

Capital Investment Analysis

A problem oriented language with built-in facilities
for sensitivity analysis and simulation

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The article describes a problem oriented computer language which can assist a decisionmaker in analysing his investment problems before he commits himself to capital expenditures. The theory behind the sensitivity analyses and simulations which can be made by the system is explained in details, and finally the use of the system is demonstrated by an example of an investment problem.

1. Introduction

It is an exception if an investment decision can be made under full certainty. Expectations as to future income – which is hoped to be derived from the investment – will almost always be estimated with more or less uncertainty. Therefore, it is of great importance that the decision maker is aware of this uncertainty, and that he tries to analyse the consequences it may have to the profitability of the project.

One way of obtaining greater knowledge is to make sensitivity analyses which can give information about which parts of the model are the most critical ones and where it is therefore important to obtain as accurate data as possible.

Sensitivity analyses itself gives no information about the uncertainty of the data which are used, it only can tell something about which intervals certain data should be kept within if the project should give a certain profitability. Thereafter it is left to the decision maker to judge whether uncertainty about the used data will be within these boundaries.

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The other way that is open if one wants to have a more detailed picture of a project is to use simulations. The decision maker must here in advance make a judgement of the uncertainties of the used data, and the model must be formulated in such a way that the judged uncertainties can be taken into account in the calculations. The result of such a simulation can for example be a probability distribution of the present day value of the project.

2. Description of the System

The following is a description of a problem oriented computer language which makes it very easy for the user to model his problem and to make the simulations and the sensitivity analysis mentioned before. The philosophy behind the system is a split-up of the problem in two parts:

1. Data definition
2. Report definition

This philosophy is also behind the way in which the user builds up his investment model. In the first part of the input to the system all data relevant to the model are defined, and the second part defines all the wanted reports and analysis. In doing so a great advantage is achieved for the user, as a change in the basic data only have to be registered in one place, and the system will hereafter make sure that the changes will be taken into account anywhere in the model it is needed. From this follows that alternative analyses are very easy to carry out.

2.1. Definition of Data

As mentioned earlier, the input starts by defining all relevant data. The system distinguishes between the following types of data: investment data, fixed income and cost, depreciations, sales/capacity data, variable costs and finally variable income. All read data are stored in tables with the following lay-out:

	Type			
	Forecast 1	forecast 2	forecast 3
Year 1	Numeric data			
Year 2				
⋮				
⋮				
Year 20				

Table 2.1.

In the table, "type" stands for one of the above mentioned data types. There will therefore normally be at least 6 tables, i.e. one for each data type. However, very often more tables will be present, because variable cost and income can consist of several tables namely one table for each element which goes into the cost or income. One might for example think of a table for variable production cost, and another table for variable transportation cost. The total variable cost will then be the sum of these two elements.

Each column in the table contains data related to a certain part of the model. For sales/capacity data, variable cost and variable income it could be a column for each product which goes into the investment model. The table for sales/capacity data will then for each product have a column that contains information about the expected sales/production of that particular product. In the same way the tables for variable cost and income will have a column for the cost and income which are related to the sales/production given in the sales/capacity table.

Each row in a table holds data for one year, and the system has the possibility of going up to 20 years.

The table for investments will keep information about the investments which are necessary for the project. For example, the first element in a column could keep information about investment in a new machine, and the following elements in that column could then have information about the investments that the new machine implies in the years to come, and finally, the last element which is equivalent to the last year of the machine's life time can have the residual value.

All income and cost not directly related to volume are stored in the table for fixed income and cost, that could be maintenance, rent as a cost or income and so forth. Each group of fixed cost or income can be read in as a separate column in the table and the system will automatically take care of the necessary summations. The criteria for whether certain data should be defined as investments or as fixed cost is a question about taxation. Those data which are defined as fixed cost will automatically be deducted for tax purpose the same year as they occur, whereas data defined as investments does not effect the tax calculations.

The last table, depreciations, holds all the information about how much the depreciations can be on each investment for each year. These data are only used for tax calculations, and does not effect the cash flow before tax.

Very often it involves quite some work to obtain and calculate the data which should go into a model. Very often, one will see that there is a relation between production of different products or between cost and income of products. The system has therefore been built in such a way

that data can be given either explicitly or implicitly. By explicit data definition is meant that the exact value which should go into a certain table in a certain column in a certain year must be punched in a punch card. By implicit data definition is meant that the equation from which the data can be calculated, using earlier defined data, can be punched in a punch card, and the system will then carry out the necessary calculations.

2.2. Report Specifications

When all the necessary data has been defined, the report specifications can start. The user can here define which reports he wants to have in terms of contents and form. He can choose between print out in table forms or as curves, or he can ask for special sensitivity or simulation reports.

The system makes it possible for the user to ask questions of the type: "How much should the sales of a certain product change?", "How much should the price or the cost of one or several products change?", "How much should a certain group of investments and/or cost and income change?" in order to achieve a certain earning power. By asking this type of questions to the system the decision maker will get a much more detailed picture of the project possibilities and profitability than the conventional investment calculations can give.

The answers will tell which elements in the model are the most critical ones, and how broad the margin to operate within is.

To each of the above mentioned questions the system will give two sets of answers, namely one set based on the result before tax, and one set which is valid for the result after tax. Each set has again two answers, first how big the changes should be per year, in percentage of the original data, the assumption here is that the percentage change is the same for every year of the project's life-time. Secondly, the answer will tell, how much the change should be per year in absolute figures, the assumption here is that the change in absolute figures for each year of the project's life-time is constant.

Another very important type of report is based on stochastic simulation. The user must here give an estimate of the uncertainty on the different forecasts which goes into the model, f. ex. that the selling price can vary within $\pm 10\%$ and the production cost within $\pm 15\%$ and that the sales at the same time can vary within $\pm 8\%$. The system will then generate a number of forecasts which are within the given variation intervals, and then calculate the resulting present day value. The result will be given as a probability distribution for the present day value.

2.3. System Structure

Figure 1 shows, how the system is built up of two main parts. The first part will read in all data and store them in tables as described earlier. When the input stream comes to the report specifications, control is given to the other part of the system, where all analyses are made, and where the building up and the printing out of reports are made. Figure 2 shows in broad outline the progress in the calculations. First all variable cost and income are picked up for each product to give the contribution margin per unit per product for each year. Then the contribution margins per unit are multiplied by the respective quantities to obtain the contribution margin per product for the equivalent year. The next will be that the total variable income and cost will be added to the fixed income and cost. The tax calculations can now be made on this sum minus depreciations. The only thing which is left now, is to take the investments into account before the results before and after tax for each year of the project's life-time can be calculated. If the user only wants print-outs in the form of tables and curves for the different forecasts, no further calculations are necessary, but in case he wants sensitivity analysis and simulation reports, further and more complicated calculations have to be carried out. These calculations will be explained in detail in the following.

3. Sensitivity Analysis and Simulation

If the result in year t is given the name R_t the project's present day value with a given discount rate, r , is calculated in the following way:

$$K = \sum_{t=1}^L R_t (1+r)^{-t} \quad (1)$$

where L is the project's life-time.

If one wants to determine the earning power, i , one has to solve the following equation for i :

$$0 = \sum_{t=1}^L R_t (1+i)^{-t} \quad (2)$$

By means of these two basic equations it is, however, possible to get much more relevant information out.

If the result of the year is broken down into its main components, it could be written as follows:

$$R_t = \left(\sum_j (P_j - C_j) S_j - \sum_k F_k \right)_t (1-T)_t - \sum_m I_{m,t} + \sum_m D_{m,t} T_t \quad (3)$$

where P_j stands for selling price for product j
 C_j stands for variable cost for product j
 S_j stands for sales of product j
 F_k stands for fixed cost of type k
 T stands for the tax percentage
 I_m stands for investment no m
 D_m stands for depreciation on investment no m
 t stands for the actual year

If all the used data have a certain error in them (indicated with small letters) one will get:

$$\begin{aligned}
 R_t + r_t = & \left[\sum_j (P_j + p_j - C_j - c_j) (S_j + s_j) - \sum_k (F_k + f_k) \right]_t (1-T)_t \\
 - & \sum_m (I_m + i_m)_t + \sum_m D_m + d_m)_t T_t
 \end{aligned} \quad (4)$$

which is very easy rewritten to:

$$\begin{aligned}
 R_t + r_t = & \left(\sum_j (P_j - C_j) S_j - \sum_k F_k \right)_t (1-T)_t - \sum_m I_{m,t} + \sum_m D_{m,t} T_t \\
 + & \left(\sum_j (S_j p_j - S_j c_j + P_j s_j - C_j s_j + p_j s_j - c_j s_j) - \sum_k f_k \right)_t (1-T)_t \\
 - & \sum_m i_{m,t} + \sum_m d_{m,t} T_t
 \end{aligned} \quad (5)$$

As the three first elements (the first line) equals the original R_t value the error on R_t is given by:

$$\begin{aligned}
 r_t = & \left(\sum_j (S_j p_j - S_j c_j + P_j s_j - C_j s_j + p_j s_j - c_j s_j) - \sum_k f_k \right)_t (1-T)_t \\
 - & \sum_m i_{m,t} + \sum_m d_{m,t} T_t
 \end{aligned} \quad (6)$$

If we now go back to the expression for the present day value (1)

$$K = \sum_{t=1}^L R_t (1+r)^{-t} \quad (7)$$

that expression can, when the error is taken into account be written

$$K + k = \sum_{t=1}^L (R_t + r_t) (1+r)^{-t} \quad (8)$$

From this expression we can find an expression for the error on the present day value which will be:

$$k = \sum_{t=1}^L r_t (1+r)^{-t} \quad (9)$$

by inserting the expression for the annual error, (6), this may be written

$$k = \sum_{t=1}^L \left[\left(\sum_j (S_j p_j - S_j c_j + P_j s_j - C_j s_j + p_j s_j - c_j s_j) - \sum_k f_k \right)_t (1-T)_t \right. \\ \left. - \sum_m i_{m,t} + \sum_m d_{m,t} T_t \right] (1+r)^{-t} \quad (10)$$

In order to progress with this expression it is necessary to make certain assumptions about the errors. In the system this expression is dealt with under two different assumptions, partly that the percentage error is constant, and partly that the numeric value of the error is constant.

3.1. Constant Percentage Error

The first assumption is that the error can be expressed in percentages, which for a certain variable is a constant percentage for the whole life-time of the project. Thereafter, it is assumed that the error for a certain variable will have a certain numeric value which is a constant for the whole life-time of the project.

By regrouping the elements in the expression for k , this can be written as:

$$k = \sum_j \sum_{t=1}^L (S_j p_j - S_j c_j + P_j s_j - C_j s_j + p_j s_j - c_j s_j)_t (1-T)_t (1+r)^{-t} \\ - \sum_k \sum_{t=1}^L f_{k,t} (1-T)_t (1+r)^{-t} - \sum_m \sum_{t=1}^L i_{m,t} (1+r)^{-t} \\ + \sum_m \sum_{t=1}^L d_{m,t} T_t (1+r)^{-t} \quad (11)$$

First assumption was that the errors could be expressed as percentages, which gives

$$\begin{aligned} p_j &= P_j p_j \% \\ s_j &= S_j s_j \% \\ c_j &= C_j c_j \% \\ f_k &= F_k f_k \% \\ i_m &= I_m i_m \% \\ d_m &= D_m d_m \% \end{aligned}$$

Where the left hand side gives the absolute error, whereas the right hand side should be read as the original variable, multiplied by their

percentage error. If these expressions are introduced in the expression for k (11), and at the same time errors of the second order are neglected, one gets:

$$\begin{aligned}
 k = & \sum_j \sum_{t=1}^L (S_j P_j p_j \% - S_j C_j c_j \% + P_j S_j s_j \% - C_j S_j s_j \%)_t (1-T)_t (1+r)^{-t} \\
 - & \sum_k \sum_{t=1}^L F_{k,t} f_k \% (1-T)_t (1+r)^{-t} - \sum_m \sum_{t=1}^L I_{m,t} i_m \% (1+r)^{-t} \\
 + & \sum_m \sum_{t=1}^L D_{m,t} d_m \% T_t (1+r)^{-t}
 \end{aligned} \quad (12)$$

By taking the time independent parts out of the time summation and at the same time regroup, this can be written:

$$\begin{aligned}
 k = & \sum_j (s \% + p \%)_j \sum_{t=1}^L P_{j,t} S_{j,t} (1-T)_t (1+r)^{-t} \\
 - & \sum_j (s \% + c \%)_j \sum_{t=1}^L C_{j,t} S_{j,t} (1-T)_t (1+r)^{-t} \\
 - & \sum_k f_k \% \sum_{t=1}^L F_{k,t} (1-T)_t (1+r)^{-t} \\
 - & \sum_m i_m \% \sum_{t=1}^L I_{m,t} (1+r)^{-t} + \sum_m d_m \% \sum_{t=1}^L D_{m,t} T_t (1+r)^{-t}
 \end{aligned} \quad (13)$$

From this it can be seen, that when calculating the present day value, if one makes the discounting for each type of element that goes into the annual results separately, it is relatively easy to calculate the effect of a certain deviation from what was expected.

3.2. Constant Absolute Error

Now we will assume that the error has a constant absolute value, instead of being a constant percentage. By splitting up the expression for k in the same way as before, we may write:

$$\begin{aligned}
 k = & \sum_j \sum_{t=1}^L (S_j P_j - S_j c_j + P_j s_j - C_j s_j + p_j s_j - c_j s_j)_t (1-T)_t (1+r)^{-t} \\
 - & \sum_k \sum_{t=1}^L f_{k,t} (1-T)_t (1+r)^{-t} - \sum_m \sum_{t=1}^L i_{m,t} (1+r)^{-t} \\
 + & \sum_m \sum_{t=1}^L d_{m,t} T_t (1+r)^{-t}
 \end{aligned} \quad (14)$$

As the numeric errors are assumed to be independent of time, they can be taken out of the time summations. This gives, after some re-grouping, when we again neglect errors of the second order:

$$\begin{aligned} \epsilon = & \sum_j (p_j - c_j) \sum_{t=1}^L S_j (1-T)_t (1+r)^{-t} + \sum_j s_j \sum_{t=1}^L (P_j - C_j)_t (1-T)_t (1+r)^{-t} \\ & - \sum_k f_k \sum_{t=1}^L (1-T)_t (1+r)^{-t} - \sum_m i_m \sum_{t=1}^L (1+r)^{-t} \\ & + \sum_m d_m \sum_{t=1}^L T_t (1+r)^{-t} \end{aligned} \quad (15)$$

Again the expression is seen to be very easy to work with. The discounting which here should be made on the expected sales, expected unit prices, expected unit cost and so on, can be made completely independent of the error calculation.

If the user wants to have the system to make sensitivity analyses on certain of the used forecasts, k is set to the original present day value for the project, and the two expressions (13) and (15) are solved with respect to the error on the forecasts given by the user (the errors of the other forecasts are set to zero) that means one will have information about how big the errors should be, in percentage and units, if the present day value with the chosen discount rate should be zero ($K - k = 0$).

If, however, a stochastic simulation is wanted the user must again specify which forecasts the simulation should be made on, and moreover within which intervals the errors should be. The system will then generate random values for errors within the given intervals, and for each set of values calculate the resulting value of the error. By doing so a sufficient number of times, a probability distribution for the error can be drawn under the given assumptions.

4. An example

A firm is considering to buy a new machine which will cost \$15000. The machine can produce 5 different products in the following quantities:

Product 1 First year 1000 units, thereafter increasing by 10 % per year.

- Product 2 First year 2000 units, thereafter increasing by 500 units per year.
- Product 3 $\frac{2}{3}$ of the production of product 1
- Product 4 $\frac{1}{3}$ of the total production of product 1 and product 2
- Product 5 Half of the production of product 2 from the preceding year.

The variable production costs are expected to be:

- Product 1 First year \$1.25 per unit thereafter increasing by 5 % per year.
- Product 2 None.
- Product 3 \$1.00 per unit for the next 5 years.
- Product 4 \$1.50 per unit for the first year, thereafter decreasing by 3 % per year.
- Product 5 The average for product 1 and 3.

Moreover two of the products will have variable transportation costs, which are:

- Product 2 \$2.00 per unit, however, a quantity rebate of \$0.10 per unit for every 20 units will be given.
- Product 4 \$0.10 more than the transportation cost for product 2.

The firm thinks that the whole production can be sold, and they expect the following prices:

- Product 1 Unchanged \$2.00 per unit for the next 5 years.
- Product 2 The first year \$3.00 per unit, thereafter decreasing by 8 % per year.
- Product 3 Starts with \$1.50 per unit and is then expected to increase by \$0.10 per year.
- Product 4 Total variable cost plus 25 %.
- Product 5 Variable production cost plus \$0.50.

Furthermore it should be taken into account that the machine can be depreciated completely over 5 years. That there will be an installation cost of \$500 and there will be a maintenance cost of \$165 the first year, and then increasing by \$15 per year.

The firm's marginal tax is 50 %, and they want to use a 10 % discounting factor.

4.1. Construction of the Model

```

PROJECT    NEW MACHINE
INVEST
  * MACHINE
  1 15000
SALES
  * PRD1
  1 1000
  PRD1 = PRD1(— 1)*1.1          I = 2,5
  PRD2 = 1500 + 500*I           I = 1,5
  PRD3 = PRD1*2/3               I = 1,5
  PRD4 = (PRD1 + PRD2)/3        I = 1,5
  PRD5 = PRD2(— 1)*0.5         I = 2,5
COST PRODUC
  * PRD1 PRD3
  1 1.25  1.50
  PRD1 = PRD1(— 1)*1.05        I = 2,5
  PRD3 = 1.00                  I = 1,5
  PRD1 = PRD1(— 1)*1.05        I = 2,5
  PRD4 = PRD4(— 1)*0.97        I = 2,5
  PRD5 = (PRD1 + PRD3)**0.5     I = 2,5
COST TRANSP
  PRD2 = 2.0-PRD2(SALES)*0.01/20 I = 1,5
  PRD4 = PRD2 + 0.1            I = 1,5
PRICE
  * PRD2
  1 3.00
  PRD1 = 2.00                  I = 1,5
  PRD2 = PRD2(— 1)*0.92        I = 2,5
  PRD3 = 1.40 + 0.1*I          I = 1,5
  PRD4 = (PRD4(PRODUC) + PRD4(TRANSP))*1.25 I = 1,5

  PRD5 = PRD5(PRODUC) + 0.5     I = 2,5
DEDUCT
  DEPRIC = 3000                I = 1,5
EXPENS
  MAINTAIN = 150*(1 + I/10)     I = 1,5
  * INSTAL
  1 500
  TAX = 50
  RATE = 10
REPORT
  PRINT ALL
  PLOT PDV

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```

PLOT TOT
SENSITIV PRD1 PRD3
SENSITIV PRICE PRD4
SENSITIV PRODUC PRD4
SIMULATE 100
  PRD1 SALES 12
  PRD1 PRICE 15
SIMULATE 100
  PRD2 SALES 8
  PRD4 SALES 18
STOP

```

4.2. *Explanation to the Model*

The first punch card have the key word PROJECT which simply says that now starts the reading of all the data for a new project.

The next punch card has the key word INVEST, which means that the data which now follows should be stored in the investment table. Thereafter follows the card which gives the name of the forecasts which should be placed as columns in the investment table, in this case MACHINE. Now follows the data which should be stored in the investment table with specification of year and value. In this case 15000 in year 1 which is the only investment cost.

The key word SALES which now follows makes the system ready to receive capacity data. The capacity data are partly explicitly and partly implicitly defined. First the expected sales of product 1 (PRD1) in the first year (1000 units) are given explicitly. As the firm expects an increase of 10 % per year of product 1, it can be left to the system to calculate the expected sales for the following 3 years (year 2–5). This is done by the instruction:

$$PRD1 = PRD1(-1) * 1.1 \quad I = 2,5$$

which says that the sales of product 1 should be equal to the sales of the preceding year. $PRD1(-1)$, multiplied by 1.1, and that this equation should be used from year 2 to year 5 ($I = 2,5$).

The sales of product 2 for all the 5 years can be calculated from an expression, it was expected that the sales in the first year should be 2000 units and thereafter increase by 500 units per year, which can be written as 1500 plus 500 times the year, or as input to the system

$$PRD2 = 1500 + 500 * I \quad I = 1,5$$

where $500 * I$ means that the 500 should be multiplied by the number of the actual year, and $I = 1,5$ means that the calculations should be carried out for each of the years 1 to 5.

The sales of product 3 was estimated to be 2/3 of the sales of product 1. This is simply given by

$$PRD3 = PRD1 * 2/3 \quad I = 1,5$$

Finally, the sales of product 4, which was one third of the total sales of product 1 and product 2 can be expressed as

$$PRD4 = (PRD1 + PRD2)/3 \quad I = 1,5$$

and then the last sales forecast for product 5, which was equal one half of the sales of product 2 from the preceding year

$$PRD5 = PRD2(-1)*0.5 \quad I = 1,5$$

We have now completed the specifications of all the quantity data, and the building up of the next table can start. It is in this example a table for variable cost.

In the way the problem was formulated, two different variable costs have to be taken into account, namely production cost and transportation cost. To keep them separated, it is necessary to build up two tables with different names. The way to do this is very simple, it is simply to give the key word COST together with the name which the user wants to allocate to the table, for example

COST PRODUC

now follows explicit and/or implicit information about the data which should be stored in the table for production cost. As the principles are the same as at building the capacity table, there is no need to go into details. It should only be mentioned that both product 1 and product 2 have to be given values in year 1 explicitly, and that the production cost for product 3 is constantly \$1.00 per unit for all 5 years.

After the last information about production cost has been read in, there comes a new punch card with the key word COST, but now followed by another name, namely TRANSP. The result of this is that the system will start on a new table for variable cost, but this time for transportation cost. The calculations for transportation cost for product 2 is a little bit more complicated than the earlier used expressions, and that is because of the quantity rebate, which means that the costs are dependent on the expected sales. This relation is expressed by the term $PRD2(SALES)$ which means that the value which should go into the calculation here, should be picked up from the capacity table (SALES), and that it should be the estimated sales of product 2 in the same year as for which the transportation cost should be calculated. This operation should be carried out for each of the years 1 to 5.

The last table which is related to volume dependent variables is the variable income. This table is activated by the key word PRICE. Now follows, as explained earlier, information about the volume dependent

income. It should only be mentioned that, in order to calculate the income for product 4, which was the total variable cost plus 25 %, it is necessary to pick data out from two of the earlier defined tables. This is done with the terms PRD4(PRODUC) and PRD4(TRANS), where the names within parentheses are the names the user have allocated to the two cost tables.

The only extra information, needed now, is information about depreciation and fixed cost and income. The depreciation is started with the key word DEDUCT, followed by information about the annual depreciation, given either explicitly or implicitly. In this example, \$3000 per year in all 5 years.

The fixed cost and income are introduced with the key word EXPENS. In this example, we have first the maintenance cost which is calculated by the system for each of the years 1 to 5 after the given equation, and finally, the installation cost which is only of interest in the first year.

The two last punch cards with input data gives information about the marginal tax percentage and about, which discounting rate the user wants to use in the calculations.

In order to finish the reading of data, and to start the report specifications, the key word REPORT should be used. This key word is followed by specifications of the reports the user wants to have written out. The first report specification, PRINT ALL, will result in a print-out of all the forecasts which go into the model. Moreover, 11 columns with totals will be written out

- 1 total sales
- 2 total variable costs
- 3 total variable income
- 4 total fixed cost and income
- 5 total investments
- 6 total depreciations
- 7 tax, calculated on contribution margins
- 8 tax, calculated on fixed cost and income and depreciations
- 9 total tax
- 10 cash flow before tax
- 11 cash flow after tax

PLOT TOT means the the above-mentioned 11 totals should be plotted as curves.

The next report specification, PLOT PDV, causes the system to plot a curve which shows the present day value of the project as a function of the discount rate.

Now follows three specifications for sensitivity reports. First the sensitivity on product 1 and product 3. This automatically will give sensitivity analyses on the sales of the two products, followed by sensitivity analyses on the cost and income for the two products.

The next sensitivity report will analyse the selling price for product 4, and finally the last sensitivity analysis will give information about, how much the production cost for product 4 can vary.

Finally, the two last reports will tell something about, how the present day value, before and after tax, can be expected to be if the original forecasts do not hold.

It is first analysed, what will happen if the sales of product 1 have an uncertainty of $\pm 12\%$, at the same time as the selling price for the same product has an uncertainty of $\pm 15\%$.

The last report in this example tells, what will happen if the sales of product 2 vary with $\pm 8\%$ at the same time as the sales of product 4 is within $\pm 18\%$.

The last punch card, STOP, tells the system that the analysis of this project is finished for this time.

4.3. *Description of Output*

The output which is shown, are some typical reports from the example. The first sheet of output is simply a printout of the inputcards, which makes it easy for the user to check back on his original problem formulation when analysing the results.

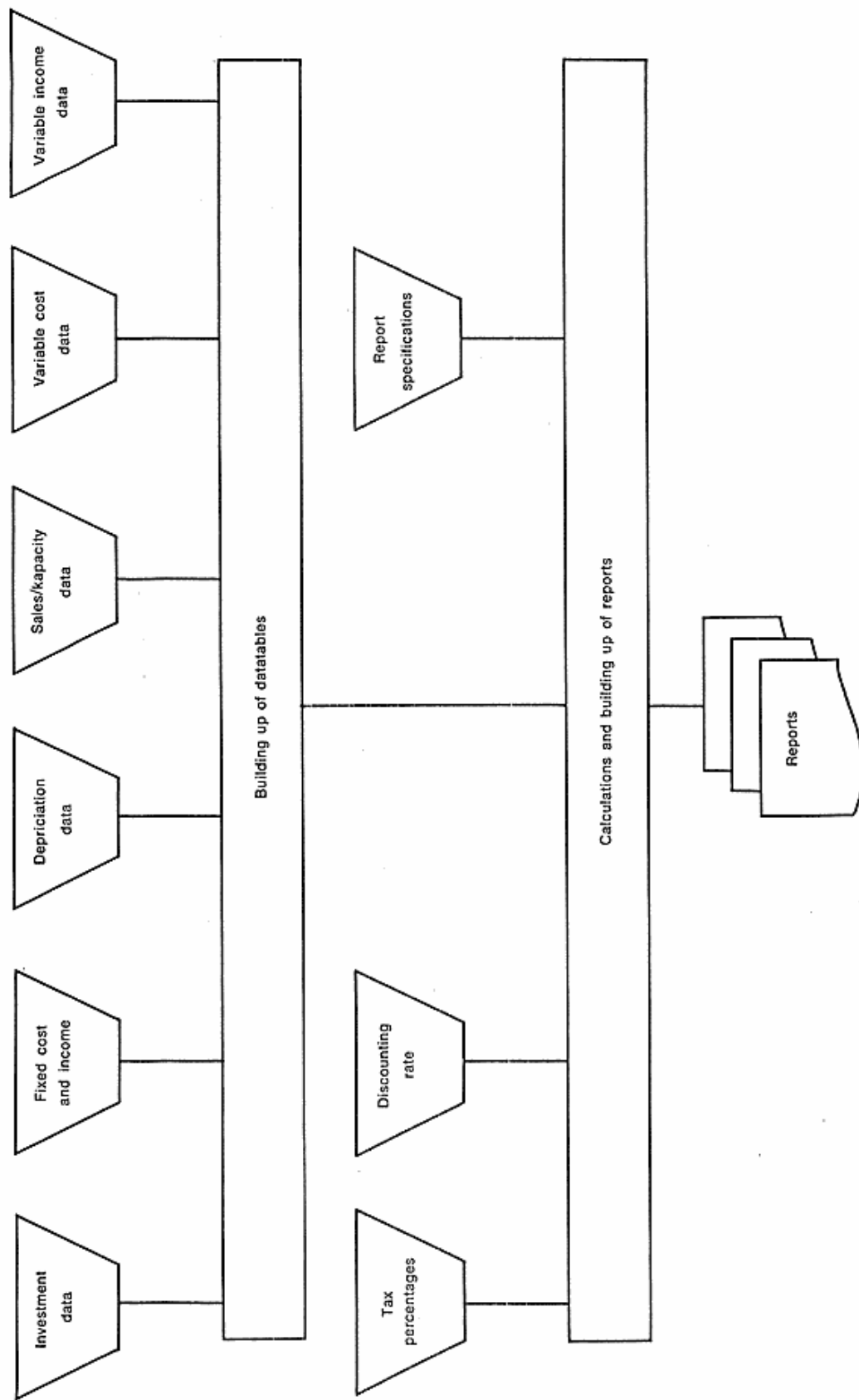
The first report specification was PRINT ALL, which will tabulate all forecasts as shown on the second output example. The four last lines, named PDV, will probably need some explanation. The first line is simply the discounted value of the forecasts. The second line is the discounted value of the yearly forecast values multiplied by $(1-T)$ where T is the estimated marginal tax percentages for the equivalent year, e.g. the discounted value of the forecast after tax. The last two lines are only used for variable cost and income, and they are again discounted values before and after tax, but now the forecast figures have been multiplied by the equivalent quantities. The reason that these figures are calculated and printed is, that they are all key figures in the equations (13) and (15).

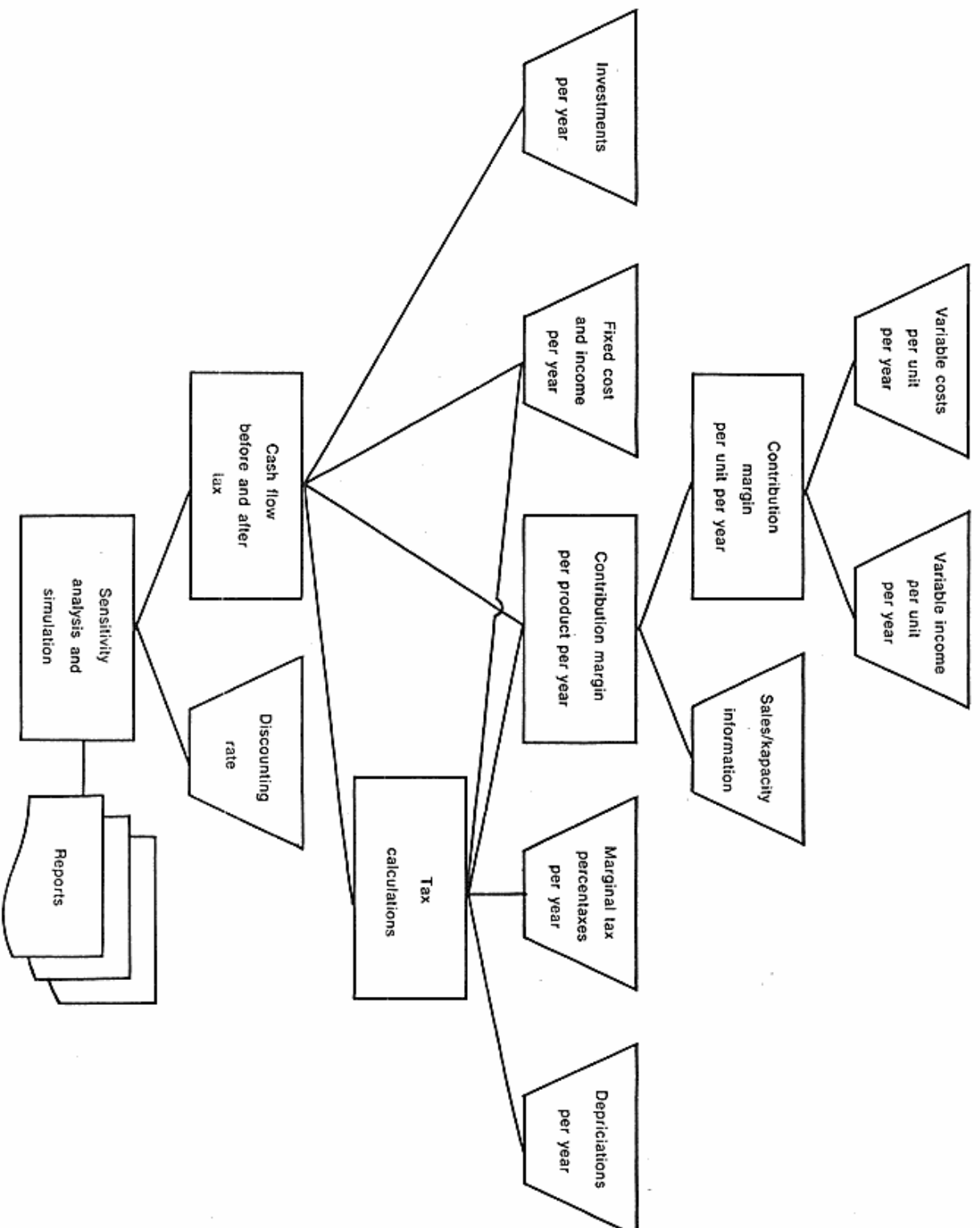
The next report example was caused by the specification PLOT PDV, and it shows a curve of the present day value as a function of the discount rate. It can be seen, that the earning power of this project is about 40 %.

Then follows a part of the report which was requested by PLOT TOT. This part shows the total sales in units, total variable costs in \$, total variable income in \$, total expenses in \$. Note that this curve (4) has been scaled by 10. Scaling is done automatically by the system

when necessary. Finally the total investments are shown as curve (5). There were also requests for sensitivity analysis in the example, and the report is here shown for the specification SENSITIV PRD1 PRD2. This report should speak for it self.

The last output examples are the results from a stokastic simulation on product 1. The sales was allowed to vary within $\pm 12\%$ at the same time as the price could vary within $\pm 15\%$. 100 random numbers within the variation intervals were generated and the resulting present day value before and after tax were calculated. The print-outs show the probability distribution before and after tax for the present day value together with probabilities for different outcomes and the accumulated probabilities.





ANALYSIS OF NEW MACHINE

LIST ON

INVEST

MACHINE

1 1000

SALES

PRO1

1 1000

PRO1 = PRO1(-1) * 1.1 I = 2.5

PRO2 = 1000 * 500 * 1 I = 1.5

PRO3 = PRO1 * 2 / 3 I = 1.5

PRO4 = (PRO1 + PRO2) / 3 I = 1.5

PRO5 = PRO2(-1) * 0.5 I = 2.5

CCST PRODC

PRO1 PRO4

1 1.25 1.50

PRO1 = PRO1(-1) * 1.05 I = 2.5

PRO3 = 1.0 I = 1.5

PRO4 = PRO4(-1) * 0.97 I = 2.5

PRO5 = (PRO1 + PRO3) * 0.5 I = 2.5

CCST TRANSP

PRO2 = 2.00 - PRO2(SALES) * 0.01/20 I = 1.5

PRO4 = PRO2 + 0.10 I = 1.5

PRICE

PRO2

1 3

PRO1 = 2 I = 1.5

PRO2 = PRO2(-1) * 0.92 I = 2.5

PRO3 = 1.40 * 0.1 * 1 I = 1.5

PRO4 = (PRO4(PRODC) + PRO4(TRANSP)) * 0.1 * 0.5 I = 1.5

PRO5 = PRO5(PRODC) * 0.5 I = 1.5

DEDUCT

DEPRIC = 3000 I = 1.5

EXPENS

MAINTAIN = 150 * (1/10) I = 1.5

INSTAL

3 500

TAX = 50

RATE = 10

REPORT

0456803

ANALYSIS OF NEW MACHINE

PAGE 1

	PRODUC			SALES			PRODUC			EXPENS			INVEST			DEPRIC																
	PRODUC	TRANSP	PRICE	SALES	PRODUC	PRICE	EXPENS	INSTAL	MACHINE	DEPRIC																						
	PAID4																PAID5															
1	1.50	1.10	3.25	6.0	0.0	0.50	165.00	500.00	1500.00	3000.00																						
2	1.45	0.85	2.85	1000.00	1.16	1.66	160.00	0.0	0.0	3000.00																						
3	1.41	0.60	2.51	1250.00	1.19	1.65	195.00	0.0	0.0	3000.00																						
4	1.37	0.35	2.18	1500.00	1.22	1.72	210.00	0.0	0.0	3000.00																						
5	1.33	0.10	1.78	1750.00	1.26	1.76	225.00	0.0	0.0	3000.00																						
6	0.90	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0																						
7	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0																						
8	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0																						
9	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0																						
10	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0																						
11	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0																						
12	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0																						
13	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0																						
14	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0																						
15	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0																						
16	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0																						
17	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0																						
18	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0																						
19	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0																						
20	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0																						
PAID4	5.39	2.45	9.86	3876.73	3.47	9.20	728.41	444.55	13636.37	11372.03																						
PAID5	2.69	1.23	4.90	19388.37	1.73	2.60	3044.20	227.07	6018.18	5666.16																						
PAID5	73082.21	2973.64	12844.80	0.0	4694.60	6632.96	0.0	0.0	0.0	0.0																						
PAID5	36514.11	1486.82	6435.48	0.0	2377.36	3216.46	0.0	0.0	0.0	0.0																						

NEUCC DANMARKS TEKNISKE HUSKOLE

Gule Tryk

0456805

2	
4	
6	ANALYSIS OF NEW MACHINE PAGE 6
8	PLOT PIV
10	PRESENT DAY VALUE
12	AMOUNT
14	1500.0000
16	
18	1250.0000
20	
22	1000.0000
24	
26	
28	750.0000
30	
32	500.0000
34	
36	
38	250.0000
40	
42	0.0
44	
46	
48	-250.0000
50	
52	
54	-500.0000
56	
58	-750.0000
60	
62	-1000.0000
64	
66	DISCOUNT RATE 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49
68	
70	
72	

N E U C O DATAWAYS FOUNDED HADLOCKE

0456808

One TPA

ANALYSIS OF NEW MACHINE

ITEM	DESCRIPTION	SCALE	UNIT
1	TOTALS	SCALE	1
2	T-COST	SCALE	1
3	T-PRICE	SCALE	1
4	T-EXPENSE	SCALE	10
5	T-INVEST	SCALE	1

AMOUNT

16	20000.00001	1	3
18	1	1	3
20	17500.00001	1	3
22	1	1	3
24	1	1	3
26	15000.00001	1	5
28	1	1	1
30	12500.00001	1	3
32	1	1	1
34	10000.00001	1	1
36	1	1	1
38	1	1	1
40	7500.00001	1	2
42	1	1	1
44	1	1	1
46	5000.00001	1	1
48	1	1	1
50	2500.00001	1	4
52	1	1	4
54	1	1	4
56	0.0	1	5

0456809

NEWCC DANMARKS TEKNIKSKE HUSKOLE

Gate Trak

ANALYSIS OF NEW MACHINE

SENSITIV PROJ PRICE

A PRESENT DAY VALUE OF 0 BEFORE TAX WILL OCCUR IF

PROJ SALES, PROJ PRICE,

ARE CHANGED BY 281.22 PERCENTAGES OR BY -3483.71 UNITS PER YEAR

AFTER TAX THE CHANGES SHOULD BE -303.44 PERCENTAGES OR -3026.63 UNITS PER YEAR

NOTE - A POSITIVE FIGURE MEANS THAT SALES MUST BE INCREASED

A PRESENT DAY VALUE OF 0 BEFORE TAX WILL OCCUR IF

PROJ PRICE, PROJ PRICE, PROJ PRICE,

ARE CHANGED BY -73.55 PERCENTAGES OR BY -1.14 UNITS PER YEAR

AFTER TAX THE CHANGES SHOULD BE -83.97 PERCENTAGES OR -8.59 UNITS PER YEAR

NOTE - A POSITIVE FIGURE MEANS FOR VARIABLE INCOME AN INCREASE AND FOR VARIABLE COST A DECREASE

0456812

Date Time

MONTE-CARLO SIMULATION

PERCENT PROBABILITY	ACC	PRESENT CAY VALUE BEFORE TAX
0	0	24404.52 1
0	0	24118.40 1
0	0	23627.47 1
0	0	23328.74 1
0	0	23250.02 1
0	0	22981.29 1
0	0	22472.56 1
0	0	22424.86 1
0	0	22075.11 1
0	0	21606.35 1
1	1	21517.66 1
1	2	21226.93 1
1	3	20940.20 1
3	3	20651.46 1
3	3	20362.75 1
3	7	20074.02 1
1	10	19785.30 1
5	15	19496.57 1
4	15	19207.84 1
6	25	18919.12 1
7	32	18630.39 1
5	37	18341.66 1
5	42	18052.94 1
4	46	17764.21 1
7	53	17475.48 1
2	55	17186.76 1
3	56	16898.03 1
8	64	16609.30 1
9	75	16320.58 1
4	78	16031.85 1
2	81	15743.13 1
2	83	15454.40 1
0	89	15165.67 1
3	92	14876.95 1
2	94	14588.22 1
3	97	14299.49 1
0	97	14010.77 1
3	100	13722.04 1
0	100	13433.31 1
0	100	13144.59 1
0	100	12855.86 1
0	100	12567.13 1
0	100	12278.41 1
0	100	11989.68 1
0	100	11700.95 1
0	100	11412.23 1
0	100	11123.50 1
0	100	10834.77 1
0	100	10546.05 1
0	100	10257.32 1

0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100

MONTE-CARLO SIMULATION

PERCENT
FREQUENCY
ACC PRESENT DAY VALUE AFTER TAX

0 0 11070.46 1
0 0 10526.09 1
0 0 10781.73 1
0 0 10637.37 1
0 0 10493.00 1
0 0 10348.64 1
0 0 10204.28 1
0 0 10059.91 1
0 0 9915.55 1
0 0 9771.19 1
1 1 9626.82 1
1 2 9482.46 1
1 3 9338.10 1
0 3 9193.73 1
3 6 9049.37 1
3 6 8905.01 1
1 10 8760.64 1
5 15 8616.28 1
4 19 8471.92 1
6 25 8327.55 1
7 32 8183.19 1
5 37 8038.83 1
5 42 7894.46 1
4 46 7750.10 1
7 53 7605.74 1
5 55 7461.38 1
3 58 7317.01 1
5 66 7172.65 1
9 75 7028.29 1
4 79 6883.92 1
2 81 6739.56 1
6 89 6595.20 1
3 92 6450.83 1
3 92 6306.47 1
2 94 6162.11 1
3 97 6017.74 1
0 97 5873.38 1
3 100 5729.02 1
0 100 5584.65 1
0 100 5440.29 1
0 100 5295.93 1
0 100 5151.56 1
0 100 5007.20 1
0 100 4862.84 1
0 100 4718.47 1
0 100 4574.11 1
0 100 4429.75 1
0 100 4285.38 1
0 100 4141.02 1
0 100 3996.66 1

0456817

0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100