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Corporate Prediction Models, Ratios or Regression Analysis?

by

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Corporate Prediction Models, Ratios or Regression Analysis?

Abstract

The models developed in the literature with respect to the prediction of a company's failure are based on ratios. It has been shown before that these models should be rejected on theoretical grounds. Our study of industrial companies in the Netherlands shows that the ratios which are used in insolvency models do not have the predicting properties they are credited with. We have investigated whether the alternative for ratios mentioned in the literature, i.e. the regression analysis, gives reliable insolvency models. However, the regression analysis appears to be useful in a limited sense only, depending on the size of the company.

Introduction¹

An insolvency model intends to describe the connection between a company becoming insolvent and a number of explanatory variables. The final goal is to obtain an instrument by means of which insolvency can be predicted. Nearly all the insolvency models developed so far are based on ratios that are derived from the annual accounts of companies (see i.e. Beaver (1966), Altman (1968), Bilderbeek (1983) en Taffler (1991)). Many authors have already expressed their objections to the statistical reliability of the use of ratios in these kinds of studies. Only a few have cared about the theoretical foundation of the ratio analysis (Bouma, 1977; Lev and Sunder, 1979; Whittington, 1980; Barnes, 1982; Wijn 1988a; Rees, 1990, Berry and Nix, 1991). We will argue that, also on a basis of empirical material, the use of ratios must be advised against.

Since as a possible alternative to ratio analysis, the regression analysis in the literature is sometimes mentioned (Wijn, 1988b; Rees, 1990; Berry and Nix, 1991), we will also investigate in this paper whether the use of this analysis with insolvency models does give reliable information. For both the ratio analysis and the regression analysis we will base our case on data of industrial companies in the Netherlands, compiled by the Netherlands' Central Bureau of Statistics.

This study also shows that the regression analysis can only be used in a limited sense. Again the cash flow is the most important variable. We will begin to briefly recall the objections to the use of ratios.

Limitations on the use of ratios

A ratio reflects the quotient of the values of two variables, i.e. the cash flow of a company divided by the total production value in a certain period. Since we want to compare bankrupt and continued companies, we could calculate a ratio for the bankrupt company on the one hand and one for the continued company on the other. If the ratios appear to be equal, we can conclude that the two kinds of companies mentioned do not differ. This conclusion may be wrong. In order to support this thesis, we look at the (rather special) situation shown in Figure 1. The closed curves define the scatter diagrams of the different values of the variables of the two categories (for each category we have more than one observation at our disposal). When with respect to these categories we regard the mean values of these variables as characteristic, the variables being relevant to the distinction between both, then the ratio ought to differ per category. The mean values (\bar{X}, \bar{Y}) of both scatter diagrams in this example are on a line which runs through the origin ($Y = bX$). The ratio of the two variables is equal for both categories, namely b . The use of regression lines ($Y = a + bX$, without any preconditions with regard to a) would have led to quite different conclusions, namely that the categories are different indeed.

Figure 1
about here

For the use of regression lines, in the prediction of bankruptcies, it is necessary that a. the regression line of the bankrupt company differs from the one of the continued companies and that b. the individual companies can be assigned to a certain regression line. This means that the dispersion around the line will have to be limited.

Adaptation of the basic material²

We have used data collected by the Netherlands' Central Bureau of Statistics (CBS)³ with regard to Dutch industrial companies (10 - 500 employees). The analyses are made on the level of the manufacturing class (2-digit, 1974 Standard Business Classification (SIC)⁴. In 1982 sad record was set as far as the number of bankruptcies in the Netherlands is concerned. We have taken this year as a basis for our study. To make it impossible for the results of our analysis to be assigned to chance circumstances in 1982, we have taken into consideration for comparison the declarations of bankruptcy in 1981. As of now, the years 1981 and 1982 will be referred to as the reference years 1981 and 1982 respectively.

From the viewpoint of statistical analysis we have made it an additional requirement that in a manufacturing class there are at least 15 bankrupt companies per reference year (see Table 1).

Table 1: Numbers of bankrupt and continued industrial companies in the manufacturing classes under investigation, 1981 and 1982

SIC*	Classes of manufacturing	bankrupt		continued	
		1981	1982	1981	1982
20/21	Manufacture of foodstuffs, beverages and tobacco	18	28	1116	1003
25	Manufacture of wood products, incl. furniture	38	53	622	535
34	Manufacture of fabricated metal products, except machinery and transport equipment	29	51	1014	878
35	Mechanical engineering	<u>17</u>	<u>28</u>	<u>847</u>	<u>763</u>
	Total	102	160	3599	3179

* 1974 Standard Business Classification (SIC)

Available variables

With regard to the reference years 1981 and 1982 the profit and loss accounts, the fixed capital formation and the number of employees as of 1978 of all companies are available to us.

Using correlation analysis and factor analysis, the number of variables was reduced to thirteen, without essential information being lost. These thirteen variables (ten of which are exploitation variables, and three of which are investment variables), are⁵: number of employees; labour costs; gross result; cash flow; total production value; interest expense less interest income; export; indirect taxes (excl. VAT) and levies less operating subsidies received; value added (f.c.); miscellaneous income less expense; fixed capital formation in plants, other buildings and site improvements, sites transport equipment; fixed capital formation in machinery and other equipments; and total fixed capital formation. Henceforth we will only use these variables in our analyses.

Testing of ratios from existing models

From existing insolvency models we have selected five ratios⁶ whose usability in the prediction of bankruptcy will be tested with the help of our data set. These ratios are⁷:

- a) cash flow / interest (pl/in)
- b) cash flow / total production value⁸ (pl/pr)
- c) interest / total production value (in/pr)
- d) gross result / total production value (gr/pr)
- e) labour costs / total production value (lc/pr).

Analysis

In order to establish whether a ratio is usable in the prediction of bankruptcy, we compare the values

of that ratio measured in bankrupt companies with the values in the continued companies. If a ratio is usable, the values of that ratio must clearly differ between bankrupted companies and continued companies.

In view of the small number of bankrupt companies per manufacturing class, publication of the data under investigation might conflict with the secrecy code of the CBS, which lays down as a precondition for publication that individual companies are not recognizable. For this reason we do not use the ratios of the individual companies but "rough" characteristics such as mean, standard deviations and correlation coefficients between variables. On the basis of these characteristics adequate estimations can be made with regard to the mean and the standard deviation of a ratio (Mood a.o., 1974)⁹.

Testing ratios

In the comparison of the values of the ratios of the bankrupted and the continued companies, we have used intervals reflecting the expected value (mean) of the ratio plus or minus 1.96 x the standard deviation of that ratio. In a normal distribution these intervals cover 95% of the cases. Table 2 shows the percentage by which the interval for the bankrupted companies is overlapped by that of the continued companies.

Table 2 The percentage by which the interval of the ratios indicated for the bankrupt companies is overlapped by that of the continued companies per manufacturing class, per reference year (1981 = I 1982 = II) and per year.

Manufacturing year class		pl/in		pl/pr		in/pr		gr/pr		lc/pr	
		I	II	I	II	I	II	I	II	I	II
20/21	1978	0	0	100	82	100	91	100	79	90	79
20/21	1979	0	0	100	68	100	94	100	71	91	84
20/21	1980	32	0	49	90	66	82	59	77	92	84
20/21	1981		0		73		84		83		79
25	1978	71	64	100	100	92	100	76*	100	96*	100
25	1979	93	100	92	90	100	100	91	96	91*	100
25	1980	34	31	54	74	80*	100	53	78	70*	100
25	1981		28		58		100		44		100
34	1978	33	0	28*	95	100	100	29*	100	77	100
34	1979	38	11	30*	100	100	100	30*	100	71	100
34	1980	0	0	83	93	65	100	48	75	43	100
34	1981		0		88		100		74		100
35	1978	79	53	100	100	100	100	100	100	97	100
35	1979	62	62	100	100	100	100	100	100	84	100
35	1980	13	14	55	50	82*	84*	54	54	100	100
35	1981		10		100		92*		61		65*

*) the interval for the continued companies is entirely enclosed in the interval for the bankrupt companies

We see that only the cash flow / interest ratios of the branch of industry 'Manufacture of foodstuffs, beverages and tobacco' (20/21) show some relevant differences (i.e. they hardly overlap) in both reference years. For the reference year 1981, however, there is some overlap in the year before bankruptcy. In all industries the other ratios show considerable overlap, from a minimum of 43% to a maximum of 100%. The mean overlap in the year before bankruptcy is 78%. Consequently, it should be concluded that the ratios themselves do not provide any useful information for discriminating between the bankrupted and the continued companies. The values of the individual ratios are therefore no sound basis for the prediction of bankruptcy. This applies not only at the level of the manufacturing class but also at the level of the total industry, which, after all, is composed of manufacturing classes.

Conclusion

On the basis of our findings we must conclude that the ratios used in the insolvency models do not have the predicting power they are supposed to have.

The use of regression analysis

As we already mentioned in the introduction, the regression analysis is mentioned as an alternative to the ratio analysis. With the CBS data set we shall now check whether the use of regression analysis in insolvency models does give reliable information.

Regression analyses

Per manufacturing class it is investigated for which combination of two variables the two categories show significant differences¹⁰. If the test shows differences between the two categories, it is, however, not evident that these differences are caused by the independent variable; other as yet unperceived influences may also play a part. As in many other empirical studies we will apply a significance level of five percent.

In addition to the five ratios mentioned earlier we look into another nine regression equations, which on theoretical grounds appear to be of importance. Per regression analysis the following variables are used (the numerator of the ratio is the dependent variable in the regression analysis and the denominator is the independent variable):

- export / total production value
- total production value / number of employees
- labour costs / total production value
- value added / total production value
- gross result / total production value
- interest expense less interest income / total production value
- interest expense less interest income / cash flow
- miscellaneous income less expense / total production value
- cash flow / total production value
- fixed capital formation in machinery and other equipments / total production value
- fixed capital formation in machinery and other equipments / total fixed capital formation
- total fixed capital formation / total production value
- total fixed capital formation less fixed capital formation in machinery and other equipments / total fixed capital formation
- total fixed capital formation less fixed capital formation in machinery and other equipments / total production value

Scatter diagrams of all regression analyses have been made. An analysis of the data shows that no curvilinear relations exist.

In order to detect the differences between the two categories we first of all test, per manufacturing class, whether the regression lines are equiangular. If the slopes differ significantly, we also check whether the mean values of the variables differ from each other. We compare the regression coefficients (the b 's) directly whilst we compare the Y-intercepts (a 's) not directly but via the mean¹¹. For a comparison of mean values of all variables used we refer to Wijn's dissertation (1988a). In this paper we will only pay attention to the differences in mean value when the slopes appear to differ significantly, because in principle a comparison of means does not come under regression analysis.

The tests show that for the same manufacturing class in both reference years 1981 and 1982 only a few, significantly differing, regression equations occur. Some equations appear to differ significantly only incidentally. That is the reason why we decided to submit only those equations to a closer analysis that show a significant difference both in reference years 1981 and in reference year 1982 in a linked period of two years before the reference year. In Table 3 we include the differences that are of importance to us.

Table 3: Variables of which the regression coefficients per manufacturing class show significant differences in both reference years 1981 and 1982.

SIC	Classes of manufacturing	variables		
		IN and PR	PL and PR	FCP and PR
20/21	Manufacture of foodstuffs, beverages and tobacco	-	-	-
25	Manufacture of wood products, incl. furniture	-	X	X
34	Manufacture of fabricated metal products, except machinery and transport equipment	X	X	-
35	Mechanical engineering	-	-	-

(IN= interest expense less interest income PR= total production value; PL= cash flow; FCP = fixed capital formation in plants, other buildings and site improvements, sites transport equipment)

Of the equations mentioned in Table 3 we have also calculated the confidence intervals (95%) around the regression lines, in order to check whether companies can be grouped in one of the two categories in a reliable way. The regression lines will be reviewed per manufacturing class in the next section.

Empirical findings

In this section we focus especially on the economic interpretation of the regression analyses relevant to our research rather than on the statistical significance. We shall constantly check whether the differences are consistent and whether the differences can be given an economic interpretation. For a full survey of the regression analyses reviewed per manufacturing class and confidence intervals we refer to Appendixes I and II.

Manufacture of wood products, including furniture

In this manufacturing class the slopes of two of the fourteen regression equations appear to differ significantly (see Table 3). It is about the equation of a. cash flow and total production value and b. investments in machinery and equipment and total production value.

Equation of cash flow and total production value.

In reference year 1982 the regression coefficients of the bankrupt as well as the continued companies appear to take a rather capricious course. We also see this in reference year 1981. From a total production value of over Hfl. 3,000,000.- the confidence intervals of the cash flows of both bankrupt and continued companies appear not to coincide for two years before the bankruptcy.

Figure 2
about here

At a total production value of for example Hfl. 3,000,000.- the lower limit of the cash flow of the continued companies amounts to Dfl 100,000.- in 1979 for reference year 1981, while in that case the bankrupt company has an upper limit of Hfl. 77,000.-. The regression coefficients of the category 'continued' are reasonably stable; a reliable grouping of companies (from a total production value of Hfl. 3,000,000.-) need not be a problem whatsoever.

Equation of investments in machinery and equipment and total production value

In reference year 1982 there is no clearly visible relationship between the two variables in the category 'bankrupt'. In reference year 1981 there is a relationship, with the exception of the year 1980. Consequently there is no strong consistency between the two reference years.

Figure 3

At a total production value over Hfl. 3,000,000.- it is clear that in both reference years the confidence intervals of both categories do not coincide until in the last year before bankruptcy. The regression coefficients of the category 'continued' are reasonably stable, again from a total production value of Hfl. 3,000,000.-.

Manufacture of fabricated metal products, except machinery and transport equipment

In this manufacturing class the regression coefficients of two regression equations show significant differences between both categories. This is the case for the relationship between the interest expense

less interest income and total production value and for the relationship between cash flow and total production value.

Equation of interest expense less interest income and total production value

In reference year 1981 the regression coefficients for the bankrupt companies go up sharply every year from 1978. In reference year 1982 this is only the case in 1980. Consequently the equations of the bankrupt companies are not very consistent.

Figure 4

When we look at the confidence intervals and link the two reference years, we see that two years and one year before bankruptcy respectively the categories distinguished by us start to differ from a total production value of over about Hfl. 5,000,000.-. The regression coefficients of the category 'continued' appear to be stable, so that from two years before the reference year the companies can reliably be grouped from Hfl. 5,000,000.-.

Equation of cash flow and total production value

The differences in regression coefficients of the category 'bankrupt' appear to be bigger in both reference years than that which resulted from the equation discussed earlier. We can only talk of any

consistency in the regression coefficients in the category 'continued'.

Figure 5

However, if we look at the confidence intervals and link the two reference years, we can conclude that there are indeed differences between both categories. From three years before bankruptcy both categories clearly distinguish themselves at a total production value of Hfl. 5,000,000.-. One year before bankruptcy the difference is visible from a total production value of Hfl. 3,000,000.-. The companies can be grouped in a reliable way from the total production values mentioned above from respectively Hfl. 5,000,000.- and Hfl. 3,000,000.-, because the regression coefficients of the continued companies in both reference years are pretty consistent.

Conclusion

In this section we reviewed those manufacturing classes of which the regression analyses show significant differences between bankrupt and continued industrial companies. Nearly all of these

regression lines appear to go approximately through the origin; in fact we are dealing with ratios (Y-intercept = 0). It is remarkable to see that from a certain total production value the confidence intervals of the categories distinguished do not coincide and that the regression coefficients of the category 'continued' are pretty stable in both reference years. This means that on the basis of the data available to us more reliable predictions can be made for the larger companies, but not for the smaller companies with a relatively low range of production.

Summary and conclusions

We have submitted to a closer analysis five ratios which appeared to be relevant in published insolvency models. Our analyses seem to support the theoretical objections to ratio analysis made earlier.

As an alternative to the ratio analysis, which appeared not to be reliable in predicting the insolvency of companies, the use of regression analysis has been suggested. In order to check this we have compared 262 bankrupt and 6778 continued industrial companies in the Netherlands at the level of manufacturing class (2-digit). The analyzed manufacturing classes are: the manufacture of foodstuffs, beverages and tobacco, the manufacture of wood products, including furniture, the manufacture of fabricated metal products, except machinery and transport equipment and the mechanical engineering. Per manufacturing class we have tested fourteen regression equations. Only three of them seemed useful, in only two out of four manufacturing classes investigated. The three lines appear to go approximately through the origin so that we are in fact dealing with ratios! These equations (ratios) appear to be useful to companies from a certain range of production, onward.

We can conclude that we can do less with regression analysis than we had hoped for and that the three equations selected in fact appear to be ratios. The "extra" that regression analysis offers with regard to ratio analysis is that for different values of one variable we look at the size of the other variable; in other words, a level component has been introduced.

From the beginning of the twentieth century a great many researchers have tried to trace ratios or groups of ratios with which company insolvency could be perceived at an early stage. Advanced mathematical techniques have been used for this (see a.o. Theodossiou, 1993; Robertson and Mills, 1991; Zmyewski, 1984), but so far these have had little effect. We do not think much of the idea Inman (1993) advocates to keep on experimenting with data sets, until eventually a satisfactory theory comes out. If the research in this field is to lead to any success, we are of the opinion that also other factors, such as socio-scientific (i.e. sociological, psychological and ethical aspects), should be taken

into consideration (see for example Laitinen, 1991).

1. We would like to thank prof. dr. W. van Hulst and prof. dr. P. Verheyen for their remarks on a previous version of this paper.
2. More detailed figures may be obtained from prof. dr. E.J. Bijnen, Tilburg University, P.O. Box 90153, 5000 LE TILBURG, the Netherlands.
3. We are grateful to the Netherlands' Central Bureau of Statistics, which enabled us to carry out operations on data collected by the Bureau, while meeting strict conditions with respect to secrecy.
4. We only include those classes of manufacturing in the research, in which a minimum of 80 per cent of the companies employ less than fifty employees. We have done this because (internal) information of the Netherlands' Central Bureau of Statistics shows that the majority of the bankrupt companies employ less than fifty employees.
5. Definitions used by us:
 - *Labour cost* (=lc): companies' total amount of wages, which is equal to the sum total of the gross wages and salaries of the total number of personnel (excluding sickness pay and unemployment pay) and the social security contributions, contributions re pension schemes, buying-in sums and contributions re pension schemes and savings plans to be charged to the company and expenditure re other social services.
 - *Gross result* (=gr) of the added value at market prices minus labour cost and the "contributions and taxes increasing the cost price minus operating subsidies". It is the remuneration of the capital factor, being the capital employed in the companies.
 - *Cash flow*: (=pl) profit or loss before depreciation and corporate income tax.
 - *Industrial sales*: the invoice value of the products delivered, man-hours and services rendered excluding VAT and external selling expenses and including excise taxes and cost of the company's own transportation charged on. For the export of a number of food stuffs supplementary payments are received in the framework of the European agricultural policy to bridge the difference between EG market prices and world market prices. These so called export restitutions are included in the industrial sales.
 - *Total production value* (=pr): the sum total of the industrial sales (incl. export restitutions), internally manufactured capital goods, changes in inventories of finished products and goods in progress, the margins attained with regard to trade goods and revenue from other non-industrial activities and insurance payments because of company damage.
 - *Interest* (=in) : balance interest paid and received.
 - *Export*: the products directly sent abroad as well as the invoiced amount for services rendered to foreign principals (wage earnings, repairs, etc.). This does not include any received export repayments.
 - *Cost-price increasing taxes and levying; exploitation subsidies*: the most important taxes are the excise on tobacco, alcoholic beverages, sugar and soft drinks. Furthermore it consists of a number of levies and taxes that have been remitted directly by the companies. Examples: levying air pollution, water pollution, cleaning costs, real estate taxes, road taxes. Turnover tax is not taken into consideration. Examples of exploitation subsidies: wage subsidies, public subsidies, etc.; in this connection investment subsidies are not taken into consideration.
 - *Value added*: the value added to market prices minus the cost-price increasing taxes and levies; exploitation subsidies.
 - *Miscellaneous income less expense*: assets are the extras and withdrawals from provisions, liabilities are the extras and dotations to provisions.
 - *Fixed capital formation in machinery and other equipments* (=fcp): machinery and

- equipment. This includes machinery and working plants, large implements and instruments, internal transport, office machinery and office furniture.
- *Total fixed capital formation*: five kinds of assets are distinguished:
 - Commercial buildings. These include factory-buildings, depots, laboratories, offices, commercial canteens, etc. The amounts in question include the costs of provisions placed in these buildings like electricity, gas, water, heating and air conditioning, elevators, cranes etc.
 - Other buildings. These include parking lots, site partitions, railways, wharfs, shipways, distribution lines for gas, water and electricity etc. Soil improvements (drainage, raising, etc.) are also included in this category rather than in the category "ground and terrains" (The reason for this deviation is the fact that - with the exception of reclamation of land - macro-economically the obtaining of land is not an investment; however, land improvement is).
 - Ground and terrains. As mentioned above improvements in ground and terrains are not included. This category includes land which has been bought to derive raw materials from (clay, loam, peat, gravel, etc.).
 - Transportation. This includes cars and lorries, trailers, ships, carriages, etc. intended for external transportation. Internal transportation (lorries, lift trucks, assembly lines, etc.) is included in the category "machinery and equipment".
 - Machinery and equipment, see above.
6. These ratios appear to discriminate in studies by, among others, Ooghe, Coorevits, Verbaere (1981, 1982), Gombola and Ketz (1983), Ooghe and Verbaere (1984), Platt and Platt (1990, 1991), Skogsvik (1990) and Giacomino and Mielke (1993).
 7. The variables we have used are:
 - labour costs
 - gross result
 - cash flow: profit or loss before depreciations and taxes
 - industrial sales
 - total production value
 - interest: interest expense minus interest income.
 8. The correlation between the total production value and the industrial sales is at least .999 (see Wijn, 1988a, page 71). However, most studies speak of the sales rather than the total production value. Because of the high correlation between these two variables we regard them as equivalent.
 9. The variable in the denominator must not allow both positive and negative values. After all a very low, positive number in the denominator gives a high positive value of the ratio and a close, very low negative number a high negative value. The variance will then become extremely high.
 10. Strictly speaking we do not use random samples but populations; however, we use the statistical test in order to trace relevant differences. For the tests used see Kleinbaum and Kupper (1978) and Kendall and Stuart (1973).
 11. $a = \bar{y} - b\bar{x}$

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Appendix I*

Table 4. Manufacture of wood products, incl. furniture
Regression of cash flow on total production value

year	category	reference year 1981	reference year 1982
1978	bankrupt	PL= 0.051PR- 7	PL= 0.013PR+108
	continued	PL= 0.072PR- 7	PL= 0.066PR+ 32
1979	bankrupt	PL=-0.023PR-28	PL=-0.080PR+163
	continued	PL= 0.042PR+19	PL= 0.025PR+125
1980	bankrupt	PL=-0.075PR-37	PL=-0.001PR-106
	continued	PL= 0.039PR+36	PL= 0.037PR+ 74
1981	bankrupt		PL=-0.034PR-115
	continued		PL=-0.004PR+174

Table 5. Manufacture of wood products, incl. furniture
Regression of fixed capital formation in machinery and other equipments on total production value

year	category	reference year 1981	reference year 1982
1978	bankrupt	FCP=0.051PR-77	FCP=0.003PR+58
	continued	FCP=0.021PR+ 3	FCP=0.028PR-23
1979	bankrupt	FCP=0.016PR+ 4	FCP=0.015PR+17
	continued	FCP=0.030PR-40	FCP=0.037PR-67
1980	bankrupt	FCP=0.002PR+16	FCP=0.002PR+42
	continued	FCP=0.020PR+ 2	FCP=0.023PR- 7
1981	bankrupt		FCP=0.001PR+ 8
	continued		FCP=0.015PR+ 5

* For the abbreviations see note 5

Table 6. Manufacture of fabricated metal products, except machinery and transport equipment
Regression of interest expense less interest income on total production value

year	category	reference year 1981	reference year 1982
1978	bankrupt	RE= 0.064PR- 130	RE= 0.014PR+ 14
	continued	RE= 0.011PR+ 6	RE= 0.010PR+ 4
1979	bankrupt	RE= 0.096PR- 250	RE= 0.010PR+ 30
	continued	RE= 0.015PR- 6	RE= 0.014PR- 9
1980	bankrupt	RE= 0.152PR- 406	RE= 0.047PR- 83
	continued	RE= 0.019PR- 16	RE= 0.015PR- 2
1981	bankrupt		RE= 0.042PR- 40
	continued		RE= 0.014PR+ 16

Table 7. Manufacture of fabricated metal products, except machinery and transport equipment
Regression of cash flow on total production value.

jaar	category	reference year 1981	reference year 1982
1978	bankrupt	PL=-0.433PR+1503	PL= 0.022PR- 25
	continued	PL= 0.054PR+ 75	PL= 0.049PR+ 125
1979	bankrupt	PL=-0.536PR+1937	PL=-0.031PR+ 147
	continued	PL= 0.033PR+ 111	PL= 0.040PR+ 100
1980	bankrupt	PL=-0.208PR+ 247	PL=-0.029PR+ 97
	continued	PL= 0.039PR+ 121	PL= 0.044PR+ 125
1981	bankrupt		PL=-0.004PR-294
	continued		PL= 0.051PR+ 26

Appendix II. Confidence intervals (95%).

Table 8. Manufacture of wood products, incl. furniture
Regression of cash flow on total production value

	Reference year 1981				Reference year 1982			
	bankrupt		continued		bankrupt		continued	
	pl		pl		pl		pl	
PR III*	min	max	min	max	min	max	min	max
1000	- 139	164	22	109	5	269	97	213
2000	- 65	194	97	179	- 64	177	125	235
3000	- 2	234	172	250	- 137	89	152	257
4000	48	286	246	321	- 214	6	179	281
5000	85	352	318	394	- 297	- 72	204	305
6000	112	427	390	467	- 384	- 146	229	330
7000	134	508	462	541	- 475	- 216	252	357
8000	153	592	532	615	- 570	- 282	275	384
9000	169	679	602	691	- 666	- 346	297	413
10.000	184	767	671	767	- 764	- 409	318	441
PR II*	min	max	min	max	min	max	min	max
1000	- 149	157	9	114	- 180	20	58	166
2000	- 150	112	55	153	- 172	11	98	200
3000	- 160	77	100	193	- 167	5	136	235
4000	- 184	54	143	234	- 165	2	174	270
5000	- 219	44	186	276	- 167	3	212	305
6000	- 264	43	228	318	- 172	7	249	342
7000	- 316	48	268	363	- 180	13	285	379
8000	- 370	57	308	408	- 191	23	320	417
9000	- 427	68	346	453	- 203	34	354	455
10.000	- 486	81	384	500	- 216	46	389	495
PR I*	min	max	min	max	min	max	min	max
1000	- 419	- 86	23	123	- 436	124	98	245
2000	- 467	- 15	64	159	- 456	173	98	237
3000	- 526	- 106	105	196	- 483	- 215	97	230
4000	- 598	- 183	145	233	- 516	- 251	95	224
5000	- 685	- 246	185	271	- 556	- 279	92	218
6000	- 783	- 298	223	310	- 603	- 301	88	215
7000	- 890	- 340	261	349	- 655	- 318	83	212
8000	-1003	- 376	298	390	- 710	- 331	77	210
9000	-1121	- 408	335	431	- 768	- 342	69	209
10.000	-1241	- 437	371	472	- 827	- 351	61	209

*) PR III, PR II, PR I: Total production value in Hfl. 1000,- including cash flow, three, two and one year before the reference year

Table 9. Manufacture of wood products, incl. furniture

Regression of fixed capital formation in machinery and other equipments on total production value

	Reference year 1981				Reference year 1982			
	bankrupt		continued		bankrupt		continued	
	fcp		fcp		fcp		fcp	
PR III*	min	max	min	max	min	max	min	max
1000	- 152	107	6	70	- 8	76	- 59	48
2000	- 83	139	29	70	10	88	- 21	48
3000	- 22	180	51	90	28	101	17	83
4000	28	232	73	111	44	115	55	119
5000	66	295	95	132	59	131	92	155
6000	97	366	116	154	72	148	128	192
7000	122	442	136	176	84	167	164	229
8000	145	522	157	355	95	187	199	467
9000	166	603	177	221	105	207	234	306
10.000	185	685	196	244	114	228	268	345

PR II*	fcp		fcp		fcp		fcp	
	min	max	min	max	min	max	min	max
1000	- 4	54	- 34	52	13	74	- 10	69
2000	16	66	- 2	52	17	73	14	69
3000	34	79	29	81	20	73	38	91
4000	49	95	60	110	23	74	62	113
5000	63	113	91	140	24	75	85	135
6000	74	133	120	171	24	78	108	158
7000	85	154	150	202	23	82	130	181
8000	94	176	178	412	22	87	152	356
9000	104	198	207	266	20	92	174	228
10.000	113	221	235	298	17	97	195	252

PR I*	fcp		fcp		fcp		fcp	
	min	max	min	max	min	max	min	max
1000	4	32	1	68	0	17	4	51
2000	7	32	23	68	2	17	20	51
3000	9	33	44	87	3	18	36	66
4000	11	34	65	107	4	19	51	80
5000	12	36	85	127	5	20	66	95
6000	12	39	105	147	5	22	81	109
7000	12	43	125	167	5	24	96	125
8000	11	47	145	333	5	26	110	250
9000	10	51	164	210	5	28	124	156
10.000	9	55	182	231	5	30	138	171

Table 10. Manufacture of fabricated metal products, except machinery and transport equipment
Regression of interest expense less interest income on total production value

PR III*	Reference year 1981				Reference year 1982			
	bankrupt		continued		bankrupt		continued	
	in	in	in	in	in	in	in	in
	min	max	min	max	min	max	min	max
1000	-156	6	1	31	- 16	97	- 14	25
2000	- 82	60	13	41	2	99	2	38
3000	- 11	116	24	51	19	102	17	52
4000	57	176	36	62	35	108	31	65
5000	120	240	47	72	46	116	46	79
6000	230	258	70	71	74	109	76	78
7000	234	381	80	83	60	143	91	92
8000	287	455	79	105	64	161	89	122
9000	338	531	90	117	65	179	103	136
10.000	388	608	100	128	66	199	117	151

PR II*	in		in		in		in	
	min	max	min	max	min	max	min	max
	1000	-249	- 48	-11	28	- 116	0	- 12
2000	-144	39	5	42	- 61	39	4	50
3000	- 41	129	21	56	- 8	79	20	64
4000	59	221	37	71	43	121	35	78
5000	157	316	53	86	91	167	50	92
6000	315	350	84	85	155	197	83	89
7000	343	515	98	101	178	267	100	102
8000	433	618	98	131	218	320	95	136
9000	520	723	113	147	256	375	110	151
10.000	606	829	127	163	294	431	124	166

PR I*	in		in		in		in	
	min	max	min	max	min	max	min	max
	1000	-450	-102	-24	28	- 77	61	4
2000	-296	47	- 3	46	- 27	95	20	70
3000	-142	197	17	64	20	131	35	83
4000	11	346	37	83	65	170	50	97
5000	164	497	57	101	106	213	65	110
6000	459	505	96	101	178	225	99	104
7000	468	799	117	118	180	307	115	116
8000	620	951	115	159	214	357	108	153
9000	771	1103	134	178	246	408	122	167
10.000	921	1256	152	198	277	461	135	182

Table 11. Manufacture of fabricated metal products, except machinery and transport equipment
Regression of on cash flow on total production value.

PR III*	Reference year 1981				Reference year 1982			
	bankrupt		continued		bankrupt		continued	
	pl		pl		pl		pl	
	min	max	min	max	min	max	min	max
1000	395	1830	66	170	- 31	371	84	220
2000	53	1307	123	222	- 33	309	128	257
3000	-313	809	180	274	- 40	253	171	295
4000	-713	343	235	327	- 54	205	213	333
5000	1151	- 84	291	380	- 80	167	255	372
6000	1627	-472	345	434	- 118	143	297	412
7000	2134	-831	399	488	- 167	128	337	453
8000	2662	1168	452	544	- 223	122	377	494
9000	3205	1490	505	600	- 284	120	416	535
10.000	3756	1804	557	656	- 349	122	455	578

PR II*	pl		pl		pl		pl	
	min	max	min	max	min	max	min	max
	1000	948	2063	89	227	- 177	330	86
2000	459	1480	125	257	- 171	267	133	291
3000	- 41	908	161	287	- 170	209	180	332
4000	-554	349	197	318	- 180	161	227	373
5000	1083	- 194	231	349	- 202	127	272	415
6000	1628	- 721	265	381	- 239	106	318	458
7000	2188	-1232	298	415	- 289	99	362	501
8000	2762	-1730	330	448	- 348	100	406	545
9000	3346	-2218	361	483	- 412	107	449	590
10.000	3938	-2698	392	519	- 481	119	491	635

PR I*	pl		pl		pl		pl	
	min	max	min	max	min	max	min	max
	1000	-248	517	76	235	- 530	- 165	- 18
2000	-451	302	118	269	- 513	- 189	36	213
3000	-654	89	160	305	- 502	- 207	90	260
4000	-859	- 123	201	341	- 499	- 218	143	308
5000	1065	- 335	242	377	- 504	- 220	196	357
6000	1271	- 545	281	415	- 518	- 214	248	406
7000	1479	- 754	320	453	- 538	- 201	299	456
8000	1688	- 962	358	492	- 564	- 183	349	507
9000	1898	-1169	396	532	- 593	- 161	399	559
10.000	2109	-1375	432	572	- 625	- 137	448	611