sawmill to the planing mill have been shown on the revenue side, estimated at manufacturing costs. The two methods give, of course, different results. The gross method shows revenues of MU 2 700 000, while the net method shows MU 2 100 000 for those 3 000 m^3 of sawn timber internally delivered to the planing mill. Total costs have been estimated according to the figures used in Exhibit 4.4. The gross method gives a profit for the sawmill that exceeds the net method profit by MU 600 000. This is due to the fact that the sawmill has been credited for all revenues from by-products.

Next part of Exhibit 4.5 shows the effects of the two methods on the results of the planing mill. Using the gross method, the planing mill will get a raw materials cost that is MU 600 000 higher than it gets with the net method.

But the sawmill and the planing mill are both sub-units in the same company and profit will be exactly the same with both methods. However, this profit, MU 2 752 000, will be differently distributed, depending on what method is chosen. To choose the net method is important in large companies with several units, such as a sawmill, a planing mill, a mill for door-frames, window-frames, etc., and, perhaps, an over-the-counter sales unit. In this case, it is important that the net method be adopted throughout the whole company, because management must know how much each unit contributes to the overall profit. Another reason is that the net method helps motivate the staff of different units. The gross method obviously gives an improper advantage to the sawmill unit as compared to those units that internally buy sawn timber. It is important to avoid the pitfall of closing down, e.g. a planing mill unit due to "incorrect loss estimate". In the latter case, the overall analysis would be extremely poor for such a decision.

Sometimes objections against the net method are put forward because the manufacturing costs are not used in the internal pricing of sawn timber. Opponents to the net methods like to point out that they use the opportunity cost in internal pricing, but their objection is as illogical as the gross method itself. To show this, we will estimate the opportunity cost of sawn timber for our company itself. To do this, we have to bring the sawmill's direct, traceable selling costs into the picture. If these costs amount to MU 40 per m^3 of sawn timber, we find the opportunity cost of sawn timber as:

+ Sales price of sawn timber	MU/m^3	1 000
- Direct, traceable selling costs	"	40
= Opportunity cost of sawn timber	"	960

The opportunity cost, MU 960 per m^3, measures what the sawmill unit will refrain from by delivering internally one m^3 of sawn timber (cf. Section 2.5). To evaluate "the sacrifice" made by the sawmill in this way is the only logical approach, if the following conditions prevail:

1. The market demand of sawn timber must be at least equal to the production capacity of the sawmill.

2. It must be possible for the planing mill to buy sawn timber from outside agents.

Specification *)	Gross method MU	Net method MU
Revenues from sawn timber:		
7 000 x 1 000 (open market sales)	7 000 000	7 000 000
3 000 x 900 (internal deliveries), gross method **)	2 700 000	
3 000 x 700 (internal deliveries), net method		2 100 000
Revenues from by-products:		
10 000 x 200	2 000 000	
Total revenues, sawmill	11 700 000	9 100 000
Total costs (cf Exhibit 4.4):		
10 000 x 900, gross method	9 000 000	
10 000 x 700, net method		7 000 000
Profit from sawmill	2 700 000	2 100 000
Revenues from planed boards:		
2 650 x 1 500***)	3 975 000	3 975 000
Revenues from by-products:		
4 700 x 50****)	235 000	235 000
Total revenues, planing mill	4 210 000	4 210 000
Total costs:		
Sawn timber at manufacturing costs		
3 000 x 900, gross method	2 700 000	
3 000 x 700, net method		2 100 000
Sum of all other costs:		
2 650 x 550	1 457 500	1 457 500
Profit from planing mill	52 500	652 500
Profit analysis, total company		
Profit from sawmill	2 700 000	2 100 000
Profit from planing mill	52 500	652 500
Overall company profit	2 752 500	2 752 500

*) No account has been taken to direct, traceable selling costs of the sawmill.

**) At manufacturing costs. Internal pricing will most probably be made with the opportunity cost concept. This does not alter the difference between the gross and net methods' effects.

***) One m3 of sawn timber has been assumed to give .85 m3 of planed boards at an average over all dimensions.

****) Assumed average figure for planing mill by-products. The size of this figure does not influence the analysis.

Exhibit 4.5 Comparison between the effects of gross and net methods in estimating the log costs - total for integrated company

Let us assume that these conditions have been fulfilled. The sawmill will then use the opportunity cost as a basis for its internal pricing. Substituting MU 900 and MU 700 (revenues from the sawmill's internal deliveries and the raw materials cost of the planing mill) respecively with MU 960 gives the profit figures for the two units as shown in Exhibit 4.6.

Specification		Total estimates in MU (equal for both methods)
Revenues from sawn timber:		
7 000 x 1 000 (open market sales)		7 000 000
3 000 x 960 (internal deliveries)		2 880 000
Total revenues, sawmill		9 880 000
Total costs (net method used):		
7 000 x 740*)		5 180 000
3 000 x 700*)		2 100 000
Profit from sawmill		2 600 000
Revenues from planed boards:		
2 650 x 1 500		3 975 000
Total costs:		
Sawn timber, gross,**) 3 000 x 960	2 880 000	
Revenues from by-products, 4 700 x 50	- 235 000	
Sawn timber, net	2 645 000	2 645 000
Sum of all other costs:		
2 650 x 550		1 457 500
Loss from planing mill		- 127 500
Profit analysis, total company		
Profit from sawmill		2 600 000
Loss from planing mill		- 127 500
Overall company profit		2 472 500

*) Total cost in MU/m3 has been increased by MU 40/m3 as direct, traceable selling costs have been added to the previous cost used in Exhibits 4.4 and 4.5. For internal deliveries the costs remain at the level MU 700/m3.

**) In this Exhibit the net method has been used for also the planing mill, i.e. revenues from by-products have been deducted from costs of sawn timber, gross.

Exhibit 4.6 Profit analysis for the integrated company when the opportunity cost concept is used for internal pricing purposes.

As we are now using the opportunity cost concept in estimating the internal price of sawn timber, there will be no difference between the gross and the net methods. However the opportunity cost shows that the planing mill is no longer profitable. If, on the other hand, we measure from the sawmill's point of view how profitable the planing mill is as a customer as compared to open market customers, the two methods give different results as is shown in Exhibit 4.7. We find that the gross method gives different results per m^3 for open market customers and for deliveries to the planing mill. Based on this, the management could arrive at an incorrect and economically devastating decision to close down its own planing mill.

Choosing the net method, we find a different pattern. Both types of customers are equally profitable, based on "the-profit-per-m^3-of-sawntimber-figure", i.e. both customer groups give a profit of MU 260 per m^3. This effect is important. All "customers" - external or internal - should be judged in relation to their actual contribution to profit. Using the net method eliminates the risk of mis-judging the "internal customers". This is also obvious if we compare the overall profit of Exhibits 4.5 and 4.6. True, there is a difference in the two profit figures, but this difference is due to the traceable selling costs. These are not included in Exhibit 4.5. A quick analysis gives the following result:

+ Overall company profit, Exhibit 4.5	MU	2 752 500
- Traceable selling costs, 40 x 7 000	"	280 000
= Overall company profit, Exhibit 4.6	"	2 472 500

Specification	Figures in MU/m3			
	Gross method		Net method	
	Open market customers	Planing mill	Open market customers	Planing mill
Sawn timber revenues	1 000	960	1 000	960
Revenues, by-products	200	0	0	0
Total revenues	1 200	960	1 000	960
Actual log costs, gross	500	500	500	500
Less by-product revenues			-200	-200
Selling costs	40		40	
Sum of all other costs	400	400	400	400
Total costs	940	900	740	700
Profit analysis				
+ Total revenues	1 200	960	1 000	960
- Total costs	940	900	740	700
= Profit/m3, sawn timber	260	60	260	260

Exhibit 4.7 Comparison between the effects of the gross and the net methods in estimating profitability per customer group.

4.4.3 Budgeting total expenses of the sawmill

Let us now return to our "model company". With the sales budget as a starting point, our next task is to budget the company's total expenses for the budget year. This means to analyse costs of both logs and log handling as well as costs accruing from sawing and storing, selling and general administration (cf. Exhibit 4.3).

We have, in the sales budget, assumed an overall sales figure of 10 000 m^3. Out of this, 6 000 m^3 have been forecast for Species A and 4 000 m^3 for Species B. In order to estimate the corresponding expenses, we have to differ between various costs. These costs can be separated in four main groups:

1. Variable costs that can be estimated per unit of production, for example log costs.
2. Costs that are variable but difficult or impossible to estimate per unit of production. Among these costs we can find consumable items such as saw blades, conveyor belts and the like. We estimate these costs based on experience.
3. Fixed costs of the sawmill giving rise to actual payments during the year. These may take on different values for different output levels, as many of them are of a step-fixed nature. But if we assume that the overall output is roughly the same from one year to another (cf. the relevant range concept in Section 2.2), also the expenses will remain fairly unchanged. Due regard must be paid, though, to price changes. Among these cost items we find e.g. labour costs (fixed within the relevant range, otherwise step-fixed) and various administration costs (fixed over a series of ranges, or, more correctly, having a wider relevant range than e.g. labour costs).
4. Finally, various kinds of capital costs, for example, the costs of depreciation.

As we now proceed into the actual budget construction, a few things should be kept in mind. Firstly, the most important part of budgeting is to identify all sacrifices made to produce and sell the desired output. Secondly, it is important to analyse how a certain cost changes in different situations. Thirdly, cost estimates are difficult to make, and the responsible manager must, therefore, be careful in his choice of figures to be put into the budget. He must analyse the effects of possible deviations from his budget. This means he has to carry out proper sensitivity analyses.

Some of the problems mentioned here will be taken up in this chapter. Others will be postponed until Chapter 5, which, among other things, brings the sensitivity analysis into the picture.

An example of a sawmill budget, showing the total cost of the company, has been given in Exhibit 4.10. In this example, emphasis has been put on what cost items to bring into the analysis. Each cost in the budget has been given an identification code (Item No.) and will be commented on in the text. Before we look into the overall budget, we find two more Exhibits, 4.8 and 4.9, treating two important parts of the budget. In commenting on the overall budget references will be made to all three Exhibits.

Item No. (Exhibit 4.10) — Comments

100 Raw material (log) costs. This is the sawmill's cost of what in other industries is usually called direct material. It includes cost items 101 – 106.

101 a,b Logs at buying costs for species A and B respectively. Log costs have been assumed to MU 250 and MU 225 for Species A and B respectively. Sawn timber recovery has been set at 50% for both species, which gives log costs of MU 500 and MU 450 for A and B measured per m^3 of sawn timber. All costs are shown both in total and per m^3. Log cost per m^3 will be known to the sawmill manager. In budgeting his log costs a weighted average of volumes and prices could be used.

102 Transportation costs paid by the sawmill have been estimated to MU 222 000 for the whole year.

The total cost divided by the total number of m^3:s bought gives a per unit cost (MU 22). This is multiplied with the forecast production volume for each species in order to get a figure in the species' total columns.

103 a,b Inventory costs are often overlooked in budgeting. The cost of tying up capital must be estimated, and this estimate will be made with the opportunity cost of capital. In other words, the amount which the sawmill will lose, because its money is tied up in a certain type of inventory.

In order to budget the cost of log inventory, it is necessary to estimate how it changes over the budget period. This has been done in Exhibit 4.8. The first row shows the starting inventory for each month. The 13th month is the first month of the next year. The second row shows estimated production per month. (Vacation periods during months 6 and 7). Row 3 shows forecast deliveries of logs. In this example two periods – months 4 through 6 and month 11 – deliveries have been put at zero, e.g. due to blocked roads.

The commencement point for analysing the figures in Exibit 4.8 is the starting inventory for Month No. 1, estimated production figures, and forecast log deliveries. The beginning inventory for Month No. 2 is estimated as:

$$4\ 040 - 1\ 080 + 1\ 320 = 4\ 280$$

The important figure to obtain is the average log inventory during the year. This is estimated as the sum of all 13 inventories (38 120 m^3) divided by 13, which gives an average inventory of 2 930 m^3. This means a capital tied up in log inventory of MU

$$2\ 930 \times 250 = 732\ 500$$

Month No. / Specification	1	2	3	4	5	6	7	8	9	10	11	12	13	Total
Species A														
Beginning inventory	4 040	4 280	4 160	3 880	2 800	1 720	1 120	1 320	1 440	4 360	3 880	2 800	2 320	38 120
Production	1 080	1 080	1 080	1 080	1 080	600	600	1 080	1 080	1 080	1 080	1 080	–	–
Log deliveries	1 320	960	800	0	0	0	800	1 200	4 000	600	0	600	–	–

Average log inventory = Sum of beginning inventories over 13 months divided by 13 = 38 120/13 = 2 930 m3.

Month No. / Specification	1	2	3	4	5	6	7	8	9	10	11	12	13	Total
Species B														
Beginning inventory	2 360	2 520	2 440	2 120	1 400	680	280	200	280	2 360	2 040	1 320	1 000	19 000
Production	720	720	720	720	720	400	400	720	720	720	720	720	–	–
Log deliveries	880	640	400	0	0	0	320	800	2 800	400	0	400	–	–

Average log inventory = Sum of beginning inventories over 13 months divided by 13 = 19 000/13 = 1 460 m3.

Costs of capital tied up at 10 per cent interest: 2 930x250x0.1 = 73 250 or MU 12.20 per m3 of sawn timber, Species A.

Costs of capital tied up at 10 per cent interest: 1 460x225x0.1 = 32 850 or MU 8.20 per m3 of sawn timber, Species B.

Exhibit 4.8. Estimates of capital costs for log inventory of Species A and B, opportunity cost at 10 percent interest.

Item No. (Exhibit 4.10) Comments

103 a,b cont. It has, throughout this example, been assumed that the sawmill's cost of capital is 10 percent p.a. This gives a capital cost of MU

$$732\ 500 \times 0.1 = 73\ 250$$

which shows up in the budget as MU 73 000 (cf. Exhibit 4.10). This in turn gives a cost of MU 12.20 per m^3 of sawn timber.

The lower part of Exhibit 4.8 shows the same estimations for Species B. Here we arrive at a capital tied up of MU 328 500, a capital cost of MU 32 850. The cost per m^3 of sawn timber amounts to MU 8.20.

104 The sum of the costs so far gives the gross log cost. This sum shows what the sawmill actually has to pay to buy and store its logs during the year.

105 The next procedure is to deduct estimated revenues from by-products in order to arrive at the net cost of logs. Estimating this figure is always based on experience.

We must know the quantity of chips, slabs, sawdust and bark that we obtain for each m^3 of timber sawn. With these figures and their prices we can estimate the total revenue from by-products. These have been estimated to MU 212 000 for a production of 10 000 m^3 of sawn timber. It has been assumed that all by-products, regardless of species, are equally valuable.

In case there is no market for by-products, we put either a zero on line 105 or a positive amount, i.e. a cost of disposing the by-products.

106 Summing up the figures so far presented gives log cost net. This is the value of the raw material, when the log enters the debarking process.

107 Log handling costs. These costs are indirect, showing up as the same per unit cost for both species.

108 Labour costs can quite easily be estimated from the company's payroll. Account must be made for staff insurances, pension costs, etc. and estimated wage increases. However there is often no need (in a sawmill) to allocate labour costs on various parts of production. The reason for this is that the sawmill can be looked upon as a process industry. No worker can be eliminated without disturbing the whole production system (cf. Example 21 and its solution in Section 2.7). For cost control reasons, though, labour costs have been split on all three cost-centres. This offers the possibility of keeping control of the amount of such labour input as overtime and shift work.

109-111 Costs of watering repair and maintenance, fuel and miscellaneous consumption have been put in as examples of cost items that might show up in this part of the budget. Watering is definitely part of the log handling. Other costs, such as fuel consumption, do not necessarily have to be brought into this part of the budget. Fuel expenses for a forklift truck, used over the whole sawmill, can also be taken up elsewhere. However, if the truck is only used in log handling, its fuel expenses should be allocated to the log handling cost centre.

112 Costs of depreciation are often treated as a lump sum at the end of the budget. But if machines and buildings can be traced to a certain cost centre, this should be done also in the budget. There are at least two reasons for this.

If logs for some reasons are sold, without being sawn, it is suitable to know the actual handling cost.

Another reason is that depreciation rates may vary for machines/buildings used in different parts of the sawmill. Putting all depreciations in one lump sum increases the risk of poor analyses of actual costs.

113 Adding cost items 101-112 gives the full cost of logs and log handling.

200 Sawing costs show all costs from the start of production - in most cases the debarking station - up to the point where sawn timber is stored.

201 Labour costs include all operators from debarking to trimming. Repairmen, drivers, etc. can be included in the overall costs for repair and maintenance. It has been assumed that the kiln drying capacity suffices for only Species A. Species B, though, is assumed to be naturally dried.

The kiln is operated by one man, and out of his time only 20 percent is estimated for running the kiln. During the remaining 80 percent he is occupied in the sawmill. Therefore, the labour cost for this operator, totalling MU 40 000 p.a., has been distributed accordingly:

Work	A	B
Kiln operation:		
0.2 x 40 000 =	8 000	-
Sawing:		
0.8 x 0.6 x 40 000	19 200	
0.8 x 0.4 x 40 000		12 800
Eleven remaining workers:		
11 x 40 000 x 0.6	264 000	
11 x 40 000 x 0.4		176 000
	291 200	188 800

202 Repair and maintenance costs include labour costs for repairmen and costs of spare parts, etc. The major part of repair and maintenance expenses will most probably be traceable to the sawing process. Allocation of these expenses should be based on capacity demand from various parts of the mill.

203 Heating costs, mainly for artificial drying, might be difficult to estimate. If the sawmill buys the needed energy from outside suppliers, there are no problems in cost estimating.

But if the sawmill uses its own by-products, e.g. bark, slabs or sawdust, then cost estimates must be made on the basis of the opportunity cost concept. In other words, the cost of heating must be estimated as the foregone opportunity of not selling the by-products. If, on the other hand, there is no market for by-products, there will be no cost involved

203 cont. for using these by-products in heating the kiln. (There might be other costs, of course!). Finally, if there is a cost of disposing the sawmill's by-products, these disposal costs will show up as a cost reduction for heating the kiln, when by-products are used. The main thing is that the overall budget will be balanced, i.e. not influenced by the revenues of the by-products whether these are positive, zero, or negative. The following matrix shows what happens.

Revenues, by-products	Log costs	Heating costs	Total cost balance
Positive	Decrease	Increase	Zero
Zero	Unchanged	Unchanged	Zero
Negative	Increase	Decrease	Zero

204 Costs of consumption articles are fairly easy to estimate. A source of information will be the costs of previous consumptions adjusted for price changes.

205 Cf. comments on Item No. 111.

206 a,b As species A and B are differently dried, we also get different work-in-process inventory costs. The production of 6 000 m^3 of Species A means an average production of 6 000/50 = 120 m^3 of sawn timber per week. If we consider the drying process to take, as an average, seven days, it means that we always have a process inventory of 120 m^3 measured as sawn timber. In order to get a continuous flow of production, a buffer stock of 80 m^3 of sawn timber has been assumed necessary. For Species A we then get:

Work-in-process, flow inventory	120 m^3
Work-in-process, buffer inventory	80 "
Work-in-process, total	200 "
Capital tied up, 200 x 536	MU 107 200
Capital cost, total	MU 10 720
Capital cost per m^3 of sawn timber	MU 1.80

In estimating the capital tied up we have here used the log and log handling costs (Item No. 113 in Exhibit 4.10).

For Species B the situation is slightly different. As this species is open air dried, no buffer stock is required. Average drying time has been set at 18 weeks. With a production of 4 000/50 = 80 m^3 of sawn timber per week, an inventory of 80 x 18 = 1 440 m^3 must be built up, before it is possible to take anything out as finished goods. Obviously, the inventory will vary during the year, but an average of 1 440 m^3 is good enough for estimating capital costs.

Work-in-process inventory	1 440 m^3
Capital tied up, 1 440 x 482	MU 694 080
Capital cost, total	MU 69 408
Capital cost per m^3 of sawn timber	MU 17.35

207 Cf. comments on Item No. 112.

208 Adding together cost items 101-207 gives the total manufacturing costs on a full cost basis.

300 In the last function, storing finished goods, selling, and general administration are brought into the budget to give the sawmill's overall costs.

301 Labour costs for one storekeeper. Cf. comments on Item Nos. 108 and 201.

302 Cash discounts might vary from nothing up to perhaps 5 percent of the sales price. In this budget cash discounts have been assumed to be 2 percent of the sales price. This means, for Species A, 0.02 x 900 = MU 18 per m^3 and for Species B, 0.02 x 850 = MU 17 per m^3.

303 A sales commission of 3 percent of the sales price has been assumed. This gives MU 27 and MU 25.50 for Species A and B respectively.

304 Travelling costs always accrue in connection with sales. A probable source of information is last year's costs, duly adjusted for price increases.

305 Sawmills usually have a very small sales staff; in our case one sales manager, as it has been assumed that the company also sells through outside agents. The sales manager's salary on a yearly basis has been estimated at MU 105 000, all costs included.

306 Estimates of finished goods inventory costs are made in Exhibit 4.9. The first row shows beginning inventory each month. The second row gives production figures of sawn timber in m^3. Since the recovery is 50 percent, they are half the size of the corresponding production figures in Exhibit 4.8. Finally, the third row gives estimated monthly sales. Beginning inventories are estimated in the same way as in Exhibit 4.8. For the second month, e.g., we find the beginning inventory as:

$$1\ 700 + 540 - 600 = 1\ 640$$

Estimates of average inventory capital tied up, and capital cost follow the same pattern as for Exhibit 4.8 (cf. Item No. 103).

307 Cf. comments on Item No. 112.

308 Our company has one general manager at a yearly cost of MU 127 000, all costs included.

309 One office clerk has been assumed for the sawmill. Total cost: MU 62 000 per year.

310 Miscellaneous office expenses can rather easily be estimated from last year's accounts.

311 Adding together all cost items gives the total cost for the company as a whole as well as for different species.

Month No. / Specification	1	2	3	4	5	6	7	8	9	10	11	12	13	Total
Species A														
Beginning inventory	1 700	1 640	1 580	1 520	1 660	1 800	1 700	1 600	1 740	1 780	1 820	1 760	1 700	22 000
Production, m3 of sawn timber	540	540	540	540	540	300	300	540	540	540	540	540	-	6 000
Demand, m3 of sawn timber	600	600	600	400	400	400	400	400	500	500	600	600	-	6 000

Average, finished goods inventory = Sum of beginning inventories over 13 months divided by 13 = 22 000/13 = 1 692 or approximately 1 700 m3 of sawn timber.

Month No. / Specification	1	2	3	4	5	6	7	8	9	10	11	12	13	Total
Species B														
Beginning inventory	1 100	1 060	1 070	1 080	1 140	1 250	1 200	1 150	1 160	1 170	1 180	1 140	1 100	14 800
Production, m3 of sawn timber	360	360	360	360	360	200	200	360	360	360	360	360	-	4 000
Demand, m3 of sawn timber	400	350	350	300	250	250	250	350	350	350	400	400	-	4 000

Average, finished goods inventory = Sum of beginning inventories over 13 months divided by 13 = 14 800/13 = 1 138 or approximately 1 140 m3 of sawn timber.

Cost of capital tied up at 10 per cent interest: 1 700x679.70x0.1 = 115 549 or MU 19.25 per m3 of sawn timber, Species A.

Cost of capital tied up at 10 per cent interest: 1 140x624.30x0.1 = 71 170 or MU 17.80 per m3 of sawn timber, Species B.

Exhibit 4.9 Estimates of capital costs for finished goods inventory of Species A and B; opportunity cost at 10 percent interest.

4.4.4 Profit according to budget

Let us now put together the sawmill's sales budget, which we find in Exhibit 4.2, with the budget expenses according to Exhibit 4.10. The resulting analysis is shown in Exhibit 4.11.

The first two rows are taken from the sales budget and they show total revenues as previously estimated. On Row 3 we find the total sales revenues, MU 8 800 000 for the budget year.

Total expenses are shown on Rows 4-6. The average expense of MU 792.75 and MU 733.40 for Species A and B respectively are extracted from Exhibit 4.10. Multiplying them for the forecast sales volumes of 6 000 and 4 000 m^3 respectively gives total expenses of MU 7 960 100 (figures being rounded off).

To arrive at company profit, subtract Row 6 from Row 3. We find that the two species contribute MU 643 500 and MU 465 500 to the overall company profit of MU 1 109 000. The last row of Exhibit 4.11, profit per m^3 of sawn timber, is obtained by dividing the profit figures of Row 7 by the sales volumes, i.e. 6 000, 4 000 and 10 000 m^3 respectively.

Being presented with the overall budget figures, we can state that the company as a whole, as well as each of the two species, will give a profit for the budget year. But how much can we rely on these figures? After all, they are but estimates based on assumptions, information about price changes that might occur, approximations, and perhaps even guesses. No budget figure shows what will actually happen. Instead, budgets show what will happen, given that all forecasts, assumptions, etc. underlying the budget will occur during the budget year.

In other words, the budget is a conditional tool and should be used accordingly. This means that we have to prepare for possible deviations in our forecasts and assumptions. This means in turn that we have to carry out various kinds of sensitivity analyses in order to use the budget efficiently. For this purpose, we turn to Chapter 5, in which this concept is treated.

Item No.	Specification	Total both species, MU 1 000	Species A, total, MU 1 000	Species B, total, MU 1 000	Species A, per m³ of sawn timber, MU	Species B, per m³ of sawn timber, MU
100	Log costs					
101a	+ Logs at buying cost, Species A	3 000	3 000	-	500.00	-
101b	+ Logs at buying cost, Species B	1 800	-	1 800	-	450.00
102	+ Transportation	222	132	90	22.00	22.00
103a	+ Log inventory costs for Species A	73	73	-	12.20	-
103b	+ Log inventory costs for Species B	33	-	33	-	8.20
104	= Log costs, both species, gross	5 128	3 205	1 923	534.20	480.20
105	- By-product revenues	212	127	85	21.20	21.20
106	= Log costs, both species, net	4 916	3 078	1 838	513.00	459.00
107	Log handling costs					
108	+ Labour costs	40	24	16	4.00	4.00
109	+ Watering	25	15	10	2.50	2.50
110	+ Repair & maintenance	45	27	18	4.50	4.50
111	+ Fuel & miscellaneous	30	18	12	3.00	3.00
112	+ Depreciations	90	54	36	9.00	9.00
113	= Log & log handling costs	5 146	3 216	1 930	536.00	482.00
200	Sawing					
201	+ Labour costs	480	291	189	48.50	47.25
202	+ Repair & maintenance	82	49	33	8.20	8.20
203	+ Heating costs	94	94	-	15.70	-
204	+ Consumption material	123	74	49	12.30	12.30
205	+ Fuel etc.	72	43	29	7.20	7.20
206a	+ Work-in-process inventory, Species A	11	11	-	1.80	-
206b	+ Work-in-process inventory, Species B	69	-	69	-	17.35
207	+ Depreciations	500	300	200	50.00	50.00
208	Manufacturing costs	6 577	4 078	2 499	679.70	624.30
300	Storing, selling, & general administration					
301	+ Labour costs	40	24	16	4.00	4.00
302	+ Cash discounts	176	108	68	18.00	17.00
303	+ Sales commission	270	162	108	27.00	25.50
304	+ Travelling	34	20	14	3.40	3.40
305	+ Salary, sales manager	105	63	42	10.50	10.50
306	+ Finished goods inventory costs	186	115	71	19.25	17.80
307	+ Depreciations	72	43	29	7.20	7.20
308	+ Salary, general manager	127	76	51	12.70	12.70
309	+ Salary, office clerk	62	37	25	6.20	6.20
310	+ Office, miscellaneous	48	29	19	4.80	4.80
311	= Full cost of sawn timber	7 697	4 755	2 942	792.75	733.40

Exhibit 4.10 Compilation of the sawmill's overall budget at full cost

Specification	Prices/ Costs in MU per m^3	Total in MU for:		Total in MU for the whole company in MU
		Species A in MU per m^3	Species B in MU per m^3	
1. Sales revenues/Species A, 6 000 m^3	900.00	5 400 000	–	5 400 000
2. Sales revenues/Species B, 4 000 m^3	850.00	–	3 400 000	3 400 000
3. Total revenues	–	5 400 000	3 400 000	8 800 000
4. Expenses/Species A, 6 000 m^3	792.75	4 756 500	–	4 756 500
5. Expenses/Species B, 4 000 m^3	733.40	–	2 933 600	2 933 600
6. Total expenses	–	4 756 500	2 933 600	7 690 100
7. Total profit (Row 3-Row 6)	–	643 500	466 400	1 109 900
8. Profit per m^3 of sawn sawn timber		107.25	116.60	110.99

Exhibit 4.11 Profit according to budgets – total and per m^3 of sawn timber

5. USING THE BUDGET IN SENSITIVITY ANALYSES

5.1 Sensitivity analysis

All managerial decisions can be divided into three different sub-groups:

1. Decision-making under risk.
2. Decision-making under certainty.
3. Decision-making under uncertainty.

Under the first group we find decisions, for which the outcome is known with a certain probability. In managerial decision-making it is however unusual that the manager of a company knows the probability of occurrence of an event.

Decision-making under certainty means being absolutely sure about the outcome of the decision. If a customer offers a price of MU 860 per m^3 and wants to buy 200 m^3, we will know for sure what economic effects will follow this decision. With knowledge of the cost situation, we can estimate "how profitable" the offer is. Although it looks like a decision under certainty, it is not. We must, e.g., ask ourselves what long-term effects the price will have, if it is lower than the company's ordinary price.

The majority of decisions, however, belongs to the third group - decision-making under uncertainty. This is difficult because there are such a huge number of possible outcomes and so many variables that it is quite impossible to make a quantitative analysis of them all. It is in this context that the sensitivity analysis becomes a means in helping us to improve our judgements.

It is fairly easy to calculate the cost of a product, to construct an overall budget (as was made in Chapter 4), or to carry out an investment analysis. It is more difficult to interpret the result of the initial work. It is often rather uninteresting to know what the product cost is or how profitable an investment might be. Instead, we want to know what will happen, if one or more variables take on other values than those we have put in. In carrying out a sensitivity analysis, we start varying one or more variables, in order to find boundaries within which we have good reasons to believe that the future outcome might fall. Even if this also is some kind of guesswork, we have at least a more enlightening picture of what might happen.

In trying to find the boundaries we look for, we might vary one variable at a time, or we might vary combinations of variables. We then try to identify key variables that we know will have a decisive influence on the outcome. Among key variables product prices and sales volumes always occur. In specific cases, though, other variables might also have a status of a key variable. In sawmill costing the sawn timber recovery might be such a key variable.

5.2 Breakeven volumes

In discussing the short-term profit planning in Chapter 3, the breakeven-volume-concept was introduced. It was defined as the lowest volume needed to cover the company's overall expenses. In other words, we have to find a volume that equates total revenues of the sawmill with its total expenses. Trying to find this volume for our model company, we run into difficulties. First of all, the company has two different products, Species A and B, which means that we will get a mixture of revenues and expenses for two different products. Secondly, the overall budget (Exhibit 4.10) has been built up in such a way that we cannot take expenses estimates out of the budget and put these expenses into the formulas for breakeven calculations. Before we do so, we must split our expenses into variable and fixed costs. To get a still better picture of the sawmill's profitability under different circumstances, we might have to study expenses in terms of traceable and common costs (cf. Section 2.3). But let us start with the overall picture.

In Section 3.2 we defined the breakeven volume in the following way:

$$(\text{Price/unit}) \cdot X = (\text{VC/unit}) \cdot X + FC$$

where X = breakeven volume
VC = variable costs and
FC = fixed costs

Our first task is to find a "price per unit" concept for our product mix. Let us assume that the relation between the species' sales volumes, 60 percent for Species A and 40 percent for Species B, will remain the same, even if changes occur in the forecast sales volumes. We can then use an average price for the product mix of MU 880 per m^3.

$$\text{Average price } (A, B) = 900 \times 0.6 + 850 \times 0.4 = \text{MU } 880 \text{ per } m^3$$

To solve our next problem, dividing the company's costs into variable and fixed costs, we make use of our budget in Exhibit 4.10. In the present analysis it is quite impossible to decide precisely - in advance - how the sawmill's cost structure will change with volumes. Therefore, we focus our interest towards those costs that are indisputably traceable to volume changes, i.e. traceable costs.

In Exhibit 5.1 the cost structure has been shown. Costs have been identified with the same item Nos., as we used in the overall budget in Chapter 4 (Cf. Exhibit 4.10). As can be seen from Exhibit 5.1, all costs up to Item No. 106 have been considered traceable; i.e., in case the sawmill's production is zero, these costs will not accrue. Also various inventory costs have been considered traceable, as large volume reductions should be followed by a cut down in the sawmill's inventory.

Let us look at some of the costs in the "common costs column". Labour costs, e.g., will,within reasonable volume changes,remain unchanged. (As long as workers are paid by the week or the month). The same statement can be made about staff salaries and depreciations. But how about such expenses like fuel and electricity? Will they not decrease? The answer is that there will most probably be a change, but it is very difficult to estimate. E.g., take fuel expenses. True, a lower volume means less transportation work, but the reduction in this work can be made in two ways. The number of actual transports, e.g. from the saw to the kiln, might decrease. But, as a lower volume will be transported, it is also possible that the actual load is decreased each time the fork lift truck transports the goods. The same type of argument can be used to defend electricity expenses as more or less fixed. Both the saw and the trimmer will work all day long but at a lower pace. The kiln is heated but perhaps without being fully loaded.

Let us assume that those costs we call traceable will vary with the production and sales volume and those called common costs will remain unchanged. Let us term them variable and fixed costs and estimate the contribution margin. This margin is defined as the difference between the sales price and those variable costs that are relevant for a certain decision. This margin will contribute in covering the company's common costs and in creating profit. We will here use the expression contribution to profit, CTP.

Item No	Traceable costs in MU: Species A *)	Species B *)	Common costs in MU 1,000 **)
106	513.00	459.00	
107 - 112			230
201 - 203			656
204 - 205	19.20	19.20	
206	1.80	17.25	
207			500
301			40
302 - 303	45.00	42.50	
304 - 305			139
306	19.25	17.80	
307 - 310			309
Total	598.25	555.85	1 874

*) Costs for which traceability has been assumed to be roughly proportional to larger volume changes over the budget year.

**) Costs that have been assumed constant even for rather large changes in volume. Some of these costs will change only after a decision to cut down (temporarily) the production time has been taken.

Exhibit 5.1. Analysis of the traceability of various costs in the budget

If we assume that also the traceable costs of Exhibit 5.1 change proportionately to the product mix, we get the following CTP estimate:

$$\text{CTP} = 880 - (598.25 \text{ x } 0.6 + 555.85 \text{ x } 0.4) = \text{MU } 298.71$$

We can safely round off this figure to CTP = MU 300. To check the correctness of this figure, we can estimate the overall profit of the sawmill at 10 000 m^3 as:

$$\text{Profit } (10\ 000 \text{ m}^3) = 10\ 000 \text{ x } 298.71 - 1\ 874\ 000$$

which gives a profit of MU 1 113 100. This is close enough to the figure given in Exhibit 4.11.

Let us now use the value of CTP = MU 300 to estimate the breakeven volume, but let us also put in possible changes in CTP per m^3 of sawn timber. Such changes can occur because of price and/or cost changes. In Exhibit 5.2 breakeven volumes have been shown based on the assumption of price decreases of five percent in each step. The breakeven volumes ($BEV_{i\%}$) have been estimated in the following way, where "0%" indicates the budget price for our product mix.

$$300 \cdot BEV_{0\%} = 1\ 874\ 000$$

which gives $BEV_{0\%}$ = 6 247 m^3 of sawn timber. The remaining breakeven volumes have been calculated in the same way.

Price change %	Actual price in MU	CTP reduction in MU	$CTP_{i\%}$ per m^3	$BEV_{i\%}$ in m^3
0	880	0	300	6 247
- 5	836	44	256	7 320
-10	792	88	212	8 840
-15	748	132	168	11 155

Exhibit 5.2 Changes in breakeven volumes as a function of price changes

The overall picture looks, at first glance, very good. There is a budget profit of slightly more than MU 1 100 000 and a breakeven volume of 6 247 m^3. This means a safety margin, i.e. difference between budget volume and breakeven volume, of roughly 3 750 m^3. Let us now see under what circumstances these estimations are valid.

First of all, we have used the sawmill's full cost. This means that breakeven volume, as long as the cost structure does not change, is valid in the long-term perspective. In other words, if both revenues and expenses repeated year after year, we would get the profit estimated for this budget year, given an average production and sales volume of 10 000 m^3. In this perspective the profit does not impress too much. If the budget year is an unusually good year, the expected profit also has, in part, to cover the overall, fixed costs of less-profitable years. What kind of a year is the budget year - a "good one", "a normal year", or "a bad one" ?

Secondly, looking into Exhibit 5.2, we find that price decreases rather quickly turn the sawmill into less impressing profitability. As "price changes" in Exhibit 5.2 is a combination of both price and cost changes, we realize that a negative change of 15 percent is not an unrealistic figure. In other words, rather limited downward changes in prices-costs will increase the overall breakeven volume rapidly. In spite of the promising profit figure for the budget year, we cannot, in the long run, afford too large price-cost deviations.

Thirdly, how realistic are the cost estimates made in the budget? Depreciations - cost Item Nos. 112, 207 and 307 - have not been commented on so far. Capital costs are often underestimated. The depreciation figure is put into the budget in order to show the need for profit accumulation over time. How realistic are these figures? Assume that they represent 10 percent of actual investment costs. In that case they will most probably be a heavy underestimate of the actual capital cost. If they are doubled, more than half of the estimated profit disappears. It is important, in the long-term sensitivity analysis, to make realistic assumptions about capital costs.

5.3 Profitability as a function of both CTP and sales volumes

In the preceding section we made use of only the price-cost-variable, i.e. the sawmill's CTP. Changes in prices and/or costs mostly occur together with changes in sales volumes. When market demand for one reason or another goes down, customers' price awareness tends to increase. The supplier, facing decreased demand, has a tendency to lower his prices in order to elicit demand. Costs, however, have a tendency to remain unchanged. In Exhibit 5.3 the CTP and the sales volumes have been put together in a combined sensitivity analysis of profit changes as a result of combined changes in the two above-mentioned variables.

The figures in Exhibit 5.3 have been estimated in the following way:

$$\text{Profit}\ {}^{\text{CTP}_i}_{\text{Vol.}_j} = \text{CTP}_i \cdot \text{Vol.}_j - 1\ 874\ 000$$

The first profit figure, MU 1 113 000, is the profit actually budgeted for the year. If the CTP decreased to Mu 250 per m^3 of sawn timber, the sales volume still remaining at 10 000 m^3, we would get:

$$\text{Profit}\ {}^{250}_{10\ 000} = 250 \times 10\ 000 - 1\ 874\ 000 = \text{MU}\ 626\ 000$$

Letting our CTP remain at the MU 300 level, when sales volume goes down to 9 000 m^3, gives:

$$\text{Profit}\ {}^{300}_{9\ 000} = 300 \times 9\ 000 - 1\ 874\ 000 = 826\ 000$$

For each combination of chosen CTP and sales volume, estimated profits have been calculated in the same way.

Exhibit 5.3 shows that when the CTP decreases to a certain level, the sawmill starts running at a loss. The actual, critical CTP is MU 187, when the sales volume is 10 000 m^3. It should be kept in mind that the CTP-values used are all hypothetical figures. In reality we should, based on experience, be able to judge what values to choose. Each step of MU 50, by which the CTP-values have been decreased, corresponds to a combined negative price-cost-change of 5.7 percent based on the sales price of MU 880. Or, if we base the price-cost-change on the combined per-m^3-cost, we find that each step of MU in CTP-value corresponds to a cost increase of 8.7 percent. Over a spectrum of years, these percentage figures seem to be fairly realistic.

Let us return to Exhibit 5.3. Lowering the sales volumes also reduces profits. But we see that even limited combined changes in CTP and sales volumes give drastic effects. A 10 percent cut in the CTP and sales volume variables, i.e. CTP = MU 200 and sales volume = 9 000 m^3, throws the budgeted profit into the loss area giving rise to a net loss of MU 74 000. So, after all, the budgeted profit is one thing. The actual profit according to the post-analysis at the end of the budget year might be quite different.

Finally, let us look at the fixed costs or common costs in Exhibit 5.2. Changes in the CTP do not influence any costs other than those indisputably traceable, but among those costs that we have considered to be common costs, i.e. not influenced by volume changes, we might find minor errors in our judgements. For very limited volume changes, the so-called common costs will remain unchanged; but if we find that demand decreases heavily, we must make a more thorough study.

First of all, large decreases in sales volume will probably affect part of those costs that we have termed common costs. Many of these are in fact variable, but it is difficult to analyse how these costs will change. Therefore, we can say that the analysis is made in a slightly "pessimistic" way. There should be a positive "error margin".

Sales volumes / CTP per m3	Profits in MU 1 000				
	10 000	9 000	8 000	7 000	6 000
300	1 113*)	826	526	226	- 74
250	626	376	126	- 124	
200	126	- 74	- 274		
150	- 374				

↑ = profit combinations

↓ = loss combinations

*) Profit according to budget, i.e. CTP = MU 298.71. All other figures on this row are based on a CTP of MU 300.

Exhibit 5.3 Profits in MU 1 000 as a function of changes in CTP and sales volume

There is another possible cost change that we should study. We have estimated the "common costs" according to the budget as MU 1 874 000. Part of this amount can be influenced by our decisions. In a situation with rapid decrease in demand, we have to study the step-fixed nature of our fixed costs (cf. Section 2.2, especially Exhibit 2.4). We will find that the following costs are of step-fixed character:

Item No.	Cost
108	Labour, log handling
110	Repair & maintenance (at least the labour component and services purchased from outside)
201	Labour, sawing process
202	Repair & maintenance (cf. Item No. 110)
203	Heating (If the sawmill has more than one kiln, perhaps one can be closed, at least temporarily. Or one chamber can be blocked depending on the technical construction of the kiln).
301	Labour, storing
305 & 310	Salaries, sales manager and office clerk

Besides step-fixed costs we must also analyse those costs that are variable or mixes of fixed and variable costs (semi-variable) to see how they will change with various decisions. What we can do, if we believe that a decrease in demand will last over a long period, is to decide on a temporary shut-down of the whole mill either for an extended period or by reducing the number of work-days per week. The two possibilities will to some extent have different effects on costs. Reducing the number of work-days per week will, e.g., have no effect on such costs as drying costs, as the kiln cannot be shut off.

5.4 Production disturbance and its economic effects

In production one always has to be prepared for various kinds of unforeseen or unplanned production disturbances. Some of them are possible to influence, like production stops due to poor maintenance, poor planning of raw materials inflow, or careless operation of machinery. Others we cannot influence, such as defective parts in machines, strikes or various kinds of catastrophe. But whatever the reason, all disturbances have one thing in common: they are extremely expensive to the sawmill.

Let us once more return to our budget in Exhibit 4.10 to study the economic effects of production disturbances. Strikes, fires, catastrophes and the like can be long lasting. Other disturbances might vary from minute-long stops to stops of several days. Very few costs are changed during these temporary stops, but one thing we know for sure is that the m^3 not produced during a stop will never be produced. For our company, every stop, long enough to eliminate production of one m^3 of sawn timber, reduces the revenues by MU 880 as an average.

We also know that the m^3 we do not produce will save us the raw materials cost, the cash discount, and the sales commission, but no other costs of significance will be reduced. Our average inventories will not be affected by a minute-long - not even a few days' long - production stop. The very few traceable costs for this kind of disturbance have been summarized in Exhibit 5.4 As can be seen from this, the raw materials costs calculated in Exhibit 4.10 have been reduced by the raw materials inventory costs (Item No. 103). Deducting these costs from the average sales price, gives us a CTP that is relevant for this profitability estimate. As an average the sawmill will lose MU 355.40 for each m^3 of sawn timber not produced.

The importance of this CTP-reduction becomes obvious, if we calculate what it means per day. If we assume 50 working weeks per year less 15 legal holidays, we arrive at 235 working days. With a normal daily production of 10 000/235 = 42.6 m^3 of sawn timber, the reduction in the sawmill's CTP will be 42.6 x 355.40 = MU 15 140 for one day's breakdown. With an 8-hour working day we get a CTP drop of MU 1 893 per hour or MU 31.55 per minute.

The cost estimates made here are based on the opportunity cost concept. It is important to find out the actual costs of production stops, but it is also important to instruct the operators, especially those in key positions, what even short stops mean economically to the sawmill's profit.

Specification	Costs in MU per m3: Species A	Species B	Weighted average in MU
- Log costs, net method	513.00	459.00	
+ Log inventory costs	12.20	8.20	
- Cash discounts	18.00	17.00	
- Sales commission	27.00	25.00	
= Relevant cost per m3	545.80	492.80	
+ Average price, m3			880.00
- Average, relevant cost m3			524.60
= Relevant CTP per m3			355.40
Relevant CTP per day			15 140
Relevant CTP per hour			1 893
Relevant CTP per minute			31.55

Exhibit 6.4 Different CTP:s for evaluating production stops

5.5 The CTP in price negotiations

Customers always try to negotiate for a lower price. In such a situation we will have the following possibilities:

1. Demand is good and we can find other customers, if our refusal to cut the price means a lost customer.
2. Demand is bad and price cut is necessary to get the customer to buy now.

We leave long-term effects out, e.g. the influence that a price cut might have on the customer's future expectations. We also do not consider the possibility of losing the customer permanently. Instead we concentrate our interest on what CTP we will use in the two situations described above in order to estimate short-term effects on profit. To simplify, we take only species A as an example.

The first case is simple: If demand is good, and the sawmill can sell its product without cutting the price, there is no need for a price cut at all. But if the price is cut, the consequences will be a reduction in CTP. Let us assume a price cut of MU 25, i.e. from the price MU 900 to MU 875 per m^3.

Specification	Ordinary price	Reduced price
Price per m^3	900.00	875.00
Cash discount	18.00	17.50
Sales commission	27.00	26.25
CTP per m^3	855.00	831.25

The price difference of MU 25 will be reduced to a difference of MU 23.75 after having taken changes in cash discount and sales commission into consideration.

But what economic effects will accrue in the second case? We assume that the sawmill's inventory of finished boards has piled up, and that one possibility of selling the boards is to cut the price.

In this situation there are two possibilities. Let us call them C_1 and C_2:

C_1: We try to maintain the ordinary price.

C_2: We cut the price to the extent that the new price elicits an immediate sale.

We now have to see what will happen when choosing either of the two alternatives.

If we decide to maintain present price (C_1), we can have the following expectations:

1. We will get this price sooner or later. But how long will it take?
2. The boards will remain in stock and thereby give rise to inventory costs during the waiting time.
3. When demand increases in the future, we can sell the boards for the ordinary price (assumption), but there is a possibility that the boards have deteriorated during storage (cracks, discoloration, stains, etc.).

If we decide to cut our price (C_2), the boards will be sold immediately. It is presumed that the price cut will be large enough to elicit immediate demand.

Let us use the following denotations to quantify the required decision:

Let: X = the waiting time, expressed in months,
Y = the lower price needed to elicit an immediate demand,
e = the mathematical error, if we do not take possible deterioration into consideration and
i = our capital cost, i.e. the interest we have to pay on capital tied up.

We have not taken into consideration any other cost than deterioration (e) and capital costs (i). All other costs, like manufacturing costs and company overheads, are equal for both courses of action. In other words they are sunk costs, and they should, therefore, not influence our decision. Deterioration and capital costs, though, are incremental costs to C_1 (cf. Section 2.6). There are two more incremental costs, namely cash discounts and sales commissions. But if we define the present (ordinary) price as well as the variable Y as the net price we get after deduction of cash discounts and sales commissions, we have taken these incremental costs into consideration as well.

What are the unknown variables in this problem? Y is the dependent variable that we are supposed to estimate. The waiting time - X - must be assumed. Finally, the capital cost (i) must be decided. But this is the opportunity cost concept that we used many times in Chapter 4, and we will probably use the interest the sawmill has to pay on its credit account.

The average price for Species A is MU 900. Most probably the boards show a much lower price, let us say MU 700 per m^3. We can now state our problem as:

Economic consequences: C_1 Economic consequences: C_2

$$700 - \frac{Y \cdot i \cdot X}{100 \cdot 12} - e = Y$$

The formula reads: If we choose C_1, we will get the desired (ordinary) price minus the interest we would have earned at i percent p.a. during X months minus the costs of deterioration that will accrue.

The economic consequences of C_2 are merely the price we get today, after having accepted a price cut. Equating the two courses of action and solving for Y gives the price that is economically justified.

Let us assume that it will take at least nine months (X) before the customers are willing to pay MU 700 for these boards. Disregarding the costs of deterioration (e) and using the 10 percent interest, we can solve for Y:

$$700 - \frac{Y \cdot 10 \cdot 9}{100 \cdot 12} = Y$$

which gives Y = MU 651.16 or rounded off to MU 650.

We did not take the cost of deterioration into consideration because it varies from one place to another depending on climate factors, storing resources and so forth. Let us estimate the average cost per m^3 of a nine month wait, added storing as MU 35. All we have to do is to enter this figure in our formula which means that the ordinary price will be reduced to 700 - 35 = 665. Solving for Y gives MU 618.60 or a rounded-off price of MU 620 per m^3.

What we have done here is not to estimate a certain CTP. Instead we have calculated how much our present CTP will be reduced in order to elicit an immediate demand.

5.6 The cash flow budget

Let us now construct a cash flow budget for our company. In doing so, we focus cash inflows and cash outflows during the budget year. The starting point for this is to study the sawmill's revenues and expenses. The budgets presented in Exhibits 4.2 and 4.10 are important sources of information. These two budgets, however, do not necessarily tell the whole truth about cash flows. Log purchases, e.g., do not always coincide with log consumption, causing changes in inventory balances. We must also remember that there can be many payments during the year that have nothing to do with either sales revenues or expenses. As an example, we can mention interest and amortization payments on loans.

In planning the cash flow we have to consider not only the total amount of cash flows but also how they are distributed timewise during the year. The primary aim is to make sure that cash is available, when payments are due.

To build up a cash flow budget we turn to the expenses budget in Exhibit 4.10, which is the most complicated of our two main sources of information. The expenses budget shows the overall costs that the company will have during the year. But how much of these costs will create corresponding cash outflows? To answer this question, we will have to scrutinize each cost item, check whether a corresponding payment will accrue, and, finally, see when the payments will be due during the year. To begin with, let us leave the raw materials costs out and instead start with log handling costs (Item No. 108 in Exhibit 4.10).

To get a somewhat realistic example, we have to make some assumptions about how expenses are spread during the year. This has been made in Exhibit 5.5. Some expenses are paid monthly, others quarterly. In one case, Item No. 205, it has been assumed that payments are made once every six months. All these expenses are supposed to be paid regularly but in every company there will be a great number of payments that accrue more or less irregularly over the year. One can, of course, not take into consideration every petty sum that might flow in or out, but more important payments, showing an irregular pattern, must be studied. Examples of such payments are shown on the right in Exhibit 5.5.

In Exhibit 5.5 we recognize the items from Exhibit 4.10. Some of them, however, show different amounts in these two exhibits. Most items have been placed in the "monthly column". Item No. 109, watering costs, has been placed in the "quarterly column", i.e. it has been assumed that the electricity and water bills are paid every three months. Item No. 111 contains fuel expenses of 20, paid every month, and electricity of 8, paid quarterly. Item No. 203 had a total value of 94 in Exhibit 4.10 and has here been estimated at only 20. The difference, 74, is the value of by-products used for heating, and they do not give rise to cash outflows. The amount in the monthly column might be costs of oil and the amount in the quarterly column can be electricity costs (fans).

Item No. 304 is travelling costs. These have been assumed evenly spread over the year (22) plus extra expenses during intensive selling periods (months 8, 9 and 10). The manager is assumed to have a yearly salary of 116. In addition to this he gets a premium of one per cent of achieved profit to be paid in the 6th and the 12th month with half of the estimated amount each month.

To get a rough estimate of the cash outflow, the totals have been spread out according to the estimates shown in the footnotes. This does not give exact amounts but good enough approximations.

There are still a number of cost items in Exhibit 4.10 that are missing in Exhibit 5.5. Log costs fluctuate depending on inventory. They are, therefore, treated separately. Depreciations are costs and, therefore, part of Exhibit 4.10, but the corresponding expenses must be found elsewhere, and they will be discussed later. Cash discounts and sales commissions vary with the sales volumes and have been treated together with the cash inflows from sales.

Item No.	Expenditures taken from the budget in Exhibit 4.10					Total
	Accruing regularly per:			Accruing irregularly:		
	Month	Quarter	Half-year	Month No.	Amount	
108	40					40
109		25				25
110	45					45
111	20	8				28
201	480					480
202	82					82
203[1]	12	8				20
204	123					123
205	50	18	4			72
301	40					40
304	22			(8)	2	24
304				(9)	4	4
304				(10)	6	6
305	105					105
308	116			(6)	5.5	5.5
308				(12)	5.5	5.5
309	62					62
310	48					48
Total	1 247[2]	59[3]	4[4]		23[5]	1 333

[1] Deviates from budget figure because all bark and most of the slabs and chips are used for heating the kiln.

[2] Spread evenly over 12 months by MU 103 900 p. m.

[3] Spread by MU 14 800, months Nos. 3, 6, 9, & 12.

[4] Spread by MU 2 000, months Nos. 6 & 12.

[5] Spread over the year according to indications above.

Exhibit 5.5 Analysis of how actual expenditures (payments) are spread over the year. (Amounts in MU 1 000)

Let us now compile the cash flow budget, which is shown in Exhibit 5.6. From Exhibit 4.2 we find the estimated sales volumes. To simplify the procedure, it has been assumed that the sales recorded each month also give rise to cash inflow for that month.

On the first row we find the sales revenues for both species multiplied by 0.95. That means revenues have been reduced by cash discounts (2 percent) plus sales commissions (3 percent). Thereby we have taken also cost Items Nos. 302 and 303 into consideration. On the second row we find revenues from by-products. Summing together we get total inflow for each month, which, on the fourth row, has been accumulated month by month.

Cash outflows start with payments for logs. Our source of information is Exhibit 4.8. Thereafter transportation expenses have been estimated. For raw materials and transportation expenses we must take into account that we do not always consume the same amounts as we have purchased.

Next row shows the figures estimated in Exhibit 5.5. These have been commented upon earlier.

Finally, we have assumed bank loans due to previous investments that give rise to quarterly payments of MU 550 000. To get a realistic picture of the overall cash flow, we must also consider company taxes. They have been assumed to be paid monthly. We have accounted MU 45 000 per month for the total tax expenses during the budget year.[1]

Summing up all expenses gives the total cash outflow, which has been accumulated month by month. Comparing accumulated cash inflow and cash outflow gives the balance month by month. We see from this last line in Exhibit 5.6 that the cash flow situation varies during the year. In the beginning of the year the balance is rather small but positive, thereafter increasing up to more than MU 1 000 000 in the 8th month. During the 9th month, however, we face a negative balance of over MU 600 000. This is due to the forecast purchase of logs which is extremely high during the 9th month.

Studying the cash flows gives rise to many questions. Would it be possible to influence purchases of logs and spread them more evenly during the year? If not, how to solve the cash flow problem. Must new loans be taken? How will this influence the overall cost picture and thereby also the profit of the company? If log purchases cannot be changed, we obviously have to do something else. Is the pattern shown here typical also for other years? If so, can the overall cash outflow be restructured? There is one heavy payment, interests and amortization, that also accrues in the 9th month. Perhaps the bank re-payments can be changed to give a more even pattern over the years.

1/ We do not analyse how this amount is estimated. Tax-paying systems vary from one country to another as do taxes actually paid.

	1	2	3	4	5	6	7	8	9	10	11	12
Cash inflow												
(Species A + B) x 0.95	836.0	795.6	795.6	584.3	543.9	543.9	543.9	624.6	710.1	710.1	836.0	836.0
by-products	21.2	20.1	20.1	14.8	13.8	13.8	13.8	15.9	18.0	18.0	21.2	21.2
Total inflow	857.2	815.7	815.7	599.1	557.7	557.7	557.7	640.5	728.1	728.1	857.2	857.2
Accumulated inflow	857.2	1 627.9	2 488.6	3 087.7	3 645.4	4 203.1	4 760.8	5 401.3	6 129.4	6 857.5	7 714.7	8 571.9
Cash outflow												
Log purchases, Species A	330.0	240.0	200.0				200.0	300.0	1 000.0	150.0		150.0
Log purchases, Species B	198.0	144.0	90.0				72.0	180.0	630.0	90.0		90.0
Transportation	24.2	17.6	13.2				12.3	22.0	74.8	11.0		11.0
From Exhibit 5.5	103.9	103.9	118.7	103.9	103.9	126.2	103.9	105.9	122.7	109.9	103.9	126.2
Interests & amortizations			550.0			550.0			550.0			550.0
Taxes	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0
Total outflow	701.1	550.5	1 016.9	148.9	148.9	721.2	433.2	652.9	2 422.5	405.9	148.9	972.2
Accumulated outflow	701.1	1 251.6	2 268.5	2 417.4	2 566.3	3 287.5	3 720.7	4 373.6	6 796.1	7 202.0	7 350.9	8 323.1
Cash balance end of month	156.1	421.3	220.1	670.3	1 079.1	915.6	1 040.1	1 027.7	-666.7	-344.5	363.8	248.8

Exhibit 5.6 The Cash Flow Budget (000 MU)

6. CAPITAL BUDGETING

6.1 Decision character

In the previous two chapters we have worked with budgeting and cost calculation of routine operations, i.e. more or less daily operations of the sawmill. In this chapter, we will change the perspective into various kinds of long-term decisions within the field of capital budgeting. We define capital budgeting as "long-term planning decisions for investments and their financing" (Horngren, Charles T., ed., Cost Accounting. A Managerial Emphasis, Prentice/Hall International editions, Englewood Cliffs, N.J., 1982, p. 404).

Capital budgeting differs in many respects from short-term operating decisions. Let us point out the main characteristics of capital budgeting as compared to the company's short-term decisions.

1. In capital budgeting the time span has to be taken into account explicitly. The time span used in a capital budgeting can vary from more than one year up to time periods of 10, 15, or even more years.

2. Due to the expanded time span of the decision, "the money concept" changes. A monetary unit received (paid) today is worth more than the same, nominal amount received (paid) in a more or less remote future.

3. Some - but far from all - capital budgeting decisions have enormous impacts on a company's ability to survive in the long run. When this is the case, the capital budgeting decision involves heavy risk-taking.

4. Capital budgeting is of non-routine character, i.e. decisions are made intermittently.

5. Capital budgeting focuses cash flows, some of which do not necessarily have to correspond to the company's revenues and/or expenses.

6. Due to long time spans normally involved in capital budgeting, the degree of uncertainty is often extremely high.

There are numerous examples of capital budgeting decisions. Investing money in new production equipment and/or buildings is undoubtedly a capital budgeting decision, while the purchase of a new electric pencil-sharpener is not. Obviously, there is no easily identified line of demarcation between capital budgeting and operational decisions.

In assessing the economic consequences of a certain decision, the time span and its influence can be taken as something typical for capital budgeting. True, as we will see later, there are models of capital budgeting that do not consider the difference between the present and the future value of money. But it is always possible to change such models into new models, in which this difference is regarded. So let us start with the task of comparing present and future values of money.

6.2 Evaluating time-spread money

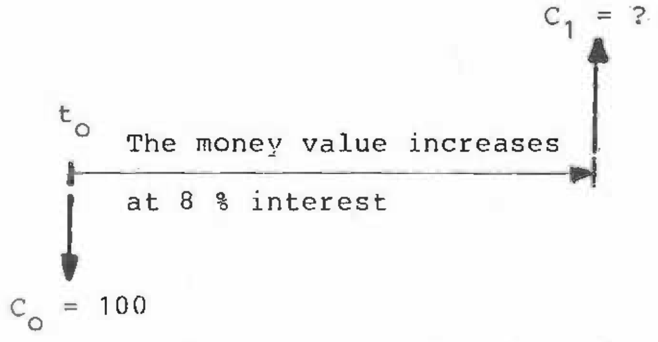
The models and some of the concepts used in capital budgeting originate from the field of banking. Assume a person who wants to put in MU 100 in his savings account. He knows that he gets 8 percent interest p.a. on money saved. How much does his capital, due to the bank interest, increase during one year? Let us use the following denotations:

C_0 = capital value now, also called **present value**.

C_1 = capital value at the end of the first year, also called future value.

r = rate of return, i.e. in this case the bank interest (8 percent).

We can now show his problem graphically. We will use this kind of graph throughout this chapter, letting upwards directed arrows show cash inflows and downward directed arrows cash outflows. Putting the money into his savings account is a cash outflow (even if the money is still his own, being just temporarily lent to the bank) and the collection of it (after one year) is a cash inflow.



The designation t_o indicates "time zero", i.e. "now" or the starting point for a project. We will use this designation occasionally.

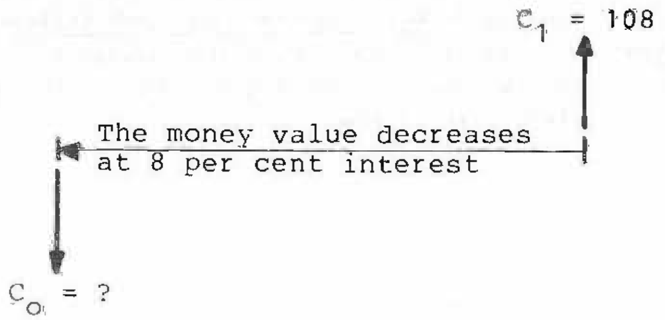
The value of the capital after exactly one year is 100 x 1.08, which will be the beginning capital value for the second year. This, in turn, will grow by 8 percent to a future capital, at the end of the second year, which amounts to 1.08^2. This ending capital of the second year becomes beginning capital the third year. In the same way, the beginning capital of the last year will be $1.08^{(n-1)}$. After exactly n years, the capital has grown to:

$$C_n = C_o \cdot \underbrace{\left(1 + \frac{r}{100}\right)}^{n} \qquad (1)$$

= Compound interest
= Present value
= Future value

In (1) we have the general formula for the compound interest, with which the present value grows into a higher, future value.

In capital budgeting we do not very often use the compound interest formula, but we always need to know the reverse process, i.e. how to convert a known, future value (C_n) into a present value (C_o). Assume that the person in our example knows that he will get exactly MU 108 in exactly one year's time. His problem is to find out the present value (C_o) of the future value (C_1) that is known to him. If the interest is still 8 percent, we can graphically state his problem in the following way:



Putting the figures into formula (1) gives:

$$108 = C_o \cdot 1.08$$

This expression is equivalent to formula (1) only that C_o now is the unknown and C_1 the known variable. Solving for C_o and, at the same time, putting in the general expression for the compound interest according to (1) we get:

$$C_o = \frac{C_1}{(1 + \frac{r}{100})^n} \qquad (2)$$

Here n = 1, and the answer becomes

$$C_o = \frac{108}{1.08} = 100$$

This is clearly the reversed process. The factor $1/(1 + \frac{r}{100})^n$ is called the compound discount, as we have discounted (diminished) the future value in estimating its present value, i.e. we have "diminished" the future, nominal value in order to make the two amounts equally large in real terms!

We do not have to calculate these factors every time. The compound interest factors, $(1 + r/100)^n$, and the compound discount factors $1/(1 + r/100)^n$, are found in tables (see Appendix 1). In Table A we find the compound interest factors for various combinations of r- and n-values. The compound discount factors are shown in Table B.

A person, who puts in an amount of MU 500 in his savings account at an interest of 12 percent p.a. will, after 10 years, have a capital that has grown to:

$$C_{10} = 500 \cdot \text{Table } A^{10\text{ years}}_{12\%} = 500 \cdot 3.1058 = 1\ 552.90$$

If we know the initial capital at t_o, in this case C_o = MU 500, we multiply this capital by the interest factor found in Table A for the pertinent r- and n-values, in this case 3.1058, to get the future value C_{10}. To save some work we use the abbreviated form:

$$TA^{10}_{12}$$

This is read "Table A for 10 years and 12 percent".

In the same way we can use the discount factors of Table B. Assume a person, who has a life insurance that will be paid in exactly seven years. Its future value is MU 10 000. If he wants to get his money now, he can do so by accepting a lower, nominal amount than what he would get, if he waited until the insurance period expired. If the insurance company discounts the future value by an interest rate of say 8 percent, he will get:

$$C_o = C_7 \cdot TB^7_8 = 10\ 000 \cdot 0.5834 = 5\ 384$$

If the insurance company had used an interest of 10 percent he would have got:

$$C_7 = 10\ 000 \cdot TB^7_{10} = 10\ 000 \cdot 0.5131 = 5\ 131$$

From this example we learn that the higher the interest rate, the lower is the compound discount factor and, thereby, also the present value.

So far we have studied movements of single cash flows along the time axis. In capital budgeting, however, we very often want to discount the sum of equally high, nominal amounts that are earned (e.g. net income figures) or saved each year during a series of years. Assume a company, for which it has been estimated that net earnings per year will amount to MU 2 000 for the next five years to come. To illustrate this problem, we can once again make use of a graphical model, which has been shown in Exhibit 6.1.

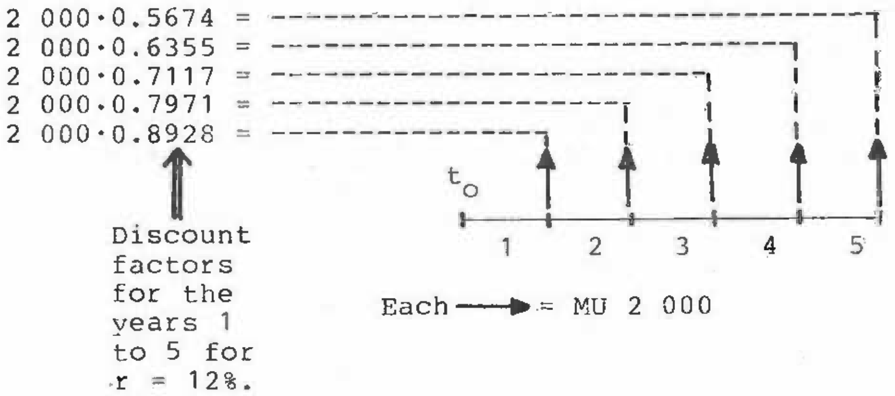


Exhibit 6.1 Discounting a series of equally high, nominal amounts

Each amount of MU 2 000 is spread out during each year. For computational reasons, it is easier to place each amount at the end of its year. This slight error brought into the analysis is, however, negligible in capital budgeting.

To find the present value or $\underline{C_o}$, we multiply and add together:

$$C_o = 2.000 \cdot TB^1_{12} + 2\ 000 \cdot TB^2_{12} + 2\ 000 \cdot TB^3_{12} +$$

$$2\ 000 \cdot TB^4_{12} + 2\ 000 \cdot TB^5_{12} =$$

$$2\ 000 \cdot [0.8928 + 0.7971 + 0.7117 + 0.6355 +$$

$$0.5674] = 2\ 000 \cdot 3.6045 = 7\ 209 \qquad (3)$$

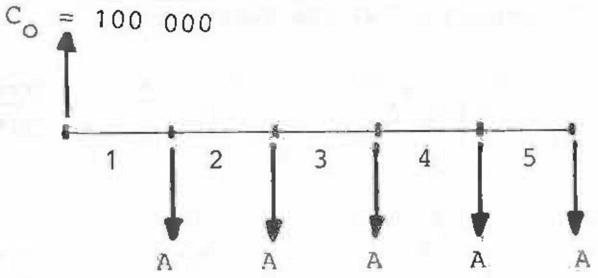
The sum of the parenthesis becomes 3.6045, or, after rounding, 3.605. If we compare this figure with the figure in TC^5_{12}, which is 3.602, we find a difference of 0.0025. The difference between our sum and the table value is due to rounding off. This means that in Table C we find <u>the sum of compound discount factors</u> for various combinations of <u>r</u>- and <u>n</u>-values. When the amount received (paid) is <u>equally high each year</u> - then and only then - we do not have to make separate calculations of each amount. Instead we just use Table C and multiply the yearly (equally high) amount by the factor sums we find in the table.

Let us introduce a new concept, <u>the annuity</u>. In taking a loan in a bank, there are two different ways of paying the money back. Either we choose to amortize the loan by the help of equal amortization amounts every year (flat amortization). In this case, the interest paid will vary over the years and so will the combined amount of interest and amortizations. Or, we ask the bank to find an <u>equally high amount</u> to be paid each year, estimated in such a way that it covers both re-payments on the loan (amortizations) and the bank's interest. This amount is called the annuity.

Assume a company taking a loan of MU 100 000 at an interest of 10 percent p.a. The loan is to be paid back in five years. The payment series for this flat amortization loan will be as follows:

End of year No.	Debt before amortization	Interest for the year	Amortization	Total amount paid
1	100 000	10 000	20 000	30 000
2	80 000	8 000	20 000	28 000
3	60 000	6 000	20 000	26 000
4	40 000	4 000	20 000	24 000
5	20 000	2 000	20 000	22 000

This series shows a maximum financial burden of MU 30 000 (first year) and a minimum financial burden of MU 22 000. Suppose the borrower finds it inconvenient with such varying financial burdens. Instead, he asks the bank for an annuity loan, i.e. a loan which will be repaid with the same, nominal amount every year. Graphically, the problem can be described as follows:



He wants to pay, in the future, MU A per year to cover both interest and amortization. The present value of this series of five payments of MU A shall be exactly MU 100 000. How much does he have to pay?

Let us go back to Exhibit 6.1. There, we estimated the present value of a series of payments, equally high each year. Now we know the present value, which is MU 100 000, and we want to find a series of equally high, nominal amounts paid every year, the present value of which shall be exactly MU 100 000. We can present the problem in a similar way as was done in Exhibit 6.1 and just reverse the process. This is shown in Exhibit 6.2.

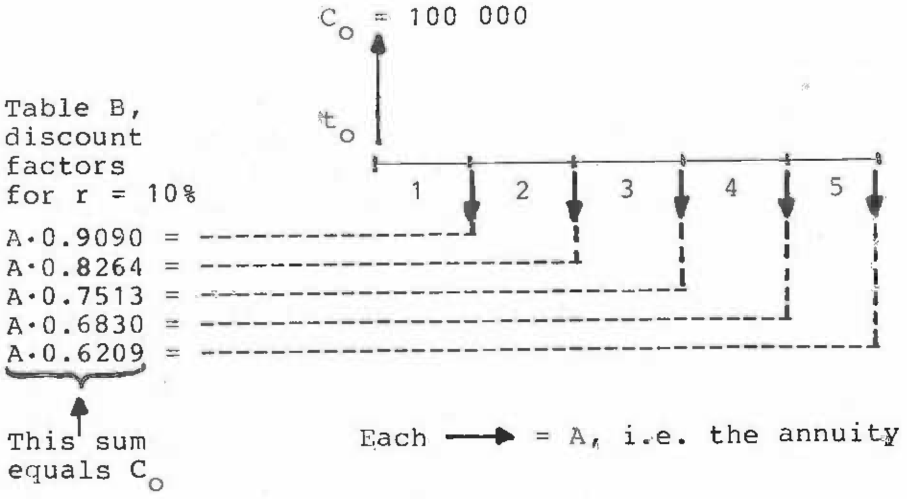


Exhibit 6.2 Discounting the annuities to present value

Putting these figures into formula (3) we get:

$$100\ 000 = A \cdot [0.9090 + 0.8264 + 0.7513 + 0.6830 + 0.6209]$$
$$= A \cdot 3.7906$$

By solving for A we get:

$$A = \frac{100\ 000}{3.7906} = 26\ 381 \qquad (4)$$

The annuity estimation is the reversed process of estimating the factors found in Table C. All we have to do is to multiply the present value (MU 100 000) of our loan by the annuity factor in Table D, which is calculated as the inverted values of the corresponding Table C values, and we get the annuity.

We have now two payment series - for the flat amortization loan and for the annuity loan. Both series are equally valuable in real terms. To prove this statement we can carry through the following two calculations:

Year No. i	Flat payment each year	Discount factors, TB_{10}^{i}	Present values
1	30 000	0.9090	27 270
2	28 000	0.8264	23 139
3	26 000	0.7513	19 534
4	24 000	0.6830	16 392
5	22 000	0.6209	13 660
Sum of present values over 5 years:			99 995 or
		rounded off	100 000

The present value of the annuity series we get by multiplying the annuity, MU 26 380 by TC_{10}^{5}, which gives a present value of MU 100 007. Also in this case a small rounding difference appears.

6.3 Decision models

6.3.1 The basic example

Let us turn to the decision models used in capital budgeting. To compare different models as well as the results of our decisions, we will use the same basic example through all five methods presented. We will focus on the methods as such, leaving for the moment all practical considerations aside.

Let us study a company planning to invest in a new machine, e.g. a lathe. Figures needed to carry out the analyses are as follows:

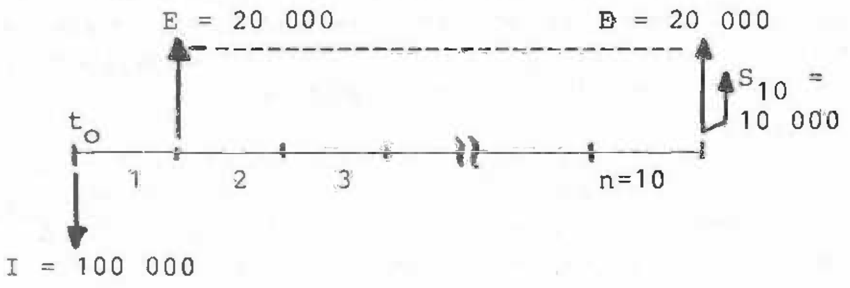
The amount to be invested, the price of the lathe, all costs included.	MU	100 000
Estimated net earnings per year as a result of the investment.	"	20 000
Scrap value of the lathe at the end of its useful life (in this case 10 years).	"	10 000

Finally, we need an interest rate to be able to discount future cash flows to their present values. This rate is the company's required rate of return, RRR. When referring to the RRR, we will denote it $\underline{r}_r$. In this example we use 10 percent.

6.3.2 The Net Present Value model

The idea behind the Net Present Value method (NPV-method) is that all cash flows, being traceable to the investment decision, will be moved to t_0 find the NPV. The model uses different time value of money depending on where along the time axis cash inflows and cash outflows accrue. The time value of money is estimated by help of the company's RRR.

Our basic example can be shown in the following way:



where I = the investment expense
E = net earnings per year
S_{10} = scrap value at the end of the 10th year

The dotted line indicates that the amount E = 20 000 accrues every year. The net present value at the RRR of 10 percent, NPV_{10}, is found by the formula:

$$NPV_{10} = E\cdot TC_{10}^{10} + S_{10}\cdot TB_{10}^{10} - I \qquad (5)$$

This formula reads in words: The net present value, all amounts discounted at 10 percent, is found as the sum of the net present values of yearly earnings plus the scrap value minus the investment expense. The designations TC and TB stand, as before, for Tables C and B.

Let us now put in the assumed figures for this investment together with the values found in Tables C and B. We get:

$$NPV_{10} = 20\ 000 \cdot 6.145 + 10\ 000 \cdot 0.3855 - 100\ 000$$

$$NPV_{10} = 26\ 755$$

This NPV of MU 26 755 tells us that the investment gives a rate of return that is higher than the RRR of 10 percent. As all future cash flows have been discounted by the RRR, a NPV of exactly zero would have yielded exactly 10 percent. But as the sum of the discounted future cash flows is larger than the investment expense that the company has to pay now, the investment obviously must yield more than 10 percent.

For the NPV-method we get the following decision rules:

1. If the NPV for a single investment is equal to or larger than zero, the investment is profitable.

2. In comparing two or more investment alternatives, the one with the largest NPV is the most profitable one.

It is important to learn to interpret the NPV one gets. First of all, the NPV is a function of the figures we put into formula (5). These amounts, in their turn, are estimations. The poorer the estimations, the less trustworthy is the NPV. There is always a degree of uncertainty in our estimates. But this we will take care of later on, when we bring the sensitivity analysis into the picture.

The NPV is also a function of the chosen RRR. As was pointed out earlier, the present value diminishes with higher interests. In Exhibit 6.3, NPV.s have been shown for various values of RRR. If we do not take any interest into consideration, we get the nominal difference between cash inflows and cash outflows as:

$$10 \cdot 20\ 000 + 10\ 000 - 100\ 000 = 110\ 000$$

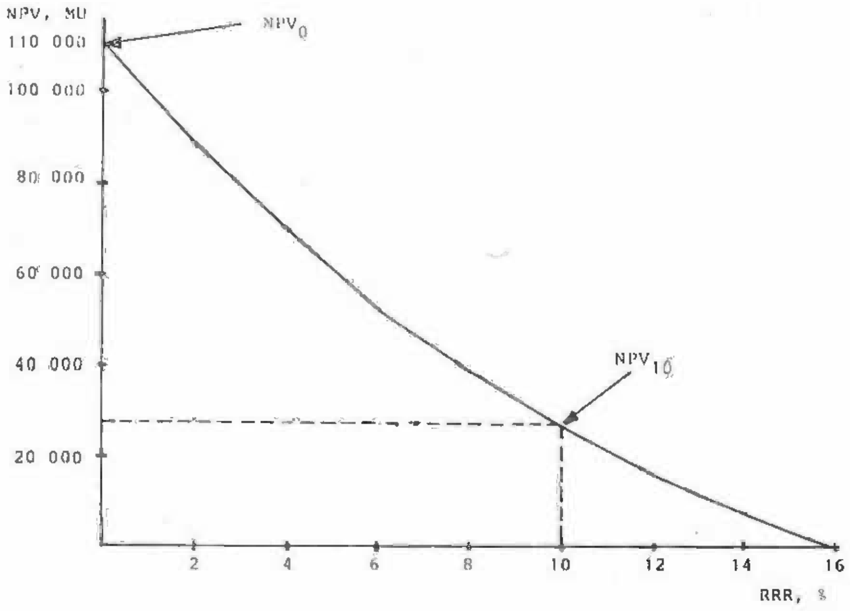


Exhibit 6.3 The NPV as a function of the company's RRR

This corresponds to the intercept with the vertical axis in Exhibit 6.3. The more we increase the RRR, the lower the NPV becomes. At a RRR of slightly less than 16 percent, the NPV becomes zero.

6.3.3 The Annuity Method

The annuity concept was introduced in Section 6.2 and defined as an equally high amount to be paid each year and large enough to cover both amortizations and yearly interest on a loan. We can use this concept also when analysing the profitability of an investment. The annuity then becomes an equally high amount needed each year to cover depreciations and RRR. From a computational point of view, depreciations are substituted for amortizations. It should be kept in mind, though, that depreciations and amortizations are two different things. A yearly depreciation is a measure of the company's sacrifice, i.e. cost, when using the machine or building that it has invested in. The amortization, on the other hand, is just the re-payment the company has to do, in case it takes a loan, e.g. from a bank.

Let us now go back to our basic example. We know that yearly net earnings (E) have been estimated to MU 20 000. When using the Annuity Method we ask ourselves, how much the investment cost is per year and compare this with E. Still using A as the annuity, we find A with the following formula:

$$A = (\underbrace{I}_{\text{= The amount to be invested}} - S_{10} \cdot \underbrace{TB_{10}^{10}}_{\text{= The present value of the scrap value to be paid in 10 years time.}}) \cdot \underbrace{TD_{10}^{10}}_{\text{= The annuity factor.}} \qquad (6)$$

In other words, we find the annuity as the annuity factor in Table D, multiplied by the difference between the investment amount and the present value of the scrap value. Putting in our figures we get:

$$A = (100\ 000 - 10\ 000 \cdot 0.3855) \cdot 0.1627$$
$$A = 15\ 643$$

In other words, we need, each year, to earn the amount MU 15 643 in order to be able to depreciate and pay interest on (the company's RRR) this investment. According to the example we will get an E-value of MU 20 000 per year, i.e. MU 4 357 more than is required. Obviously, this investment is profitable.

For the Annuity Method we get the following decision rules:

1. If the yearly earnings accruing from the investment are larger than or equal to the annuity required, a single investment is profitable.
2. In comparing two or more investment alternatives, the one with the largest difference between yearly net earnings and the annuity is the most profitable one.

If we look closer at the results we have got from the NPV-Method and the Annuity Method, we will find that they give exactly the same results. In the Annuity Method we found that the required annuity was MU 15 643. At the same time we know that we will earn MU 20 000 yearly. If we now take the difference between these two amounts and estimate the present value of this difference, we get the following result.

$$NPV_{E-A} = (20\ 000 - 15\ 643) \cdot TC_{10}^{10} = 26\ 744$$

In Section 6.3.2 we found the NPV_{10} as MU 26 755. The small difference between these NVP.s originates from table roundings. If we had calculated the two NPV.s without using table values, we would have found that:

$$NPV_{10} = NPV_{E-A}$$

Mathematically, the NPV-Method and the Annuity Method are identical. The difference between them is that we get the results in slightly different ways depending on how the initial values are introduced.

6.3.4 The Internal Rate of Return Method

Let us now look at the Internal Rate of Return (IRR) that we will denote with $\underline{i_i}$ in our formulas. The IRR-concept has actually already been mentioned in Section 6.3.2. We define the $\underline{i_i}$ as that interest rate which gives a NPV that is exactly zero. In Exhibit 6.3 we found that our basic example would yield a NPV of zero, when the company's RRR was increased to slightly less than 16 percent. This percentage is the internal rate of return that our basic example gives.

When using the Internal Rate of Return Method, we define the desired NPV as zero and put in our figures in formula (5). The unknown variable is $\underline{i_i}$ and we denote the net present value by NPV_{i_i}, which we put equal to zero. We then get:

$$0 = 20\ 000 \cdot TC_{i_i}^{10} + 10\ 000 \cdot TB_{i_i}^{10} - 100\ 000 \qquad (7)$$

as we have defined $NPV_{i_i} = 0$.

The unknown variable is our IRR. But this interest rate has been hung upon two different table values, which means that we actually have two unknown variables, TC_{i_i} and TB_{i_i}. We cannot solve a single equation with two unknown variables. There are two different techniques to solve our problem.

Sometimes there is no scrap value. In such a case we would have had only one unknown variable - the table value for TC. Let us assume that the scrap value is so small that we can overlook it to get a rough estimate of the $\underline{i_i}$. In such a case the second term will become zero, and we can solve equation (7) for TC_{i_i}.

$$0 = 20\ 000 \cdot TC_{i_i}^{10} + \underset{\uparrow}{0} - 100\ 000$$

Because we have, temporarily, overlooked the effect of the scrap value.

We then get:

$$TC_{i_i}^{10} = \frac{100\ 000}{20\ 000} = 5,$$

which we interpret in the following way. Find, in Table C, a compound discount sum that is equal to 5, when we know that the discount process will be made over 10 years. Looking into Table C, we find on the row for 10 years the following discount sum factors:

15%	16%
5.019	4.833

Obviously, the $TC_{i_i}^{10}$ of 5.000 must be very close to 15 percent. But, we have overlooked the scrap value. If this value had been taken into account, we would have got a figure close to the quotient for 16 percent. Now, when we have a first, rough estimate of our $\underline{i_i}$, we can find a better estimate by solving the whole formula (7) by using this rough estimate. So let us put in our figures as well as the table values for 16 percent to see what we get. In other words, we estimate the NPV for exactly 16 percent to get:

$$NPV_{16} = 20\ 000 \cdot 4.833 + 10\ 000 \cdot 0.2266 - 100\ 000$$

which gives $NPV_{16} = - 1\ 074$

It is clear that the investment yields almost 16 percent, which we also found in Exhibit 6.3.

The second technique of estimating the $\underline{i_i}$ value is simple. Sometimes there are many "unknowns" involved as is the case e.g. when there are different net earnings for different years. It is no help, then, to temporarily overlook the scrap value. Instead one can just make a pure guesswork and by trial and errors put in various percentage figures, until one reaches a NPV that is equal to zero.

For this method we get the following decision rules:

1. If the estimated $\underline{i_i}$ is larger than or equal to the $\underline{i_r}$, a single investment is profitable.

2. In comparing two or more investment alternatives, the one with the highest $\underline{i_i}$ is the most profitable one.

The course taken in this paper is to use the Internal Rate of Return Method only as part of the sensitivity analysis. But, for all major investments the IRR should be estimated.

6.3.5 The Simple Pay-Off Method

The Simple Pay-Off Method differs from the previous methods described in two ways. This method does not use any interest rate and it does not require decisions on the investment's useful life. Instead it is supposed that the company has a pre-determined pay-off period, within which the investment must pay back the money being invested. Let us use the following denotations in addition to those we have used before.

POT_r = restricted pay-off time

POT_a = actual pay-off time

Using this method, we will compare POT_a with POT_r to see if the former is shorter than the latter. In our basic example, we have to add a value for POT_r. Let us assume than the company requires that investments of this type must be paid back in less than eight years, i.e. we put $POT_r = 8$.

In the Simple Pay-Off Method we get the following formula for our estimations:

$$I - E \cdot POT_a = 0 \tag{8}$$

The formula reads: The initial investment is subtracted by the yearly net earnings times the actual pay-off time in years until the difference becomes zero.

Putting our values into (8) we get:

$$100\ 000 - 20\ 000 \cdot POT_a = 0$$

giving $POT_a = 5$ years.

In other words, we look for the value of I/E, which is expressed in years. If this is less than the restricted pay-off time, POT_r, the investment is profitable.

We get the following decision rules:

1. If POT_r is larger than or equal to the POT_a, a single investment is profitable.

2. In comparing two or more investment alternatives, the one with the shortest POT_a is the most profitable one, given its POT_a is less than the company's POT_r.

In using the Simple Pay-Off Method, no regard has been taken of the time value of money. In other words, all cash flows are regarded as equally valuable. This is the main objection that has been put forward in criticizing this method. To set aside this criticism, the method has been developed into the next method.

6.3.6 The Modified Pay-Off Method

The Modified Pay-Off Method differs from the previous one only in respect to how the time value of money is treated. The modification means that the company's interest is brought into the picture. This is made simply by putting in the compound discount sum according to Table C in formula (8).

For the Modified Pay-Off Method we get the following formula:

$$I - E \cdot TC_{10}^{POT}a = 0 \qquad (9)$$

The only difference, as compared to formula (8), is that the TC-value is put in. The company's i_r = 10 percent in our basic example, but we do not know for how many years we will make our calculations. The unknown variable, therefore, becomes "the year denotation for Table C". The number of years we put in is the actual pay-off time, POT_a, that we will estimate. Solving this by putting in our basic example figures we get:

$$TC_{10}^{POT}a = \frac{I}{E} = \frac{100\ 000}{20\ 000} = 5.0$$

The quotient I/E is no longer "years" as it was in formula (8). Instead the figure 5.0 represents the Table C-value for a certain number of years, i.e. the unknown variable to be found for 10 percent. Checking the "10 percent column" we find the following table values:

7 years	8 years
4.868	5.335

From this we can conclude that POT_a must be somewhere in between 7 and 8 years. By interpolation we find a more exact estimate.

$$7 + \frac{5.000 - 4.868}{5.335 - 4.868} = 7.28 \text{ years}$$

The decision rules for the Modified Pay-Off Method will be exactly the same as those for the Simple Pay-Off Method. The difference is found only in the way we estimate the POT_a.

6.4 Sensitivity analyses in capital budgeting

As has been pointed out before, all economic decisions are made under uncertainty. Obviously, the degree of uncertainty increases when we have to make decisions with a time span of many years. We cannot reduce the uncertainty as such. But we can get a feeling about what will happen, if we have made mistakes in estimating the figures put into our formulas. To show how we carry out a sensitivity analysis we will put in some further information about our basic example. Let us assume the following:

1. Buying this new lathe will increase the company's fixed costs by MU 8 000 per year.

2. The sales price of the product produced on this lathe has been estimated to MU 12 per unit. Variable costs have been estimated to MU 8, i.e. the product is supposed to give a CTP of MU 4 per unit.

3. The sales volume has been estimated to 7 000 units per year as an average for the whole period.

Consider these figures as the only ones that might fluctuate during the period. We find, if we put them together, that they give the overall figures that we have used so far.

Sales revenues, 7 000 • 12	MU + 84 000
Variable costs, 7 000 • 8	MU - 56 000
Fixed costs per year	MU - 8 000
Net earnings per year (E)	MU = 20 000

There are many ways of making a sensitivity analysis. But there will always be uncertainty about two things - the sales volume and our CTP per unit. The CTP/unit may fluctuate either as a result of price changes or as a result of variations in costs, or, as a combined result of both.

At this stage the decision-maker might ask himself questions such as:

1. How large deviations in my sales forecast can I accept?

2. How does a price fluctuation of plus/minus 10 percent affect my profitability?

3. How does a combined negative change in both prices and sales volumes affect my profitability?

As a matter of fact, we recognize this type of question from Chapter 5, when the budget of our model company was used for sensitivity analyses.

Let us now assume that the price per unit or the variable cost per unit might fluctuate in such a way that the CTP per unit will take on values between MU 3·00 (lowest) and MU 5·00 (highest). Assume further, that these are "safe figures", i.e. are possible extreme figures. In the same way we estimate sales volumes. The maximum sales figure is 9 000 units. Perhaps this is the maximum capacity of the lathe. At a minimum, total sales will be at least 5 000 units per year. Re-writing formula (5) gives:

$$NPV_{10} = (Y \cdot X - 8\ 000) \cdot TC_{10}^{10} - 10\ 000 \cdot TB_{10}^{10} - 100\ 000$$

where: Y = achieved CTP per unit and
X = achieved sales volume per year.

The first term in this equation is equivalent to $E.TC_{10}^{10}$ in formula (5). Before starting the sensitivity analysis we simplify the formula further by finding the values of those terms that will remain the same through the whole process. We get:

$$NPV_{10} = Y \cdot X \cdot 6.145 - 8\ 000 \cdot 6.145 - 10\ 000 \cdot 0.3855 - 100\ 000 \qquad \text{or}$$

$$NPV_{10} = Y \cdot X \cdot 6.145 - 145\ 305$$

Holding X constant at 7 000 units (our original estimate of the sales volume) we change Y successively. Then the process is repeated for X holding Y constant. Finally, we combine changes in both variables and register the resulting NPV:s. The results are shown in Exhibit 6.4.

In Exhibit 6.4 we recognize the NPV_{10}, previously calculated, at the intersection between the row for CTP 4.00 per unit and the column showing a volume of 7 000 units per year. Lowering the sales volume to 6 000 units, still gives a positive NPV (2 175). But at a sales volume of 5 000 units, the NPV becomes negative (-22 405). We can easily find that at exactly 5 911 units per year, the NPV becomes zero. This means that 5 911 units yields exactly 10 percent, given the estimated CTP remain at MU 4.00 per unit.

Keeping the volume constant, allows the CTP to decline to MU 3.20 per unit before the NPV becomes negative. The CTP per unit, which results in a NPV = 0, is found as MU 3.38. In other words, as long as the estimated sales volume remains at 7 000 units, the CTP may shrink to MU 3.38 without violating the company's RRR.

We can notice from Exhibit 6.4 that the investment is very sensitive to volume decreases. A decrease to 5 000 units must be compensated with high increases in the CTP per unit. Combining - even moderate - decreases in both CTP and volume results in a negative NPV.

Sales volumes / CTP:s	5 000	6 000	7 000	8 000	9 000
2.60					-1 512
2.80				-7 657	9 549
3.00				2 175	20 610
3.20			-7 657	12 007	31 671
3.40			946	21 839	42 732
3.60			9 549	31 761	53 793
3.80		-5 199	18 152	41 503	64 854
4.00	-22 405	2 175	26 755	51 335	75 915
4.20	-16 260				
4.40	-10 115				
4.60	- 3 970				
4.80	2.175				

Exhibit 6.4 Changes in NPV:s at 10 percent as a function of combined changes in sales volumes and CTP:s

6.5 Some investment decisions for the model company

Let us now return to our model company budget that we introduced in Chapter 4. The budget presented for this company, was a short-term budget. But we can also use this for long-term capital budgeting. Let us consider two different types of decisions.

6.5.1 Improving the production output

As was mentioned in Chapter 4, the production capacity of our model company is approximately 20 000 m^3 of sawn timber. Despite this, the sawmill has not produced more than 11 200 m^3 during a single year.

The production capacity could be improved, if production stops could be reduced. There are three major problem areas:

1. Many stops are caused by defective parts or by poor maintenance. Improved preventive maintenance should bring down the number of stops.
2. Other stops are caused by problems with the electronic equipment, which obviously is due to the tropical climate. To set aside this problem increased supervision (one or two operators) is required.
3. A third cause for numerous machine stops is the log quality. At present all log storing is made directly on the ground. Especially during the rainy periods, logs are muddy and stones and other particles give rise to many stops. To avoid these stops the storing ground could be covered with tarmac.

The suggested measures are costly. To get a ground for possible decisions, the sawmill manager has, during the past year, recorded number of stops in the sawmill, length and main cause for each stop. A farily correct estimate of stop-times and their causes will be as follows:

Stop cause	No. of hrs during the year
Electronic errors	86
Stones etc. on logs	152
Poor maintenance	166
Miscellanous (the cause has not been clearly identified)	220
Total stop time	624
Total, theoretical production time	2 000
Relative stop-time	31.2%

If all stops could be eliminated, total production, based on last year's production, could be increased up to 10 000/0.688 = 14 535 m^3. Even if this is a highly theoretical figure, the manager realizes that the present situation is unacceptable in the long run.

All recorded stops have accrued in the sawing process. The trimming capacity will suffice for an increased output even up to 15 000 m^3. The kiln capacity is a bottleneck that must be dealt with. This will be discussed in the following section.

To cover the log ground with tarmac is a difficult task. The space is now fully utilized. During the work the stock of logs must be cut down to give sufficient work surface for the tarmac machines. The ground, therefore, has to be covered and the process will be extended over more or less a whole year before log handling can be normalized. This must result in a reduced production volume during the year, estimated at roughly 20 percent - equally spread on both species.

Furthermore, two more men in the production process can be justified. One worker for manual support of the electronic equipment, the other mainly for repair and maintenance work.

The sawmill manager has carried out some preliminary cost estimation for the improved production programme. He has got a tender from the tarmac company, which shows the total cost will be MU 420 000. Two more workers will cost MU 80 000 per year. In all, MU 500 000 for the first year. The figure is frightening.

On the cost savings side, the manager has made a round estimate. For the first year he hopes to reduce production stops by 50 percent as compared to last year's records. For the second year and onwards, he estimates a reduced stop-time of 75 percent. This figure is based on a planned training programme for the workers. Let us base the economic analysis on these figures.

We can now separate his problem into two parts. Employing two more workers will affect stop-times caused by electronic errors and poor maintenance. This will increase labour costs as well as production volume. In Exhibit 5.4 we estimated the lost CTP/hour that the sawmill loses as a result of a production stop. We arrived at a figure of MU 1 893/hour. If hiring two more workers will reduce production stops as planned, the following economic effects will occur.

First year:

$(86 + 166) \cdot 0.8 \cdot 0.5 \cdot 1\,893 =$ MU 190 814

Second year and onwards per year:

$(86 + 166) \cdot 0.75 \cdot 1\,893 =$ MU 357 777

Within parentheses we have the recorded stop-times during the last year. If we do nothing else in the production process, we will have (roughly) the same stop-times also in the future. If we cover the log ground with tarmac, the overall production volume will decrease by 20 percent during the first year, which explains the factor 0.8. Before the training programme has been carried through, the manager has estimated the reduced stop-time to 50 percent. Each hour of reduced stop-time will increase the result of the sawmill by MU 1 893 per hour, or, in total for the first year, MU 190 814. For the second and following years, stop-times will be reduced by 75 percent. At the same time the sawmill will produce at the same total capacity as during the last year. Yearly improvements of the result will amount to MU 357 777.

These estimates are extremely uncertain. Let us, therefore, make a simple sensitivity analysis. Let $\underline{X}$ be the number of hours of reduced stop-times in case two more workers are employed. Without bothering about the first year's reduced production, we ask: How many hours of reduced stop-time must we have per year, in order to justify economically the decision to hire two more labourers? The answer is:

$$1\,893 \cdot X = 80\,000$$

which gives $X = 42.3$ hours.

The original estimate was 126 hours for the first and 189 hours for the second year. Even if these figures are incorrect, the actual stop-time will most probably be reduced by more than 42.3 hours. Employing two more workers seems to be a wise decision.

But this is actually not a capital budgeting decision, as there is no capital investment involved. But the training programme for the workers will cost the sawmill something. This programme will, of course, be directed towards the whole staff. Assume that a very serious programme, bringing in technical consultants for teaching and demonstrations, is planned. Consultancy costs and cost of stopping the production during teaching days will be high. Let us estimate the total cost to MU 300 000. Here the simple pay-off method could be used. But now we must decide on a probable reduction in stop-times. To be very conservative, let us assume 75 hours per year in reduced stop-times. How long will it take before such a training programme has payed back?

The answer is obviously:

$$\frac{300\ 000}{(75 \cdot 1\ 893)} = 2.11 \text{ years}$$

Let us now deal with the tarmac problem. We need precise cost estimates for the reduced production during the first year. In Section 5.2 we studied the sawmill's cost structure. We found that, based on the budget figures, average variable costs for both species amount to MU 580 per m^3. This is, of course, an approximate figure. The split up of total costs in variable and fixed components varies, among other things, for what purpose the analysis is made. In this case, however, variable costs might be higher. The reason is that this is a very special cut in the production. Perhaps disturbances will occur that increase some of the costs. We cannot totally rely on the estimated figure, but this uncertainty can be dealt with in a sensitivity analysis. So, for the moment let us accept a variable cost of MU 580 per m^3.

Costs of reduced production

$300 \cdot 2\ 000 =$ MU 600 000

The figure 300 is the CTP per m^3 estimated in Section 5.2 and 2 000 is the planned production decrease. This cost will occur during the first year only.

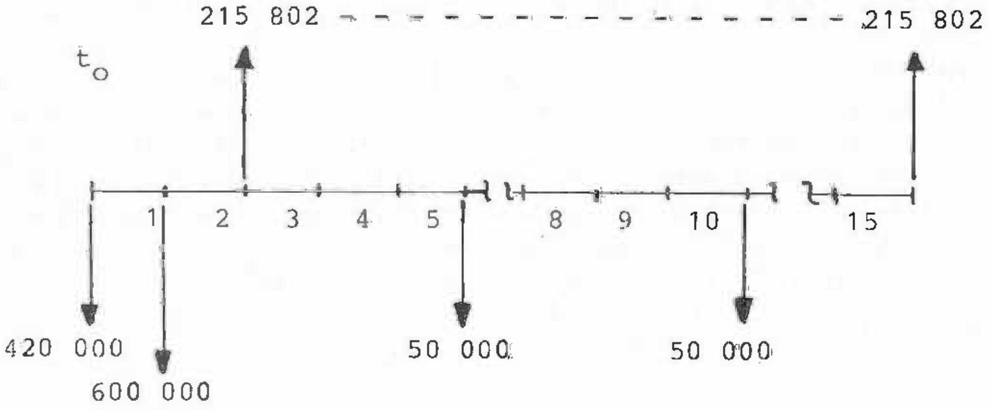
For the second year, as well as the following years, the production volume will increase as a result of improved log quality. Let us assume that stop-times will be reduced by 75 percent.

Increased CTP due to improved log quality

$152 \cdot 0.75 \cdot 1\ 893 =$ MU 215 802

The sawmill manager estimates a useful life for the tarmac ground of 15 years. During this period, he considers it necessary to make imporvements in the surface every five years at a cost of MU 50 000 each time.

The capital budgeting problem can now be shown graphically in the following way:



The investment expense is MU 420 000, placed at $\underline{t_o}$. The first year's production cut, MU 600 000, is placed at the end of the year. Also the CTP-increases, MU 215 802 yearly during 14 years, as well as the maintenance costs, MU 50 000, are placed at the end of each year.

The estimated NPV will be:

$$NPV_{10} = 215\ 802\ TC^{14}_{10} \cdot TB^{1}_{10} - 600\ 000\ TB^{1}_{10} - 50\ 000\ TB^{5}_{10} - 50\ 000\ T^{10}_{10} - 420\ 000$$

$$NPV_{10} = 1\ 445\ 140 - 545\ 400 - 31\ 045 - 19\ 275 - 420\ 000$$

$$NPV_{10} = 429\ 420$$

The yearly increase in CTP, MU 215 802, has been multiplied by two table values. The first value, TC^{1}_{14} discounts the sum of the yearly CTP:s to the beginning of year 2, which is equivalent to the end of year 1. From there, the amount is discounted one year by TB^{1}_{10}.

We have used, as before, a RRR of 10 percent. We get a positive NPV, which actually represents an IRR of almost exactly 17 percent. True, there are uncertainties in our cost estimates. These can be handled in the same way as before, i.e. by means of a sensitivity analysis. In lack of real data, we refer back to the description in Section 6.4. But to indicate the need for such an analysis, it can be pointed out that if only 50 percent of the estimated stop-time can be reduced, the NPV_{10} becomes negative. But at the same time, it is obvious that there is a high "profit potential" in measures that bring down the sawmill's stop-time.

6.5.2 Building a new kiln

In Chapter 4 we learnt that Species B is open air dried. The average work-in-process inventory for Species B was estimated to 1 440 m^3. This inventory tied up a total capital of MU 694 080, the cost of which amounted to MU 69 408 or MU 17.35 per m^3 of sawn timber.

Assume that the sawmill manager wants to bring down this capital cost by building one more kiln. Cost estimates have shown that the type of kiln suitable for the model company will cost MU 400 000.

To estimate the profitability of a new kiln, we have to study all consequences. In doing so, we have to make certain assumptions about the situation. We do not pay too much attention to the figures used. Instead we concentrate on principles.

Let us list, without detailed comments, what costs will be changed in case a kiln is built.

1. Work-in-process inventory, Species B, will decrease.
2. The kiln cannot be run without an operator. Labour costs will increase.
3. Costs of heat and electricity will increase.
4. Artificial drying gives improved product quality, which will reduce costs of refund claims.
5. Handling costs will be reduced due to the smaller inventory.

Let us check possible cost changes as a result of the decsion to build a new kiln.

Reduced inventory costs

The revenues will be unchanged. Economically a new kiln can be justified only by the net cost reduction that will accrue. The most important factor is the reduction in inventory costs. We will assume the following situation.

1. A buffer stock of 50 m^3 of undried timber will be needed. The possible inventory reduction will be 1 440 - 50 = 1 390 m^3. (Cf. Chapters 4 and 5 for information on average inventory).

2. The reduced inventory will increase the sawmill's sales volume, when the present inventory can be sold out. Thereafter, the sales volume will remain the same as before. In order to facilitate increased sales, the inventory will be reduced by only 800 m^3 during the first year. The remaining 590 m^3 will be sold during the second year.

The value of this inventory for this decision will be based on the opportunity cost concept. The sawmill will not get this money at all, unless it builds the kiln. Each sold m^3 will increase the cash inflow by:

Average sales price	MU/m^3	+ 850·00
Cash discounts	"	- 17·00
Sales commissions	"	- 25·50
Opportunity cost	"	= 807·50

Reduction in capital tied up (cash inflow):

First year, 807.50 · 800	MU	646 000
Second year, 807.50 · 590	"	476 425

Labour costs

Labour costs for kiln operations for Species A was estimated to MU 8 000 per year (Cf. Item No. 201 and comments in Chapter 4). We assume that the operator can handle the new kiln more or less simultaneously with the old one. An increased labour time of 25 percent has been assumed for additional work.

Yearly cost increase, labour	MU 2 000

Heating and electricity costs

The yearly heating and electricity costs have been estimated. Joint heating with the old kiln will improve the overall efficiency. Total costs for heating will amount to MU 121 000 per year, after the new kiln has been built. (Cf. Exhibits 4.10 and 5.5 and comments to Item No. 203).

Increased, yearly cost (121 - 94)	MU 27 000

Improved product quality

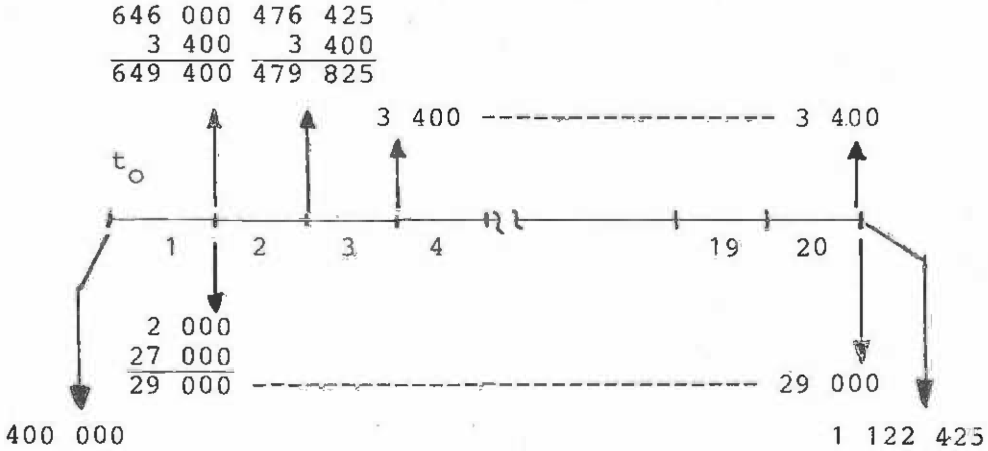
Analyzing refund claims during last year has shown that these costs are 0.1 percent less for Species A than for Species B. This difference is assumed to be assigned to different drying techniques.

Reduced, refund claims, 0.001 · 850 · 4 000 per year	MU 3 400

Handling costs

Cost reductions have been considered too difficult to estimate and, in addition, too insignificant.

Only one more decision must be made, before we put our figures together - to estimate the useful life of the new kiln. Let us assume that this kiln can be used for 20 years. The problem can now be graphically described.



We recognized all figures except the last, downward directed arrow of MU 1 122 425. This amount is the sum of the sold out inventories during years 1 and 2. How come we have put this in as a cash outflow?

If - and only if - the kiln is built, we will get during years 1 and 2 (646 000 + 476 425) i.e. 1 122 425 as a cash inflow. But what will happen, when the company no longer can use the kiln? There are two possibilities. Either the sawmill goes back to natural drying. In that case, a new buffer stock must be built up again, which means lost sales of MU 1 122 425 in current prices. If, on the other hand, a new kiln is built again, this buffer stock does not have to be built up. But that is a new decision. We do not know today what will happen 20 years from now. To simplify things a bit, as we have not discussed the theoretical basis for this decision, we choose to treat the problem as if the comapny should start drying Species B naturally again. As will be shown later on, this amount has no significant effect on our estimates.

Let us now estimate the NPV in the usual way, still using the same RRR: i.e. $\underline{i}_r$ = 10 percent.

$$\begin{aligned} NPV_{10} &= 649\ 400TB_{10}^{1} + 479\ 825TB_{10}^{2} + 3\ 400TC_{10}^{18} \cdot TB_{10}^{2} \\ &- 29\ 000TC_{10}^{20} - 1\ 122\ 425TB_{10}^{20} - 400\ 000 \\ &= 590\ 305 + 396\ 527 + 23\ 045 - 246\ 906 \\ &- 166\ 792 - 400\ 000 \\ NPV_{10} &= 196\ 179 \end{aligned}$$

We find that building a new kiln is most probably a profitable measure. As a matter of fact, all measures that can be taken in a sawmill to reduce various kinds of buffer stock should be carefully analyzed. Especially during high interest periods, the capital tied up in buffer stocks is very costly.

We assume in our estimates that we will have to build up a new buffer stock, when the kiln has worn out. This is of course not too realistic an assumption. But checking the present value of MU 1 122 425, we find that it amounts to "only" 166 792. Let us assume we could increase the useful life of the kiln by another 10 years. The present value of this future amount would then be reduced to MU 64 314. This illustrates the time value of money.

APPENDIX 1: TABLES FOR QUICK ESTIMATIONS OF

- * FUTURE VALUES
- * PRESENT VALUES
- * ANNUITIES

TABLE A: COMPOUNDED AMOUNTS of MU 1,00, i.e. the <u>future value</u> of MU 1,00

Year (n)	Interest (i)															
	4 %	6 %	8 %	10 %	12 %	14 %	15 %	16 %	18 %	20 %	25 %	30 %	35 %	40 %	45 %	50 %
1	1.0400	1,0600	1,0800	1.100	1,1200	1,1400	1,1500	1,1600	1,1800	1,2000	1,2500	1,300	1,3500	1,4000	1.4500	1,5000
2	1.0816	1,1236	1,1664	1,2100	1,2544	1.2996	1,3226	1.3456	1.3924	1,4400	1.5625	1,6900	1,8225	1.9600	2,1025	2,2500
3	1,1249	1,1910	1.2597	1.3310	1.4049	1,4815	1.5209	1.5609	1,6430	1,7280	1,9531	2,1970	2,4604	2,7440	3,0486	3.3750
4	1,1699	1,2625	1.3605	1,4641	1,5735	1,6890	1.7489	1,8106	1,9388	2,0736	2,4414	2,8561	3,3215	3,8416	4,4205	5,0625
5	1,2157	1,3382	1,4693	1,6105	1,7623	1,9254	2,0113	2,1003	2,2878	2,4883	3,0518	3,7129	4,4840	5,3782	6,4097	7,5938
6	1,2653	1,4185	1,5869	1,7716	1.9738	2.1950	2,3132	2,4364	2,6996	2,9860	3,8147	4,8268	6,0534	7,5295	9,2941	11,3906
7	1,3159	1,5036	1,7138	1,9487	2,2107	2,5023	2,6603	2,8262	3,1855	3,5832	4,7684	6,2749	8,1722	10,5414	13,4765	17,0859
8	1,3686	1,5938	1,8509	2,1436	2,4760	2,8526	3,0590	3,2784	3,7589	4,2998	5,9605	8,1573	11,0324	14,7579	19,5409	25,6289
9	1,4233	1.6895	1,9990	2.3579	2,7731	3.2519	3,5174	3.8030	4,4355	5.1598	7.4506	10,6045	14,8937	20.6610	28,3343	38,4434
10	1,4802	1.7908	2,1589	2,5937	3,1058	3,7072	4,0453	4,4114	5,2338	6,1917	9,3132	13,7858	20,1066	28,9255	41,0847	57,6650
11	1,5395	1,8983	2,3316	2,8531	3,4785	4,2262	4,6533	5,1173	6.1759	7,4301	11,6415	17,9216	27,1439	40,4957	59,5728	86,4976
12	1,6010	2,0122	2,5182	3,1384	3,8960	4,8179	5,3505	5,9360	7,2876	8,9161	14,5519	23,2981	36,6442	56,6939	86,3806	129,7463
13	1,6651	2,1329	2,7196	3,4523	4,3635	5,4924	6,1538	6,8858	8,5994	10,6993	18,1899	30,2875	49,4697	79,3715	125,2518	194,6195
14	1,7317	2,2609	2,9372	3,7975	4,8871	6,2613	7,0771	7,9875	10,1472	12,8392	22,7374	39,3738	66,7840	111,1201	181,6151	291,9293
15	1,8009	2,3966	3,1722	4,1772	5,4736	7,1379	8,1367	9,2655	11,9737	15,4070	28,4217	51,1859	90,1585	155,5681	263,3419	437,8939
16	1,8730	2,5404	3,4259	4,5950	6,1304	8,1372	9,3545	10,7480	14,1290	18,4884	35,5991	66,5417	121,7139	217,7953	381,8458	656,8408
17	1,9479	2,6928	3,7000	5,0545	6,8660	9,2765	10,7643	12,4677	16,6722	22,1861	44,4089	86,5042	164,3138	304,9135	553,6764	985,2613
18	2,0258	2,8543	3,9960	5,5599	7,6900	10,5752	12,3762	14,4625	19,6733	26,6233	55,5112	112,4554	221,8236	426,8788	802,8308	1477,8919
19	2,1068	3,0256	4,3157	6,1159	8,6128	12,0057	14,2248	16,7765	23,2144	31,9480	69,3889	146,1920	299,4619	597,6304	1164,1047	2216,8387
20	2,1911	3,2071	4,6610	6,7275	9,6463	13,7435	16,3666	19,4608	27,3930	38,3376	86,7362	190,0496	404,2736	836,6825	1687,9518	3325,2567
25	2,6658	4,2919	6,8485	10,8347	17,0001	26,4619	32,8947	40,8742	62,6686	95,3962	264,6978	705,6410	1812,7762	4499,8793	10819,3217	25251,1681

TABLE B: THE PRESENT VALUE of MU 1,00 (single amounts)

Year (n)	Interest (i)																						
	4 %	5 %	6 %	7 %	8 %	9 %	10 %	11 %	12 %	13 %	14 %	15 %	16 %	17 %	18 %	19 %	20 %	25 %	30 %	35 %	40 %	45 %	50 %
1	0.9615	0.9523	0.9434	0.9345	0.9259	0.9174	0.9090	0.9009	0.8928	0.8849	0.8771	0.8695	0.8620	0.8547	0.8474	0.8403	0.8333	0.8000	0.7692	0.7407	0.7142	0.6896	0.6666
2	0.9245	0.9070	0.8900	0.8734	0.8573	0.8416	0.8264	0.8116	0.7971	0.7831	0.7694	0.7561	0.7431	0.7305	0.7181	0.7061	0.6944	0.6400	0.5917	0.5487	0.5102	0.4756	0.4444
3	0.8890	0.8638	0.8396	0.8163	0.7938	0.7721	0.7513	0.7311	0.7117	0.6930	0.6749	0.6575	0.6406	0.6243	0.6086	0.5934	0.5787	0.5120	0.4551	0.4064	0.3644	0.3280	0.2963
4	0.8548	0.8227	0.7920	0.7629	0.7350	0.7084	0.6830	0.6578	0.6355	0.6133	0.5920	0.5717	0.5522	0.5336	0.5157	0.4986	0.4822	0.4096	0.3501	0.3010	0.2603	0.2262	0.1975
5	0.8219	0.7835	0.7472	0.7129	0.6805	0.6499	0.6209	0.5934	0.5674	0.5427	0.5193	0.4971	0.4761	0.4561	0.4371	0.4190	0.4018	0.3276	0.2693	0.2230	0.1859	0.1560	0.1316
6	0.7903	0.7462	0.7049	0.6663	0.6301	0.5962	0.5644	0.5346	0.5066	0.4803	0.4555	0.4323	0.4104	0.3898	0.3704	0.3521	0.3349	0.2621	0.2071	0.1652	0.1328	0.1075	0.0877
7	0.7599	0.7106	0.6650	0.6227	0.5834	0.5470	0.5131	0.4816	0.4523	0.4250	0.3996	0.3759	0.3538	0.3332	0.3139	0.2959	0.2790	0.2097	0.1593	0.1223	0.0948	0.0742	0.0585
8	0.7306	0.6768	0.6274	0.5820	0.5402	0.5018	0.4665	0.4339	0.4038	0.3761	0.3505	0.3269	0.3050	0.2847	0.2660	0.2486	0.2325	0.1677	0.1225	0.0906	0.0677	0.0511	0.0390
9	0.7025	0.6446	0.5919	0.5439	0.5002	0.4604	0.4241	0.3909	0.3606	0.3328	0.3075	0.2842	0.2629	0.2434	0.2254	0.2089	0.1938	0.1342	0.0943	0.0671	0.0484	0.0352	0.0260
10	0.6755	0.6139	0.5583	0.5083	0.4631	0.4224	0.3855	0.3521	0.3219	0.2945	0.2697	0.2471	0.2266	0.2080	0.1910	0.1756	0.1615	0.1073	0.0725	0.0497	0.0345	0.0243	0.0173
11	0.6495	0.5846	0.5267	0.4750	0.4288	0.3875	0.3504	0.3172	0.2874	0.2607	0.2366	0.2149	0.1954	0.1778	0.1619	0.1475	0.1345	0.0859	0.0558	0.0368	0.0246	0.0167	0.0115
12	0.6246	0.5568	0.4969	0.4440	0.3971	0.3555	0.3186	0.2858	0.2566	0.2307	0.2075	0.1869	0.1684	0.1519	0.1372	0.1240	0.1121	0.0687	0.0429	0.0272	0.0176	0.0115	0.0077
13	0.6005	0.5303	0.4688	0.4149	0.3677	0.3261	0.2896	0.2575	0.2291	0.2041	0.1820	0.1625	0.1452	0.1298	0.1162	0.1042	0.0934	0.0549	0.0330	0.0202	0.0126	0.0079	0.0051
14	0.5774	0.5050	0.4423	0.3878	0.3404	0.2992	0.2633	0.2319	0.2046	0.1806	0.1597	0.1413	0.1252	0.1110	0.0985	0.0875	0.0778	0.0439	0.0254	0.0149	0.0090	0.0055	0.0034
15	0.5552	0.4810	0.4172	0.3624	0.3152	0.2745	0.2393	0.2090	0.1827	0.1598	0.1401	0.1228	0.1079	0.0948	0.0835	0.0735	0.0649	0.0351	0.0195	0.0110	0.0064	0.0038	0.0022
16	0.5339	0.4581	0.3936	0.3387	0.2918	0.2518	0.2176	0.1882	0.1631	0.1415	0.1228	0.1068	0.0930	0.0811	0.0707	0.0618	0.0540	0.0281	0.0150	0.0082	0.0045	0.0026	0.0015
17	0.5133	0.4363	0.3713	0.3165	0.2702	0.2310	0.1978	0.1696	0.1456	0.1252	0.1078	0.0929	0.0802	0.0693	0.0599	0.0519	0.0450	0.0225	0.0115	0.0060	0.0032	0.0018	0.0010
18	0.4936	0.4155	0.3503	0.2958	0.2502	0.2119	0.1798	0.1528	0.1300	0.1108	0.0945	0.0808	0.0691	0.0592	0.0508	0.0436	0.0375	0.0180	0.0088	0.0045	0.0023	0.0012	0.0006
19	0.4746	0.3957	0.3305	0.2765	0.2317	0.1944	0.1635	0.1376	0.1161	0.0980	0.0829	0.0702	0.0596	0.0506	0.0430	0.0367	0.0313	0.0144	0.0068	0.0033	0.0016	0.0008	0.0004
20	0.4563	0.3768	0.3118	0.2584	0.2145	0.1784	0.1486	0.1240	0.1036	0.0867	0.0727	0.0611	0.0513	0.0432	0.0365	0.0308	0.0260	0.0115	0.0052	0.0024	0.0012	0.0005	0.0003
21	0.4388	0.3589	0.2941	0.2415	0.1986	0.1637	0.1351	0.1117	0.0925	0.0768	0.0638	0.0531	0.0443	0.0369	0.0309	0.0259	0.0217	0.0092	0.0040	0.0018	0.0008	0.0004	0.0002
22	0.4219	0.3418	0.2775	0.2257	0.1839	0.1501	0.1228	0.1006	0.0826	0.0679	0.0559	0.0462	0.0381	0.0316	0.0262	0.0217	0.0181	0.0073	0.0031	0.0013	0.0006	0.0002	0.0001
23	0.4057	0.3255	0.2618	0.2109	0.1703	0.1377	0.1116	0.0906	0.0737	0.0601	0.0491	0.0401	0.0329	0.0270	0.0222	0.0183	0.0150	0.0059	0.0023	0.0010	0.0004	0.0001	
24	0.3901	0.3100	0.2464	0.1971	0.1577	0.1269	0.1015	0.0817	0.0658	0.0532	0.0430	0.0349	0.0283	0.0231	0.0188	0.0153	0.0125	0.0047	0.0018	0.0007	0.0003	0.0001	
25	0.3751	0.2953	0.2330	0.1842	0.1460	0.1159	0.0923	0.0736	0.0588	0.0471	0.0377	0.0303	0.0244	0.0197	0.0159	0.0129	0.0104	0.0037	0.0014	0.0005	0.0002		
30	0.3083	0.2313	0.1741	0.1313	0.0993	0.0753	0.0573	0.0436	0.0333	0.0255	0.0196	0.0151	0.0116	0.0090	0.0069	0.0054	0.0042	0.0012	0.0003	0.0001			
35	0.2534	0.1812	0.1301	0.0936	0.0676	0.0489	0.0355	0.0259	0.0189	0.0138	0.0101	0.0075	0.0055	0.0041	0.0030	0.0022	0.0016	0.0004	0.0001				
40	0.2082	0.1420	0.0972	0.0667	0.0460	0.0318	0.0220	0.0153	0.0107	0.0075	0.0052	0.0037	0.0026	0.0018	0.0013	0.0009	0.0006	0.0001					
50	0.1407	0.0872	0.0543	0.0339	0.0213	0.0134	0.0085	0.0054	0.0035	0.0022	0.0014	0.0009	0.0006	0.0003	0.0002	0.0001	0.0001						

TABLE C: THE PRESENT VALUE SUM of MU 1,00 paid each year (a series of equally large amounts)

Year (n)	Interest (r)																						
	4 %	5 %	6 %	7 %	8 %	9 %	10 %	11 %	12 %	13 %	14 %	15 %	16 %	17 %	18 %	19 %	20 %	25 %	30 %	35 %	40 %	45 %	50 %
1	0.962	0.952	0.943	0.935	0.926	0.917	0.909	0.901	0.893	0.885	0.877	0.870	0.862	0.855	0.847	0.840	0.833	0.800	0.769	0.741	0.714	0.690	0.667
2	1.886	1.859	1.833	1.808	1.783	1.759	1.736	1.713	1.690	1.668	1.647	1.626	1.605	1.585	1.566	1.546	1.528	1.440	1.361	1.289	1.224	1.165	1.111
3	2.775	2.723	2.673	2.624	2.577	2.531	2.487	2.444	2.399	2.361	2.322	2.283	2.246	2.210	2.174	2.140	2.106	1.952	1.816	1.696	1.589	1.493	1.407
4	3.630	3.546	3.465	3.387	3.312	3.240	3.170	3.102	3.035	2.974	2.914	2.855	2.798	2.743	2.690	2.639	2.589	2.362	2.166	1.997	1.849	1.720	1.605
5	4.452	4.329	4.212	4.100	3.993	3.890	3.791	3.696	3.602	3.517	3.433	3.352	3.274	3.199	3.127	3.058	2.991	2.689	2.436	2.220	2.035	1.876	1.737
6	5.242	5.076	4.917	4.767	4.623	4.486	4.355	4.231	4.109	3.998	3.889	3.784	3.685	3.589	3.498	3.410	3.326	2.951	2.643	2.385	2.168	1.983	1.824
7	6.002	5.786	5.582	5.389	5.206	5.033	4.868	4.712	4.561	4.423	4.288	4.160	4.039	3.922	3.812	3.706	3.605	3.161	2.802	2.508	2.263	2.057	1.883
8	6.733	6.463	6.210	5.971	5.747	5.535	5.335	5.146	4.965	4.799	4.639	4.487	4.344	4.207	4.078	3.954	3.837	3.329	2.925	2.598	2.331	2.109	1.922
9	7.435	7.108	6.802	6.515	6.247	5.995	5.759	5.537	5.326	5.132	4.946	4.772	4.607	4.451	4.303	4.163	4.031	3.463	3.019	2.665	2.379	2.144	1.948
10	8.111	7.722	7.360	7.024	6.710	6.418	6.145	5.889	5.648	5.426	5.216	5.019	4.833	4.659	4.494	4.339	4.192	3.570	3.091	2.715	2.414	2.168	1.965
11	8.760	8.306	7.887	7.499	7.139	6.805	6.495	6.207	5.935	5.687	5.453	5.234	5.029	4.836	4.656	4.487	4.327	3.656	3.147	2.752	2.438	2.185	1.977
12	9.385	8.863	8.384	7.943	7.536	7.161	6.814	6.492	6.192	5.918	5.660	5.421	5.197	4.988	4.793	4.611	4.439	3.725	3.190	2.779	2.456	2.196	1.985
13	9.986	9.394	8.853	8.358	7.904	7.487	7.103	6.750	6.421	6.122	5.842	5.583	5.342	5.118	4.910	4.715	4.533	3.780	3.223	2.799	2.469	2.204	1.990
14	10.563	9.899	9.295	8.745	8.244	7.786	7.367	6.982	6.626	6.302	6.002	5.724	5.468	5.229	5.008	4.802	4.610	3.824	3.249	2.814	2.478	2.210	1.993
15	11.118	10.380	9.712	9.108	8.559	8.061	7.606	7.191	6.808	6.462	6.142	5.847	5.575	5.324	5.092	4.876	4.675	3.859	3.268	2.825	2.484	2.214	1.995
20	13.590	12.462	11.470	10.594	9.818	9.129	8.514	7.963	7.467	7.025	6.623	6.259	5.929	5.628	5.353	5.101	4.870	3.954	3.316	2.850	2.497	2.221	1.999
25	15.622	14.094	12.783	11.654	10.675	9.823	9.077	8.422	7.841	7.330	6.873	6.464	6.097	5.766	5.467	5.195	4.948	3.985	3.329	2.856	2.499	2.222	2.000
30	17.292	15.372	13.765	12.409	11.258	10.274	9.426	8.694	8.053	7.497	7.003	6.565	6.178	5.829	5.517	5.234	4.979	3.995	3.332	2.857	2.500	2.222	2.000
35	18.664	16.374	14.498	12.948	11.654	10.566	9.644	8.855	8.174	7.588	7.070	6.616	6.216	5.859	5.539	5.251	4.992	3.999	3.333	2.857	2.500	2.222	2.000
40	19.793	17.159	15.046	13.332	11.925	10.757	9.779	8.951	8.242	7.638	7.105	6.642	6.235	5.873	5.548	5.258	4.997	4.000	3.333	2.857	2.500	2.222	2.000
50	21.482	18.256	15.762	13.801	12.233	10.962	9.915	9.042	8.304	7.675	7.133	6.660	6.246	5.880	5.554	5.262	4.999	4.000	3.333	2.857	2.500	2.222	2.000

TABLE D: THE ANNUITY FACTORS, i.e. the yearly amount to be paid in order to amortize (depreciate) an amount of MU 1,00

Year (n)	Interest (i)																					
	4 %	5 %	6 %	7 %	8 %	9 %	10 %	11 %	12 %	13 %	14 %	15 %	16 %	17 %	18 %	19 %	20 %	25 %	30 %	35 %	40 %	45 %	50 %
1	1.0400	1.0500	1.0600	1.0700	1.0800	1.0900	1.1000	1.1100	1.1200	1.1300	1.1400	1.1500	1.1600	1.1700	1.1800	1.1900	1.2000	1.2500	1.3000	1.3500	1.4000	1.4500	1.5000
2	0.5302	0.5378	0.5454	0.5531	0.5608	0.5685	0.5762	0.5839	0.5917	0.5995	0.6073	0.6151	0.6230	0.6308	0.6387	0.6466	0.6545	0.6944	0.7348	0.7755	0.8167	0.8582	0.9000
3	0.3603	0.3672	0.3741	0.3810	0.3880	0.3951	0.4021	0.4092	0.4164	0.4235	0.4307	0.4380	0.4453	0.4526	0.4599	0.4673	0.4747	0.5123	0.5506	0.5897	0.6294	0.6697	0.7105
4	0.2755	0.2820	0.2886	0.2952	0.3019	0.3087	0.3155	0.3223	0.3292	0.3362	0.3432	0.3503	0.3574	0.3645	0.3717	0.3790	0.3863	0.4234	0.4616	0.5008	0.5408	0.5816	0.6231
5	0.2246	0.2310	0.2374	0.2439	0.2505	0.2571	0.2638	0.2706	0.2774	0.2843	0.2913	0.2983	0.3054	0.3126	0.3198	0.3270	0.3344	0.3718	0.4106	0.4505	0.4914	0.5332	0.5758
6	0.1908	0.1970	0.2034	0.2098	0.2163	0.2229	0.2296	0.2364	0.2432	0.2502	0.2572	0.2642	0.2714	0.2786	0.2859	0.2933	0.3007	0.3388	0.3784	0.4193	0.4613	0.5043	0.5481
7	0.1666	0.1728	0.1791	0.1856	0.1921	0.1987	0.2054	0.2122	0.2191	0.2261	0.2332	0.2404	0.2476	0.2550	0.2624	0.2698	0.2774	0.3163	0.3569	0.3988	0.4419	0.4860	0.5311
8	0.1485	0.1547	0.1610	0.1675	0.1740	0.1807	0.1874	0.1943	0.2013	0.2084	0.2156	0.2229	0.2302	0.2377	0.2452	0.2529	0.2606	0.3004	0.3419	0.3849	0.4291	0.4743	0.5203
9	0.1345	0.1407	0.1470	0.1535	0.1601	0.1668	0.1736	0.1806	0.1877	0.1949	0.2022	0.2096	0.2171	0.2247	0.2324	0.2402	0.2481	0.2888	0.3312	0.3752	0.4203	0.4665	0.5133
10	0.1233	0.1295	0.1359	0.1424	0.1490	0.1558	0.1627	0.1698	0.1770	0.1843	0.1917	0.1993	0.2069	0.2147	0.2225	0.2305	0.2385	0.2801	0.3235	0.3683	0.4143	0.4612	0.5088
11	0.1141	0.1204	0.1268	0.1334	0.1401	0.1469	0.1540	0.1611	0.1684	0.1758	0.1834	0.1911	0.1989	0.2068	0.2148	0.2229	0.2311	0.2735	0.3177	0.3634	0.4101	0.4577	0.5058
12	0.1065	0.1128	0.1193	0.1259	0.1327	0.1396	0.1468	0.1540	0.1614	0.1690	0.1767	0.1845	0.1924	0.2005	0.2086	0.2169	0.2253	0.2684	0.3134	0.3598	0.4072	0.4553	0.5039
13	0.1001	0.1065	0.1130	0.1197	0.1265	0.1336	0.1408	0.1482	0.1557	0.1634	0.1712	0.1791	0.1872	0.1954	0.2037	0.2121	0.2206	0.2645	0.3102	0.3572	0.4051	0.4536	0.5026
14	0.0947	0.1010	0.1076	0.1143	0.1213	0.1284	0.1357	0.1432	0.1509	0.1587	0.1666	0.1747	0.1829	0.1912	0.1997	0.2082	0.2169	0.2615	0.3078	0.3553	0.4036	0.4525	0.5017
15	0.0899	0.0963	0.1030	0.1098	0.1168	0.1241	0.1315	0.1391	0.1468	0.1547	0.1628	0.1710	0.1794	0.1878	0.1964	0.2051	0.2139	0.2591	0.3060	0.3539	0.4026	0.4517	0.5011
20	0.0736	0.0802	0.0872	0.0944	0.1018	0.1095	0.1175	0.1256	0.1339	0.1423	0.1510	0.1597	0.1687	0.1777	0.1868	0.1960	0.2054	0.2529	0.3016	0.3509	0.4005	0.4503	0.5001
25	0.0640	0.0709	0.0782	0.0858	0.0937	0.1018	0.1102	0.1187	0.1275	0.1364	0.1455	0.1547	0.1640	0.1734	0.1829	0.1925	0.2021	0.2510	0.3004	0.3502	0.4001	0.4500	0.5000
30	0.0578	0.0650	0.0726	0.0806	0.0888	0.0973	0.1061	0.1150	0.1241	0.1334	0.1428	0.1523	0.1619	0.1715	0.1813	0.1910	0.2008	0.2503	0.3001	0.3500	0.4000		
35	0.0536	0.0611	0.0690	0.0772	0.0858	0.0946	0.1037	0.1129	0.1223	0.1318	0.1414	0.1511	0.1609	0.1707	0.1805	0.1904	0.2003	0.2501	0.3000				
40	0.0505	0.0583	0.0665	0.0750	0.0839	0.0930	0.1023	0.1117	0.1213	0.1310	0.1407	0.1506	0.1604	0.1703	0.1802	0.1901	0.2001	0.2500					
50	0.0466	0.0548	0.0634	0.0725	0.0817	0.0912	0.1009	0.1106	0.1204	0.1303	0.1402	0.1501	0.1601	0.1701	0.1800	0.1900	0.2000						