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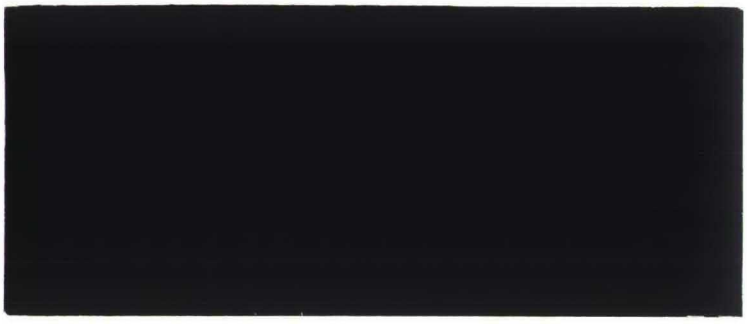
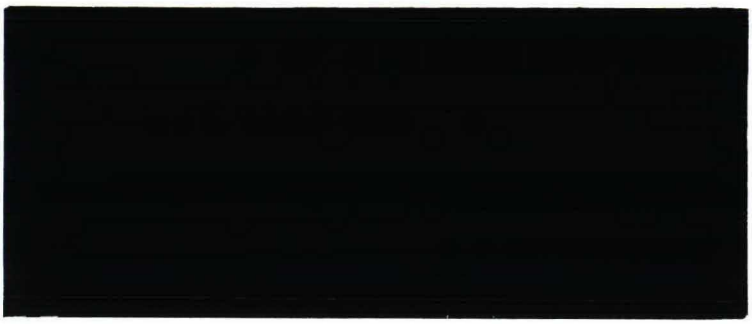


DEPARTMENT OF ECONOMICS

RESEARCH MEMORANDUM



PREDICTION OF FAILURE IN INDUSTRY
An analysis of income statements

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PREDICTION OF FAILURE IN INDUSTRY

An analysis of income statements

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This study concentrates on characteristic features of firms that exited from industry. It focuses on firms which closed down not only because of bankruptcy but also for other [exit] reasons. The study shows that from a theoretical and empirical point of view the usual ratio analysis is incapable of predicting firms' failure. Furthermore it shows that predictions cannot be made at the level of industry (1-digit) but have to be made at the level of manufacturing classes (2-digit). The differences between the classes are greater than the differences within. So the conclusions of the literature are not supported. At the level of classes of manufacturing the variable "cash flow" turns out to discriminate best, followed at a much lower level by "value added" (factor cost).

1 Introduction

From the mid-seventies there was a fall in Western economies. Many firms had to stop their activities. The big social problems of mass-dismissals,

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*We wish to thank prof. dr. P.A. Verheyen en prof. dr. W.G.H. van Hulst for their comments and suggestions at various stages in the preparation of this paper.

creditors who got involved in the bankruptcy of their clients, destruction of capital, etc. motivated many researchers to look for a model to predict the exit of firms as a result of bankruptcy, and the barriers which prevent closing down at a proper time, that is to say before the firm goes bankrupt. Knowing the exit barriers could enable a firm to change its policy in time (e.g. by hiring a consultant, or taking measures to provide a smooth and careful exit).

The causes most often mentioned for a firm's exit are: the inferior quality of the products relative to those of the competitors (Hirschman, 1970), a structural excess capacity in the business, a temporary deficit despite profitability in the long run, personal circumstances of the owner/director and last but not least bad management. Among the experts who are convinced that most often bad management is to blame for firms failure, are Argenti (1976a, 1976b), Bedeian (1983), Bibeault (1982) and Weston and Copeland (1986). To this enumeration many causes could be added, but we confine ourselves to the most important ones.
On the other hand there are reasons why firms do not like to stop their activities voluntarily in spite of the fact that - perhaps adjusted - goals are not reached. In that case there appear to be exit barriers. Research in the USA on these barriers was originally done in relation to the crisis of 1930. Many researchers looked for an explanation for the continuing excess-capacity in agriculture (Schultz, 1945, Cochrane, 1947, Johnson, 1950). Some decades later research was done into the causes of firms not voluntarily leaving industrial activities at an appropriate time (Porter, 1976; Caves and Porter, 1976; Harrigan, 1980, 1982; Harrigan and Porter, 1983; Shapiro and Khemani, 1987; Baden-Fuller and Longley, 1988).
Many reasons might exist for a firm to close down but at the same time there may be many obstacles (exit barriers) to stopping the activities voluntarily. This hampers the prediction of the exiting of firms. The models that have been developed to predict exit can be divided into strategic and financial models. In the strategic models attempts are made to gain more insight into the stages of a firm. It is assumed that a firm's existence from beginning to end can be described in terms of an (organizational) life cycle. Well-known authors in this field of research are Greiner (1972), Adizes (1981), Churchill and Lewis (1983), Quinn and

Cameron (1983) and Scott and Bruce (1987). In contrast to these authors Argenti (1976a, 1976b) states that "... all attempts to generalize about failure must be futile", because only few firms fail in the same way.
In many countries the possibility of predicting insolvency (failure) is studied, based on data from the annual reports of firms. This leads to what we call financial models. The research is directed to several sectors of the economy, like commerce, industry, banks, and so on. Pioneers in this field are Beaver (1966) and Altman (1968). In the Netherlands especially the studies by Bilderbeek (1979, 1983) and Van Frederikslust (1978) have become well known.
Surveys in this area were made by Altman (1984) and Foster (1986). In nearly all models ratios of financial characteristics based on the annual reports were used to predict failure. In recent years multivariate techniques like logit analysis, discriminant analysis and recursive partitioning are often used in order to specify these models (Zmyewsky, 1984; Jones, 1987). The problem of all these models is that they have been developed without a proper theoretical framework, with the result that every time other ratios turn out to discriminate best.

In the following sections the empirical differences will be traced between industrial firms which have stopped their activities and which have not. At first we will theoretically and empirically examine the relevance of ratio analysis.

2 Ratio analysis

Ratio analysis is often used in the literature and in the practice of advisers to predict a firm's failure. There is reason to be very critical about this method however, because the method is not based on a testable theory, the choice of the ratios is not founded in economic theory and, therefore, the empirical analyses show little consistency in ratios that discriminate.

Let us start to analyse the essence of a ratio. A ratio is a quotient of the values of two variables at the same moment or during the same period. It is the tangens of a straight line going through a point in a plane and

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Figure 1 about here

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the origin (see Figure 1). In the case of three different firms, a ratio can be calculated for each firm. If the ratio is the same it is concluded that the firms do not differ in this respect. It will be shown that this conclusion may be wrong.
The ellipses in Figure 2 indicate the scatter diagram of three

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Figure 2 about here

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categories: firms that terminated their activities voluntarily, firms that went bankrupt and firms that continued their activities. It seems to be appropriate to consider the average of a variable as the characteristic value for a category. The ratio of these averages should be different for each category. In classifying an individual firm, the ratio of the firm in question is compared with the "characteristic" ratios of the categories. In the example, however, the pair of averages $(\bar{x},\bar{y})$ of each scatter diagram is situated on a straight line going through the origin. This should indicate that the categories do not differ in respect of the relation between the variables X and Y. However, if we apply linear (least squares) regression lines ($\hat{y} = a + bx$) one observes that the categories do differ tremendously. It is obvious that, therefore, the use of ratios can actually lead to wrong conclusions. This will be further demonstrated with an empirical example. In the class of 'Manufacture of food, beverages and tobacco products', the three different categories had its own specific ratios in 1981 (see section 3). In the example we consider the ratio: value added (factor cost) / total production value (see Figure 3).

Figure 3 about here

The ratio of the averages of the two variables (denoted by the dots in Figure 3) for the group of firms that left industry voluntarily is higher than for the firms that continued their industrial activities ($c_2 > c_1$). From an economic point of view this would indicate that firms which continued their activities show a lower rate of value added (f.c.) than firms that left industry voluntarily. This conclusion is entirely unwarranted.
The linear regression lines are also drawn in Figure 3. They appear to discriminate clearly; they have the same slopes (= regression coefficients) but very different levels.

We have to conclude that both because of practical shortcomings and for theoretical reasons the use of ratio analysis to discriminate between categories of firms has to be rejected.

3 An empirical research in the Netherlands.

The preceding sections show that ratio analysis is not a suitable tool to predict the failure of a firm. Therefore alternative ways to predict failure at an early stage have to be found. In this section the differences between firms that left industry and those which did not will be analyzed. It is of special interest to compare three categories

1) the firms that were forced to exit, e.g. by bankruptcy;
2) the firms that closed down voluntarily or turned their manufacturing activities into other ones like commerce;
3) the firms that continued their manufacturing activities.

The Netherlands Central Bureau of Statistics (CBS) has at its disposal a large and reliable dataset on those firms. It gave permission, subject to strict conditions of secrecy, to analyze their data on industrial firms with ten or more employees (about 4500 firms).

3.1 Database and statistical techniques used

For the individual industrial firms the data of the income statements and the fixed capital formation were available from 1978 till 1982. For every year the following eighteen variables are known: number of employees,

industrial sales, export, total production value, total consumption value, value added, indirect taxes (excl. VAT) and levies less operating subsidies received, value added (factor cost = f.c.), labour cost, gross result, interest expense less interest income, gross result plus interest expense less interest income, miscellaneous income less expense, profit or loss before depreciation and company income tax (cash flow), cash flow plus interest expense less interest income, fixed capital formation (total) and split up into a) plants, other buildings and site improvements, sites transport equipment b) machinery and other equipments.
There are two years of reference: 1981 and 1982. This implies that on the one hand firms which existed in 1978 and still existed in 1981 or terminated their industrial activities in 1981 are analyzed and on the other hand firms which existed in 1978 and still existed in 1982 or terminated their industrial activities in 1982.
Since some of the eighteen variables are strongly correlated, they have to be checked on redundancy. The correlation matrix for these variables provides the information which supplies an answer to this question. After that the differences will be studied between the distinct categories of firms per class of manufacturing, per year of exit (1981 or 1982) and per year (1978-1981 or 1978-1982). Analysis of variance is a suitable technique for this purpose. The relations between the variables will be studied by regression analysis. Finally, the categories will be grouped in homogeneous subsets by cluster analysis.

3.2 Reducing the number of variables

The annual figures of the income statement and the fixed capital formation of the firms in industry are available from 1978 till 1981 or 1982. For the sake of economy the number of available variables is reduced. We decided to select the following variables on the basis of factor analysis (with SPSS^x): number of employees, export, total production value, indirect taxes (excl. VAT) and levies less operating subsidies received, value added (f.c.), interest expense less interest income, miscellaneous income less expense, profit or loss before depreciation and company income tax (cash flow) and fixed capital formation. Fixed capital formation has been split up into a) plants, other buildings and site improvements, sites transport equipment; b) machinery and other equipments. All these variables had an intercorrelation (Pearson r) of less than 0.80.

3.3 Selection of firms and classes of manufacturing (2-digit level)
In the pilot-study it was found that industrial firms with 500 or more employees seldom leave industry. Moreover, their figures dominate the statistics of the categories too much. Therefore the study was limited to firms with 10 - 500 employees. It appeared also that most of the firms that left industry had 10 - 50 employees (Wijn, 1988). So the decision was made to include in the research only those classes of manufacturing (2-digit, according to the Standard Industrial Classification of all Economic Activities - SBI 1974) in which 80% or more of the firms have less than 50 employees. In order to guarantee secrecy, for statistical reliability and for purposes of comparison, the classes of manufacturing were further limited to those which have at least three firms per category in 1981 and 1982 (see table 1).

Table 1 Numbers of firms in the years of exit 1981 and 1982, per class of manufacturing

SBI	class of manufacturing	1981			1982		
		v	f	c	v	f	c
20/21	Manufacture of food, beverages and tobacco products	13	18	1116	16	28	1003
23	Manufacture of wearing apparel (except footwear)	4	23	190	4	14	151
25	Manufacture of wood products, including furniture	12	38	622	8	53	535
27	Printing, publishing and allied industries	5	12	792	10	22	723
34	Manufacture of fabricated metal products, except machinery and transport equipment	9	29	1014	13	50	878
35	Mechanical engineering	6	17	847	4	27	763
	Total	49	137	4581	55	194	4053

- v = exited voluntarily; f = forced to exit [bankrupt]; c = continued

3.4 Statistical results

In order to find those variables which differ significantly for the three categories, analysis of variance was used. By means of regression analysis one looks for different effects between variables (different slopes of the regression lines). By using cluster analysis homogeneous groups are constructed in the expectation that these groups will coincide with the distinct categories.

3.4.1 Analysis of variance

For every selected class of manufacturing we checked whether each variable discriminated significantly between the three categories. The analysis of variance (SPSS^{x}, ONEWAY, significance level 5%) was completed for both years of reference 1981 and 1982. It appears (see Appendix 1) that only a few variables discriminate for both years of exit. For all years included in the analysis (1978-1981 or 1978-1982) however, cash flow discriminates best, followed at a much lower level by value added (f.c.). Interest expense less interest income discriminates in both years of exit in the Manufacture of fabricated metal products, except machinery and transport equipment.

Contrary to the expectations there were no significant differences found for the yearly fixed capital formation. The conclusion is that the levels of the variables for the three categories do not discriminate enough to characterize these categories.

3.4.2 Regression analysis

To counter the drawbacks of a ratio analysis it was decided to apply regression analysis on the variables which would otherwise be used to calculate ratios. The number of pairs of variables was limited to 12, viz:

1. export / total production value
2. total production value / number of employees*
3. value added (f.c.) / total production value
4. interest expense less interest income / total production value*
5. interest expense less interest income / cash flow
6. miscellaneous income less expense / total production value
7. cash flow / total production value*

8. fixed capital formation in machinery and other equipments / total production value
9. fixed capital formation in machinery and other equipments / fixed capital formation (total)
10. fixed capital formation (total) / total production value
11. fixed capital formation (total) less fixed capital formation in machinery and other equipments / fixed capital formation (total)
12. fixed capital formation (total) less fixed capital formation in machinery and other equipments / total production value

* this pair of variables appeared to be relevant in other studies to predict failure

In the regression analysis the numerator of the ratio will be denoted as the dependent variable and the denominator as the independent variable. All regression analyses (per category, per class of manufacturing, per year of exit and per year) are checked on linearity by inspecting the scatter diagrams (SPSS^x, program Regression). The congruence of the regression coefficients is tested with SPSS^x-MANOVA. If the regression coefficients of the three categories do not differ significantly (at the 5% level) and if the means do not either, the equation is said not to discriminate.

In the years of exit (1981 or 1982) it turns out that only in some classes of manufacturing do a few regression equations discriminate. However, very little resemblance for the classes of manufacturing exists in the years of exit (see Appendix 2), so we have to conclude that this promising method of analysis did not turn out to be very fruitful, since:

a) for the same categories, the regression coefficients differ substantially in the years of exit notwithstanding the succeeding years of exit;
b) the (relevant) regression equations do not make sense in terms of economic theory.

Our conclusion is that, we cannot predict voluntary exit or bankruptcy on the basis of linear regression analysis.

3.4.3 Search for clusters of homogeneous firms

In the preceding sections we concluded that no differences between the three categories could be specified either at the level of total industry (1-digit) or at the level of class of manufacturing (2-digit). Maybe cluster analysis (program Clustan) can indicate relevant subgroups. In cluster analysis one attempts to construct groups of objects in such a way that the objects in a cluster have "great" similarity between each other but show "little" similarity with objects outside that cluster (Bijnen, 1973, p. 2). Within "Clustan" the average linkage (unweighted pair group arithmetic average cluster) method is used (Clustan, p. 90).

3.4.3.1 Clustering at the level of total industry

First of all one has to find out whether firms within a category (e.g. the firms that left industry voluntarily) have much in common in the classes of manufacturing. Every selected class has three categories viz, bankrupt firms, firms that left industry voluntarily and firms that continued. So there are eighteen groups per year of exit. For reasons of time, means and practicality the firms could not be cluster-analyzed at the individual level. Therefore it was decided to analyze the eighteen groups as groups. The means of the variables will be taken to represent the groups. The values of a variable are rescaled from 1 till 10 (1 equals the lowest value and 10 the highest) to prevent a different influence of the variables on the results of the cluster analysis.

In the years of exit 1981 and 1982 the three categories in a class of manufacturing often belong to the same group; the same categories in different classes of manufacturing do not always cluster together (see appendix 3). As for the Manufacture of wearing apparel (except footwear) and Manufacture of wood products (including furniture) no difference at all for the three categories in 1978, 1979, 1980 and 1981 can be perceived.

The same category (e.g. firms that left industry voluntarily) of different classes of manufacturing does not always belong to the same cluster and the three categories within a class of manufacturing are often quite similar. The differences between the classes of manufacturing are apparently too big to get homogeneous categories of bankrupt firms, firms that exited industry voluntarily and firms that continued their indus-

trial activities. In the next section we will look for differences between the three categories at the level of class of manufacturing.

3.4.3.2 Clustering at the level of class of manufacturing

If homogeneous groups at the level of total industry cannot be found, it is perhaps possible to find them at the level of class of manufacturing (2-digit). Within every class of manufacturing the data for the years 1978 till 1981 or 1982 were cluster analyzed for the three categories. The data are standardized in the same way as in the preceding section. A completely different picture (see appendix 4) emerges. For the year of exit 1981 the three categories are clearly different in every year. For the year of exit 1982, however, two classes of manufacturing, the Printing, publishing and allied industries and Mechanical engineering deviate from that pattern. In the first class the firms that exited industry voluntarily and the bankrupt firms are clustered into one group. In the second class (Mechanical engineering) firms that exited industry were only split up into two groups in the last two years before exiting.

We find for the Netherlands that the three categories are apparently different groups at the level of class of manufacturing. At the level of total industry the opposite is true. Regarding the studies by Bilderbeek and Van Frederikslust this is a very remarkable result. Their models are based on the level of total industry (1-digit) and this appears not to be appropriate.

4 Summary and conclusion

We have demonstrated that the use of ratios to predict firms' failure has to be rejected, and that therefore regression analysis has to be applied. In the empirical section of the study significant differences between the categories were looked for: bankrupt firms, businesses that exited industry voluntarily and firms that have continued their industrial activities. Data from income statements and yearly fixed capital formation were used. The variable cash flow discriminates best, followed (at a much lower frequency) by value added (factor cost). It was surprising that hardly any significant difference for the fixed capital formation appeared. The significant differences could not be interpreted in economic

terms and the regression coefficients for the same categories in both years of exit are too different. After applying cluster analysis at the level of total industry (1-digit), the differences between the classes of manufacturing appear so big that the categories did not cluster together. On the other hand, at the level of class of manufacturing (2-digit) the three categories were different. This proves that, at least for the Netherlands, reliable predictions about which firms will exit industry can only be made at the level of class of manufacturing (2-digit), or lower.

Further research has to be done to explore the degree to which each variable contributes to the discrimination of the three distinct categories.

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Appendix 1. Classes of manufacturing with significant different mean values in the three categories (bankrupt firms, firms that exited industry voluntarily and firms that continued their industrial activities) for the denoted variables, per year of exit.

	1981	1982
number of employees	20/21	
export	34	
total production value		
value added (f.c.)	20/21;23;25	20/21;25;27;34
indirect taxes (excl.VAT) and levies less operating subsidies received	34	25;35
interest expense less interest income	34	34
miscellaneous income less expense	34	25
cash flow	20/21;23;25;34;35	20/21;25;34;35
fixed capital formation in machinery and other equipments	23;34	25
fixed capital formation in plants, other buildings and site improvements, sites		
transport equipment		27
fixed capital formation		

Appendix 2. Significant differences in a regression analysis for variables in classes of manufacturing in both years of exit

	EX and PR	VA and PR	IE and PR	IE and CF	CF and PR
Manufacture of food, beverages and tobacco products		C			
Manufacture of wood products, including furniture	B			C	C
Manufacture of fabricated metal products, except machinery and transport equipment	B	B	D	D	D
Mechanical engineering					B

- B: only regression coefficients differ significantly
- C: only levels (averages) differ significantly
- D: regression coefficients and levels (averages) differ significantly
- EX = export; PR = total production value; VA = value added (f.c.); IE = interest expense less interest income; CF = cash flow.

Appendix 3. Schematic representation of the groups formed by cluster analysis, year of exit 1981 at the level of total industry

	year of exit 1981			year of exit 1982			
	1978	1979	1980	1978	1979	1980	1981
	v f c	v f c	v f c	v f c	v f c	v f c	v f c
Manufacture of food, beverages and tobaco products	+	+		o +	x	+	$ +
Manufacture of wearing apparel (except footwear)	+ + +	+ + +	+ + +	+ + +	+ +	+ + *	+ + +
Manufacture of wood products, including furniture	+ + +	+ + +	+ + +	+ +	+ + +	+ + +	+ + +
Printing, publishing and allied industries	+ *	+ + *	+ + *	+ +	+ + #	+ + @	+ + *
Manufacturer of fabricated metal products, except machinery and transport equipment	+	o o *	o o *	+ + +	+ *	! + *	+ + *
Mechanical engineering	*	x x *	*	+ + +	* x *	@ + *	+ *

- v = exited voluntarily; f = forced to exit (bankrupt); c = continued;
- +; *; @; etc. denotes the membership of a specific group. To categories which are in the same group in some years, the same symbol is given.
- blank: does not belong to any group

Appendix 4. Schematic representation of the groups formed by cluster analysis, per year before exit and class of manufacturing and year of exit, at the level of class of manufacturing.

	1981			1982		
	v	f	c	v	f	c
	3 2 1	3 2 1	3 2 1	4 3 2 1	4 3 2 1	4 3 2 1
Manufacture of food, beverages and tobacco products	a a a	b b b	c c c	g g g	h h h h	i i i i
Manufacture of wearing apparel (except footwear)	d d d	e e	f f f	k k	p p p p	* * * *
Manufacture of wood products, including furniture	j j j		l l l		w w w	x x x x
Printing, publishing and allied industries	m m	n n n	o o o	y y y	y y y y	z z z z
Manufacturer of fabricated metal products, except machinery and transport equipment		q q	r r r	$ @@	$ $ $ $	& & & &
Mechanical engineering	s s	t t	u u u	% %	% % # #	! ! ! !

- v = exited voluntarily; f = forced to exit (bankrupt); c = continued
- 4, 3, 2, and 1: years before the year of exit;
- a; b; *; @; etc. denotes the membership of a specific group. To categories which are in the same group in some years, the same symbol is given.
- blank: does not belong to any group

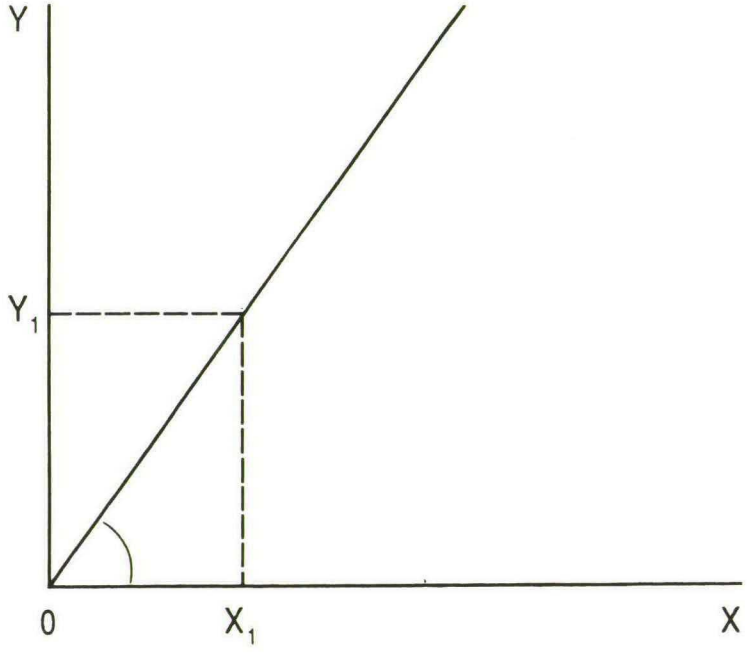

Figure 1

Graph of a ratio $\left(\frac{Y_1}{X_1}\right)$

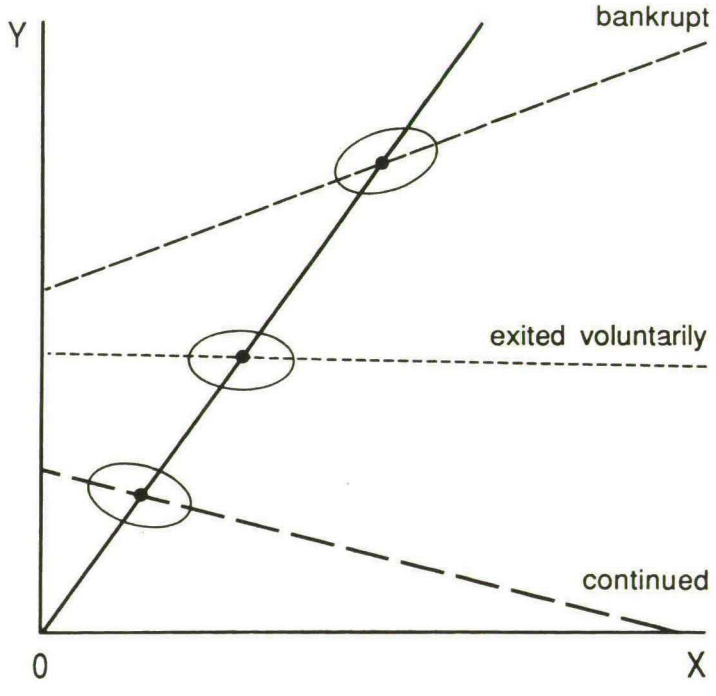

Figure 2
Example of regression lines

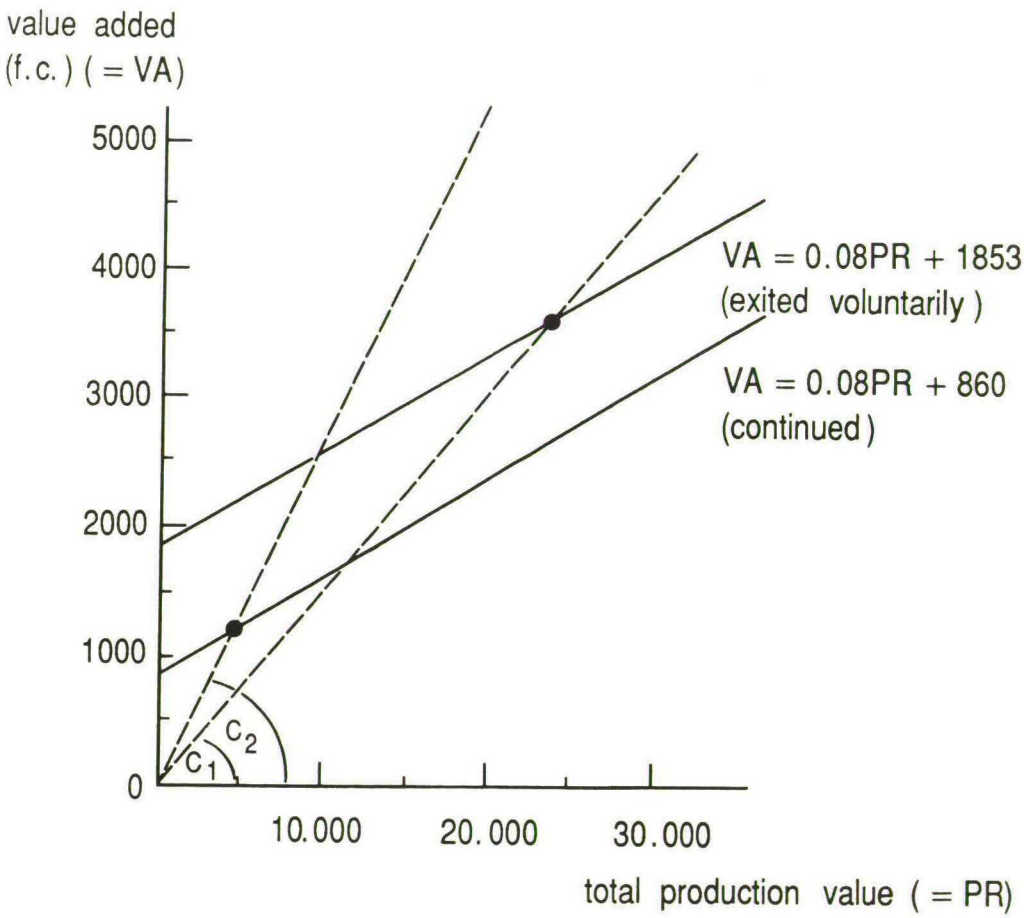

Figure 3

Value added (f.c.) (=VA) and total production value (=PR) (in 1000 guilders per annum), year 1978, in the class of Manufacture of food, beverage and tobacco products, year of exit 1981.

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