WORKING PAPER

DYNAMICS OF MANAGERIAL RISK ATTITUDES & STRUCTURAL CHANGE IN THE STEEL INDUSTRY

Wolfgang Leitner

August 1988
WP-88-070

IIASA
International Institute
for Applied Systems Analysis

DYNAMICS OF MANAGERIAL RISK ATTITUDES & STRUCTURAL CHANGE IN THE STEEL INDUSTRY

Wolfgang Leitner

August 1988
WP-88-070

INTERNATIONAL INSTITUTE FOR APPLIED SYSTEMS ANALYSIS
A-2361 Laxenburg, Austria

FOREWORD

During the recent decade, management science has become more and more interested in the strategic aspects of management. The changing social, economic, and technological environment of a company is a major challenge to which management should respond. Strategic management is regarded as a tool to increase organizational flexibility in order to overcome fluctuations originating mainly from the business cycle or from market changes.

In order to investigate empirically how companies faced this challenge, MTC developed a methodology for analyzing long-term changes of management strategies. A dynamic approach is applied in this paper which reports about the preliminary results of a study carried out in order to test this methodology.

Technological change, as well as any other kind of innovation, is traditionally associated with the idea of being potentially more risky than business as usual. Therefore, managerial risk taking behavior, measured quantitatively by use of appropriate business ratios, is regarded as an indicator for the strategic behavior of firms. The hypothesis of whether entrepreneurial risk attitudes change along the organizational life cycle is tested in this paper. A small sample of steel companies was analyzed for that purpose since the steel industry is very well suited to such a longitudinal study, thus extending IIASA's research activities on long-term economic cycles to the company level.

F. Schmidt - Bleek
Program Leader
TES - Program

1. INTRODUCTION

Change of micro- and macroeconomic structures is a necessity enforced by changing demand patterns, technological progress, and other determinants. The idea of cyclical structural change goes back to the 1920's when Kondratieff and Schumpeter developped their idea of "long waves" [1]. The long-wave issue has also been one of the major issues of IIASA's research activities in past years.[2] Empirical investigations provided some support for this idea, showing for example a clustering of innovation activities around certain periods.[3]

Attention has also been paid to the question what the incentives behind long-term cycles are. It was basically Schumpeter's hypothesis that innovative and risk-seeking entrepreneurs are responsible for economic growth. Their new ideas create technological breakthroughs, old industries loose their competitiveness, and thus structural change takes place in economy and society.[4]

Experiences from the recent past seem to support Schumpeter's hypothesis: Companies in many industries still have difficulties to cope with structural changes of the environment relevant for their business. In too many cases, steps to adapt to these changes were taken only when the firm was already in severe crisis facing losses and sharply declining sales.

For example, many steel companies worldwide were still extensively expanding capacity in the 1970's, following market forecasts published by institutes like the UNIDO[5] or the International Iron and Steel Institute.[6] In 1976, worldwide steel output had already been stagnating for several years at around 700 million tons per year. Stagnation of demand had been caused by structural changes in various industries and in society. Nevertheless "some 1,069 million tons of steel production/consumption" were forecasted for 1985.[7] Thus the real figure of 719.1 mt was overestimated by almost 50% ! As a consequence of this kind of thinking in linear terms, restructuring of the steel industry started with

---

[1] Kondratieff, 1926; Schumpeter, 1950 and 1961.

[2] Marchetti, 1981; Marchetti/Nakicenovic, 1979.

[3] Kleinknecht, 1987; Mensch, 1979

[4] Schumpeter, 1961.

[5] UNIDO, 1976.

[6] International Iron and Steel Institute, 1972.

[7] UNIDO, 1976, p.32.

a substantial delay and still causes severe problems (e. g. to the labor market) in many countries.

This paper is generally dealing with the question if - mainly large - companies can prepare for and offset economic crisis in advance by improving their strategic management. A major objective of strategic management which obviously was not met completely in the past is to guarantee that the company fulfills it's longterm goals. In market economies usually the main goal is to sustain profitability.

2. GOALS, ASSUMPTIONS AND HYPOTHESES

Most large companies are not flexible enough to adapt quickly to short-term fluctuations of the business cycle. Additionally every industry is faced with structural change in the long run. Environment changes rather smoothly according to the long waves theory, so that plenty of time is available theoretically for adaptation in ths case. Adaptation is especially necessary if the survival of the firm is important because of strategic (e.g. steel industry) or social (e.g. labor market monopoly) reasons. However, two obstacles are to be mentioned :

First, weak signals announcing the direction of changes are difficult to interpret properly. Strategic decisions are more risky, therefore, than short-term decisions, as they are taken under higher uncertainty. Expressed in mathematical terms this means that the variance of possible outcomes of a long-term decision is higher.

Second: Regarded from a short-term point of view, excluding the necessity to prepare for structural change, the goals of a company can also be met without taking risky long-term measures for a certain period of time. Especially under conditions of industrial growth, expansion of those fields that are successful currently appears to be the most reasonable way to raise profit.

The level of risk taking can be controlled by management much better than other determinants of its decisions. Even a risk-averse decision-maker would therefore incur more risk during a phase of growth provided that he takes the existence of permanent environmental change as given than if he relied on the persistence of expansion.

However, the experience of the past shows that short-term oriented goals still prevail in many companies. Long-term environmental trends seem to be excluded from strategic planning processes as long as profitability can be sustained by short-term decisions. Consequently, company strategy based on linear growth thinking deviates more and more from changing market requirements. For many companies only entrepreneurial crisis was a sufficient incen-

tive to adapt to these changes. From that, however, it appears as if increased risk-taking cannot be avoided in the long run, but only be postponed.

The question arises if companies could improve their resistence against crisis by taking more risk than they do as long as they are in a favourable position. Related to these considerations the following two hypotheses were formulated to be tested empirically:

1. Companies generally tend to take less risk during phases of industrial growth than during phases of stagnation or decline.

2. Above average risk-seeking under growth conditions helps companies to cope with recession. Relative risk aversity under growth conditions, however, has the reverse effect on a company's position under crisis conditions.

The approach presented is based on the idea that business risk taking behavior, measured quantitatively by use of appropriate business ratios, can describe decision makers' attitude towards structural change. Business performance, measured by another set of business ratios is assumed to develop in the long run according to a cyclical pattern that also became known as the industry- or business- life cycle. However, the life cycle is not seen as a normative concept but rather as a result of linear thinking during economic growth and thus neglecting structural change as long as possible.

Thus, the paper contains several new contributions to the analysis of the relationship between business risk and return :

- Changes of entrepreneurial risk attitude over time are investigated;
- the industrial life cycle (in the sense mentioned above) is tested as the explaining variable for these changes;
- several new indicators for business risk and return are suggested and used simultaneously together with conventional ones;
- in order to monitor dynamics sufficiently, all indicators are analyzed over a period of 35 years;
- the sample investigated is not restricted to the industry of one nation but contains companies from various countries.

3. THEORETICAL AND EMPIRICAL FOUNDATIONS

Schumpeter's contributions regarding the importance of entrepreneurial risk attitude have already been mentioned. More recently, both theoretical and empirical analysis has addressed the relationship between business risk and return: The conventional argument for economic rationality suggests that because the typi-

cal business executive is risk-averse[8], a higher risk investment requires a higher expected return. This hypothesis was tested for several industries in the United States by studies published in the late 60ies.[9] Empirical studies to support this approach have faced one major problem. While the risk may be considered before committing resources (i.e., ex ante), the effects and aggregation of numerous commitments can only be observed over time (i.e., ex post). Therefore, the profit variance was frequently used as a measure of risk. Return was measured by the amount of annual profit.

Both studies cited seem to confirm that risk and return are positively correlated on an industry level, at least in retrospective. Despite the fact that relatively long periods were observed, the investigations have to be regarded as static as no changes in risk attitude nor in economic performance were taken into consideration.

The positive correlation between return expectations and risk attitude has been criticized by Edward H. Bowman.[10] He applied roughly the same approach to investigate risk and return on US-company - level. Thus, he found out that enterprises with a high profitability seemed to be less risk-taking than companies in a weak position. Despite the fact that Bowman tried to strengthen his hypothesis, which he called the Risk-Return Paradox, with further investigations[11] and that he was one of the first to mention that risk attitudes might be different in different situations of business performance, his studies remained cross-sectional and therefore static. Long-term dynamics of industries or the economy as a whole were not seen as a determinant of business risk attitude.

In 1984, Manfred Perlitz and Helge Löbler confirmed Bowman's results by using his methodology to analyze 10 West-German industries[12]. The authors themselves mention at the end of their paper that economic growth and decline might have an impact on managerial risk attitudes.

Recently, Ayres and Mori mentioned in their paper that "external circumstances (i.e., the life cycle) can strongly influence attitude to risk. In fact, the conventional idea that risk aversion

---

[8] Gravelle/Rees, 1981, p. 553.

[9] Conrad/Plotkin, 1968; Cootner/Holland, 1970.

[10] Bowman, 1980.

[11] Bowman, 1982 and 1984.

[12] Perlitz/Löbler, 1985.

and risk-seeking are unchanging characteristics of decision-makers must now be challenged."[13] Consequently, this idea is going to be analyzed empirically in this paper. As mentioned, the basic assumption is that during growth phases decision-makers tend to perceive their economic environment as stable which has a substantial influence on their attitude towards risk. One reason for this ceteris paribus assumption can be provided by A. H. Simon's theory of bounded rationality[14].

This theory is a fundamental critique of the traditional, mathematically oriented theory of decision taking under uncertainty. Mainly he emphasized that in reality there is an important limitation on the computational and information processing capabilities of decision-makers which creates a constraint that makes only a limited degree of rationality possible. A decision-maker therefore would not take all possible alternatives into consideration in order to identify the optimal solution to his problem (actually this would be an infinite number in most cases). Rather he would terminate his search as soon as a sufficient solution was found in the sense that it meets the goals of the decision-maker.

4. GENERAL METHODOLOGICAL ASPECTS

4.1. Object of Investigation

For many reasons, the steel industry can serve as a good example to investigate managerial risk attitude changes over the industrial life cycle. First, the steel industry is a large-sized industry of major attention to economists and politicians. Because of that, it's development is well documented in literature, making it possible to collect the necessary information over a long range of time. Second, steel industry frequently is mentioned as a typical example for cyclical performance resulting from structural change.[15]

Two of these cycles are depicted in graph 1, showing annual growth rates of world steel production. This curve also shows that the major part of the recent cycle is included in the period from 1950 to 1985 which we chose as the period of investigation for this study. It is well-known from literature that this cycle showed very typical patterns with a substantial worldwide increase of output during the 1950's and 1960's, and a severe recession starting in the early 1970's.

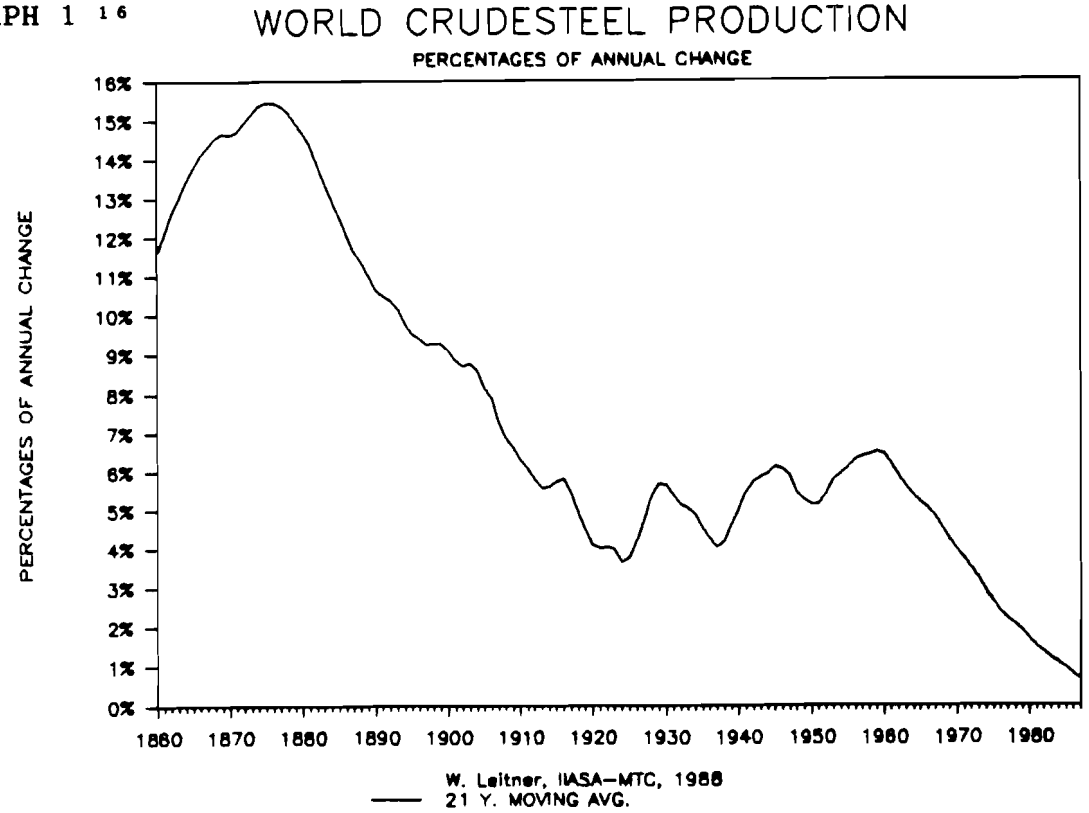
---

[13] Ayres/Mori, 1987, p. 20.

[14] Simon, 1979.

[15] Ray, 1984.

GRAPH 1 [16]



The fact that steel industry is closely interrelated worldwide, justifies our attempt to do an international comparative study based on time series. In order to homogenize the sample from a technological point of view the respondents were selected according to the following criterion: Between 1952 and 1962 exactly 30 companies from different countries adopted the so-called BOF process which is one of the most important technological innovations in steel industry since World War 2.[17] The firms were approached by letter and inquiry form and asked to provide information that is usually contained in annual reports. Approximately 50% of our sample responded positively to the request. The data of 10 companies representing 8 countries (Austria, Australia, Brazil, Canada, West Germany, Japan, Luxembourg, and the United States) have been computerized and provide the data base for this study.

4.2 Business Ratios to Measure Risk and Return

To measure the dynamic development of risk attitude and company performance, we apply principally the same tools as suggested in

---

[16] Source: ECE, IISI.

[17] Stone, 1966.

previous studies.[18] Risk attitude and company performance are assumed to be measurable by ratios calculated from the figures provided in company annual reports, balance sheets, and profit and loss statements. The desire to make companies comparable, not only within the same period, but also in a dynamic sense was one of the major reasons for developing business ratios.[19] In addition to those ratios already suggested in previous studies, we will test the validity of some others to get a more objective picture. In chapter 5 the data collected will be presented in graphic form.

4.2.1 Ratios to Measure Company Performance

The ratio "(annual company profit + interest payments) / total capital" generally known as the return on investment (ROI), is one of the measures that indicate a company's profitability. It must be stated, however, that profit as published in the annual report is usually subject to accounting measures. By analyzing the balance sheets carefully, some of these influences can be corrected. Nevertheless, these drawbacks should be taken into consideration.

The same comments are basically valid for the ratio return on equity (ROE). "Net profit (after deduction of interest payments)/shareholders' equity" can be regarded as the interest provided to the shareholders by the capital they have invested in the company.

Another ratio which we regard as relevant for this study is profit on sales. This ratio is not only a measure of company performance, but also an indicator of market strategy. During a growth phase, companies usually produce relatively small scales of products, selling them with a high profit share per unit. The maturity phase is often characterized by companies' trying to increase their sales substantially in order to cope with decreasing profit rates per unit.

The fourth performance indicator is annual change in employment rate. For several reasons, companies are very careful about increasing or decreasing their work force. Nevertheless, these movements are also considered to reflect company performance in the long run.

Changes in steel production relative to the previous year also indicate wether a company currently acts in a prosperous or in a declining market.

---

[18] Conrad/Plotkin, 1968; Cootner/Holland, 1970; Bowman, 1980, 1982, and 1984; Perlitz/Löbler, 1985.

[19] Seicht, 1983; Spurga, 1986.

The five ratios mentioned are expected to show a negative development over the period 1950-1985. Nevertheless, not all of them will reflect economic changes in the same way. Work force fluctuations especially are expected to show a certain time lag.

4.2.2. Ratios to Measure Managerial Risk Attitude

Quantitative measures for qualitative issues must always be regarded as approximations. This is also true for measuring managerial risk attitude. Variance of ROI and ROE have been used as measurements of risk attitude in several studies mentioned, since high profit fluctuations within short time periods are regarded as indications that the company is in a risky situation (see the definition of risk in chapter 2).

The ratio long-term liabilities / equity measures the readiness of a company to accept long-term commitments with external investors (banks) and also possibly to accept an increased external influence. Obviously, this ratio can indicate a readiness to take risks.

Productivity, measured by "company crude steel production / total work force", might also serve as a proxy for managerial risk attitude, although some drawbacks have to be mentioned. First, the total work force of a steel company is not usually involved in steel production. However, a high share of the work force not involved with steel production can indicate that the company is active in other strategic business units as well. Both diversification and increased productivity through technological innovation can be regarded as risky activities. This justifies, in our opinion, the inclusion of this indicator in our study.

Diversification activities generally are regarded to be more risky than business-as-usual.[20] As the fifth risk indicator, therefore, we have chosen the diversification activities that is, the annual change in the level of diversification mentioned by the company in its annual reports. The level of diversification is estimated by grouping all products produced by the company according to the 4-digit levels of the International Standard Industrial Classification of All Economic Activities (ISIC codification developed by the United Nations in 1968).

---

[20] Meffert, 1980, p. 37.

5. EMPIRICAL FINDINGS

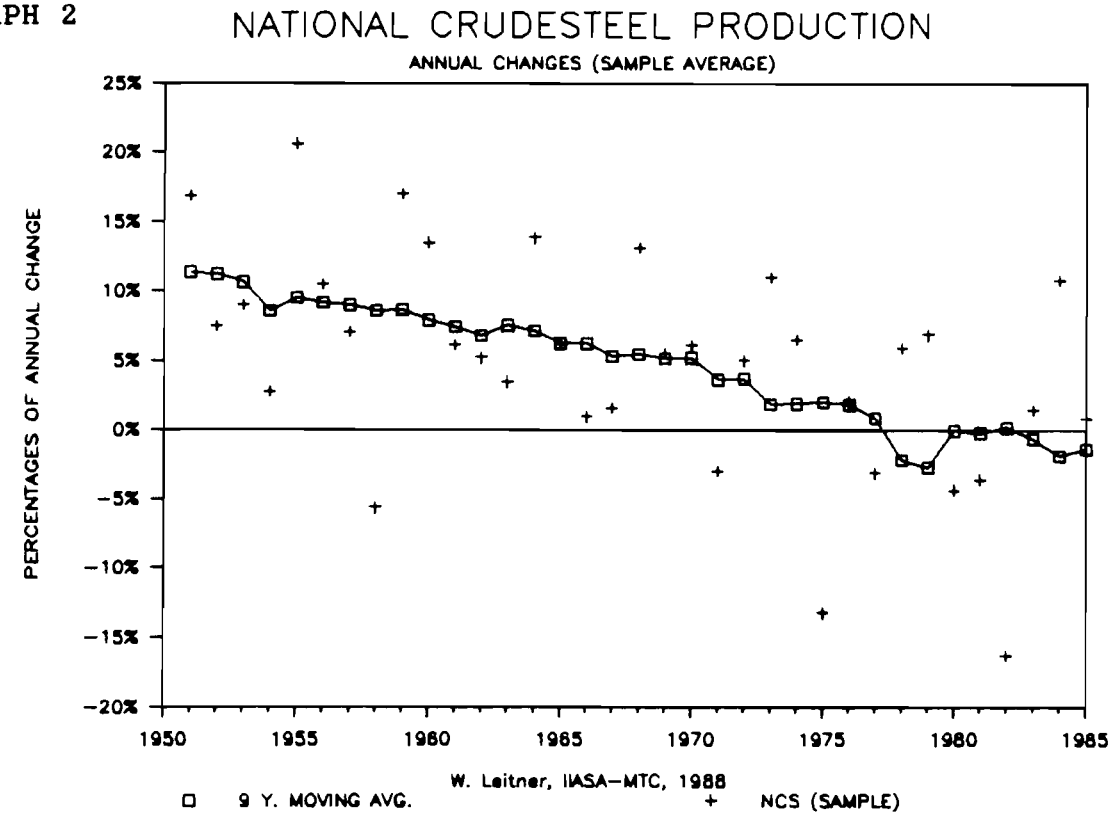
Each of the two hypotheses formulated in chapter 2 will be analyzed separately by application of different tools. The appendix contains all abbreviations used.

5.1 Empirical Findings on Hypothesis 1

The first hypothesis suggested can also be formulated in mathematical language: A negative correlation is expected to be found over time between risk ratios (ROI-variance, ROE-variance, LTL/EQ, Productivity, DIV) on the one hand and company performance (ROI, ROE, POS, LF, CCS) on the other. For regression analysis, time series of 5 risk ratios and 5 performance ratios are available, which were taken from 10 companies. Risk taking is expected to increase as a consequence of structural change indicated by deteriorating performance. Therefore the performance ratios are taken as independent variables x_1 ... x_5 to explain risk.

On a national level, the industry life-cycle can be characterized by annual output growth rates. In graph 2 the average figures are shown for the 8 countries related to our sample.

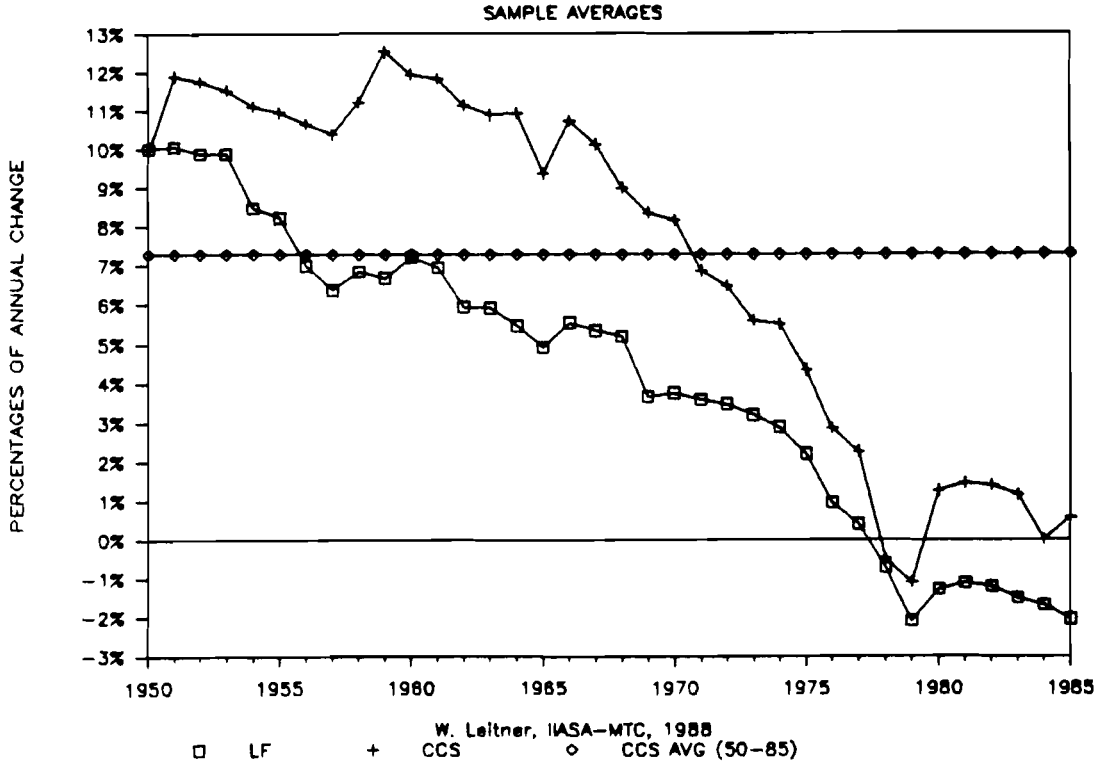
GRAPH 2



Source: Mitchel, 1980 and 1985; IISI.

A negative development similar to the trend shown in graph 1 is indicated over almost the entire period of observation. The transition of steel industry from growth to decline can be observed. How this trend is reflected by the performance of our sample?

GRAPH 3 PERFORMANCE INDICATOR TIME SERIES

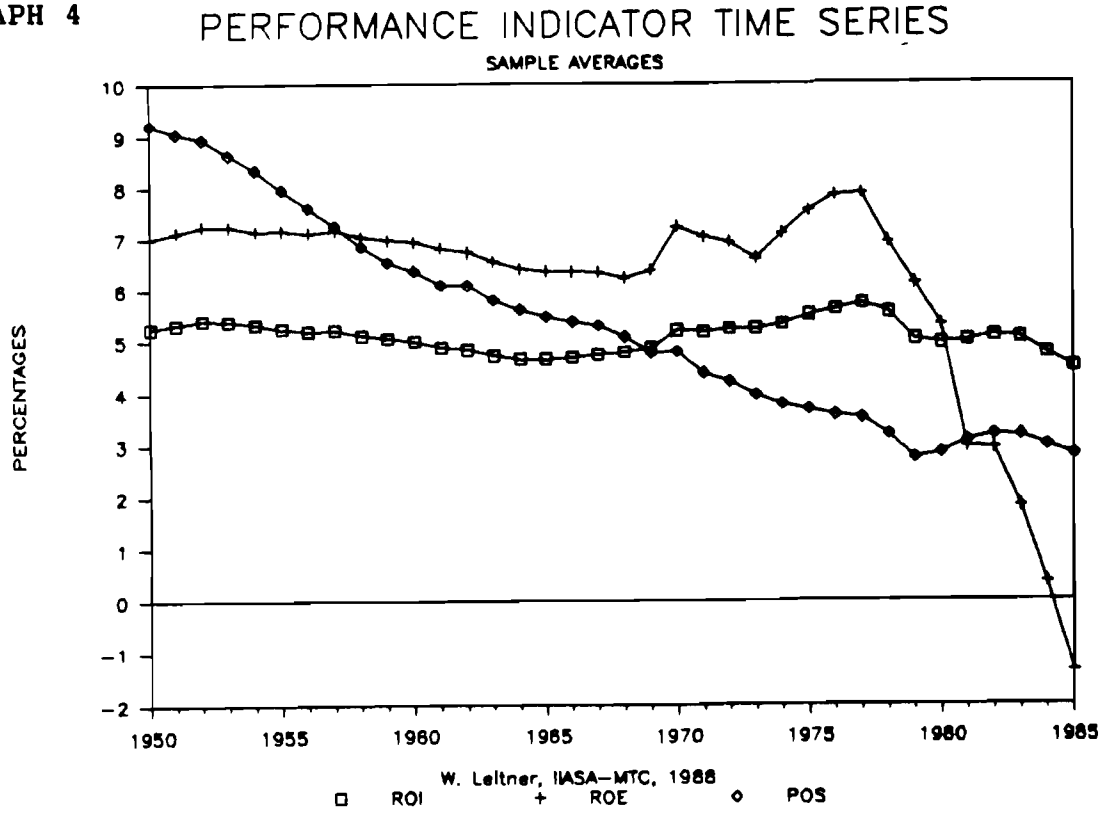


In graph 3 the development of two performance indicators is described. Regarding the average of firms, it turns out that steel production (CCS) and labour force (LF) developped roughly according to what was hypothesized. However, no time-lag can be observed with employment, but a rather constant decrease in growth rates is shown, finally even becoming negative.

Sample steel output grew more substantially than on national or world level. This is probably due to the fact that the companies investigated were more advanced from a technological point of view and therefore aimed at earning the benefit of their advantage by applying their technology more extensively.

On average the steel output growth rate was approximately 7% over the 35 years observed. After 1970 annual growth rates were below that average. This phenomenon is used in the next chapter to characterize the transition of steel industry from growth to maturity. Graph 4 refers to the other three indicators of company performance:

GRAPH 4



Again, this graph shows the development of annual averages calculated for the sample of companies investigated. Return on investment does not show the expected negative trend but remains rather stable at a 5% level. A reason for this phenomenon can be found in the fact that many steel companies had to raise loans in order to sustain profitability[21]. As a result, interest payments increased substantially, which obviously has an impact on ROI.

Return on equity is not influenced by these payments. Obviously companies were aiming at keeping this ratio stable as well. However, due to decreasing profitability they succeeeded in this goal only until 1977. On the other hand, profit on sales decreased rather constantly between 1950 and 1985.

Having shown some evidence for negative trends in business performance along the industrial life cycle, we are ready to test hypothesis 1 now. The dependence of each risk ratio (y) is tested separately by application of the following equation:

$$y = a + bx_1 + cx_2 + dx_3 + ex_4 + fx_5 .$$

---

[21] Stepan, A. et al., 1988.

According to what was mentioned above, a negative value of the coefficients b, c, d, e and f would support hypothesis 1. The five pictures below refer to the five risk ratios to be tested. Each of them contains two time-series, one (characterized by x-symbols) referring to the annual sample average of the ratio and the other showing the curve estimated by multiple regression.

GRAPH 5

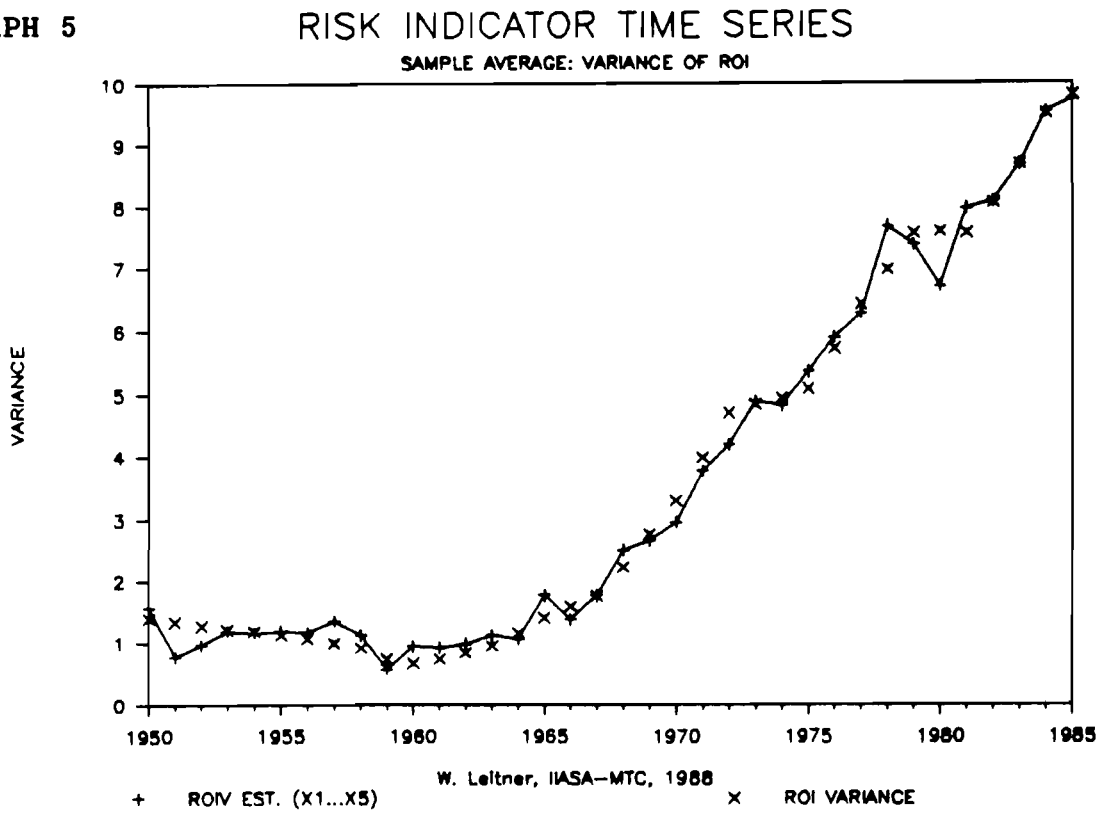


TABLE 1

Regression Output: Y = ROI VARIANCE

Constant		2.63			
Std Err of Y Est		0.324			
R Squared		0.990			
No. of Observations		36			
Degrees of Freedom		30			
	ROI	ROE	P.O.S.	LF	CCS
X Coefficient(s)	1.87	-0.56	-0.48	20.79	-47.00
Std Err of Coef.	0.35	0.05	0.13	11.08	6.00
t-TEST (H1: Coef. < 0):					
a=0.05; t= 1.697	H0	H1	H1	H0	H1
a=0.01; t= 2.457	H0	H1	H1	H0	H1

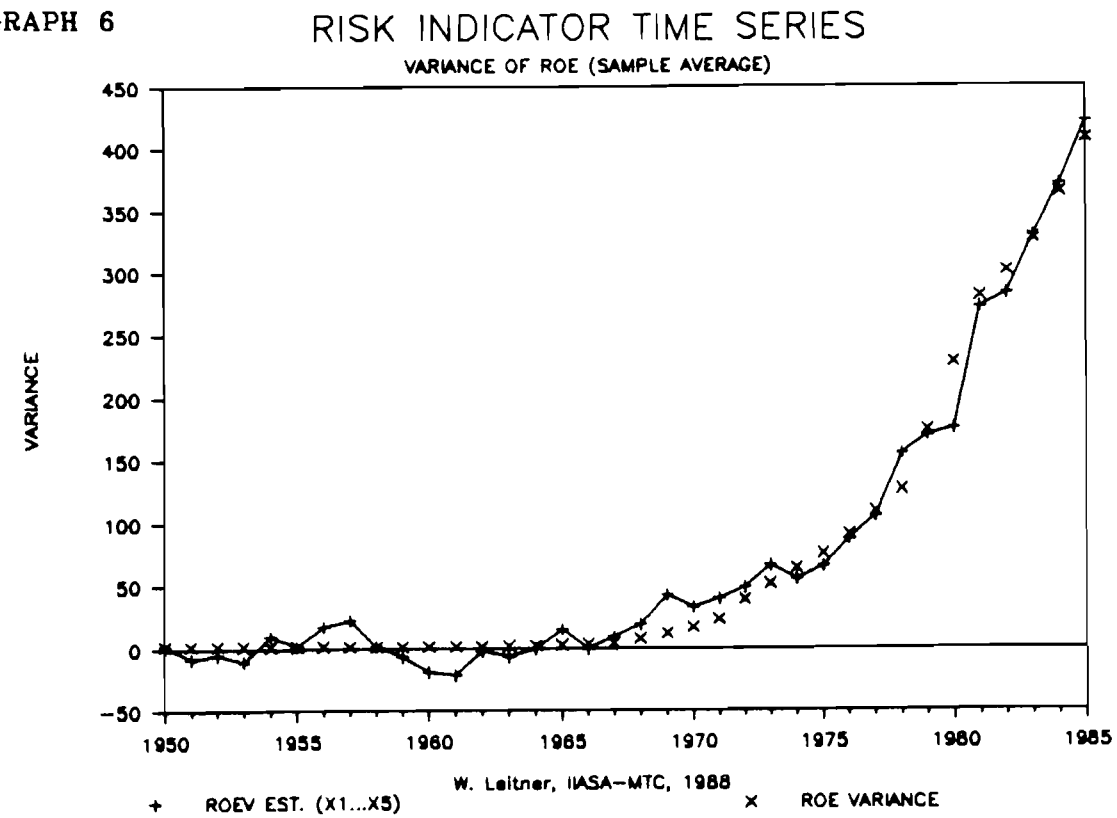
DURBIN - WATSON TEST: d = 2.09

Similarly to the method of moving averages, variances of ROI (and ROE as will be shown below) were calculated for consecutive periods of 5 years in order to monitor the dynamic changes of these indicators. Data indicate a significant increase in entrepreneurial risk taking starting in the 1960's. This observation supports the hypothesis that risk attitude changed as a consequence of structural change only.

Table 1 provides the results of regression analysis for y = ROI variance. A regression coefficient of 0.99 indicates basically that y can be explained very well by the independent variables we selected. In fact, graph 5 shows that the estimated curve fits the data quite accurately. However, only the coefficients for ROE, POS and CCS are negative. According to t-Statistics, hypothesis 1 has to be rejected for ROI and LF.

In order to check wether the estimation was influenced by autocorrelation, Durbin Watson Test was applied. A d-factor of 2.09 indicates that there is no autocorrelation regarding this risk indicator. All in all, the analysis on ROI variance seems to support hypothesis 1. Graph 6 and table 2 contain similar results on ROE variance:

GRAPH 6



ROE variance, too, increases along the period investigated. A R^2 of 0.98 indicates again that the estimated curve fits the data quite well (see table 2).

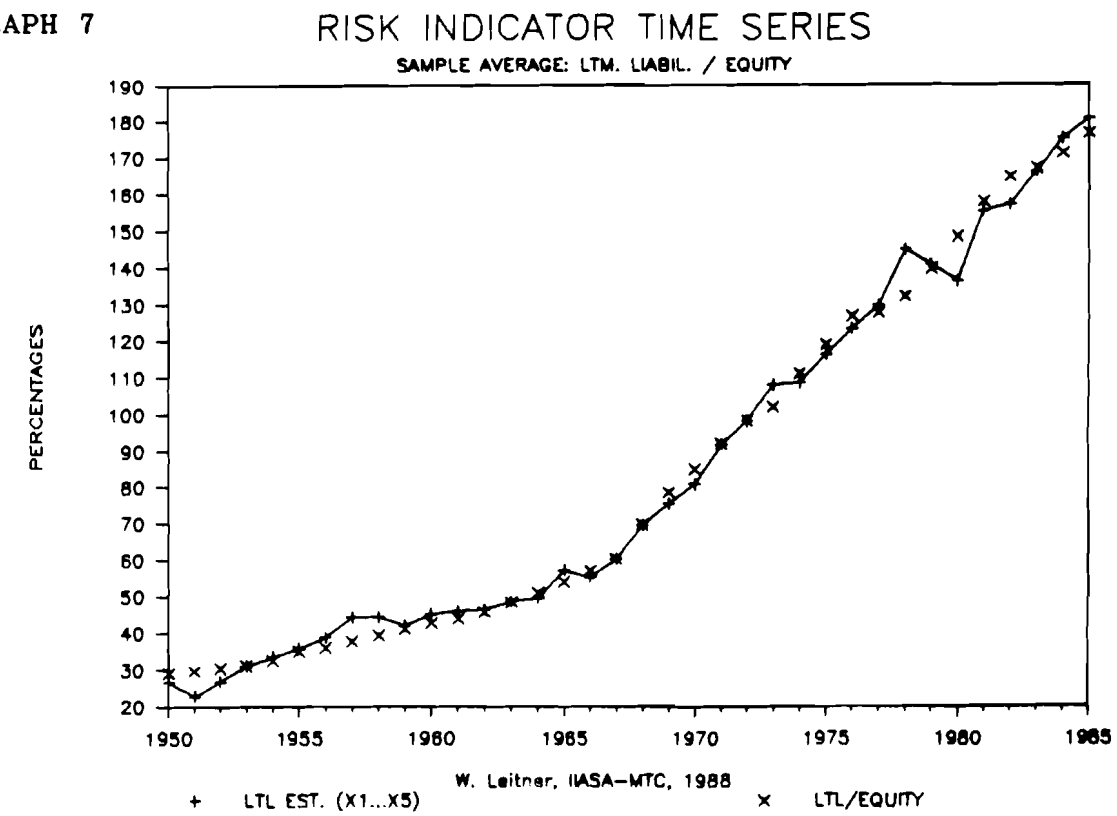
TABLE 2 Regression Output: Y = ROE VARIANCE

Constant		-28.18			
Std Err of Y Est		16.987			
R Squared		0.983			
No. of Observations		36			
Degrees of Freedom		30			
	ROI	ROE	P.O.S.	LF	CCS
X Coefficient(s)	70.37	-39.71	16.75	-1769.89	-385.47
Std Err of Coef.	18.35	2.86	6.67	581.23	314.85
t-TEST (H1: Coef. < 0):					
a=0.05; t= 1.697	HO	H1	HO	H1	HO
a=0.01; t= 2.457	HO	H1	HO	H1	HO

DURBIN - WATSON TEST: d = 1.25

Nevertheless, only ROE and LF coefficients significantly explain this risk ratio according to t-statistics. A separate analysis for POS, however, indicated a negative relationship in this case, too. According to Durbin Watson test, autocorrelation seems to be low. Consequently there is no evidence that hypothesis 1 should be rejected.

GRAPH 7



Long-term liabilities on equity increased slightly during the 1950's and 1960's (graph 7). After 1970, the companies extended long-term debts quite substantially. According to regression analysis, performance indicators again explain the dynamics of this risk ratio quite well. Significant negative coefficients were obtained on ROE, POS and CCS. Durbin Watson test does not indicate dangerous autocorrelation. To put it briefly, hypothesis 1 seems to be supported again.

TABLE 3 Regression Output: Y = LONGTERM LIABILITIES / EQUITY

Constant		51.30			
Std Err of Y Est		4.732			
R Squared		0.992			
No. of Observations		36			
Degrees of Freedom		30			
	ROI	ROE	P.O.S.	LF	CCS
X Coefficient(s)	35.19	-8.83	-12.99	86.98	-371.88
Std Err of Coef.	5.11	0.80	1.86	161.93	87.71
t-TEST (H1: Coef. < 0):					
a=0.05; t= 1.697	H0	H1	H1	H0	H1
a=0.01; t= 2.457	H0	H1	H1	H0	H1

DURBIN - WATSON TEST: d = 1.36

From graph 8 it can be concluded that productivity measured by steel output per emloyee increased steadily over the entire period observed. Companies invested continuously in the improvement of their technologies in order to save labour costs. Those investments, however, indicate that companies were ready to take the risk of technological change only when market forces induced them to do so.

Table 4 contains the testing results on productivity. As R^2 is rather high again, the estimated curve seems to explain data sufficiently. Nevertheless Durbin Watson test indicates a substantial influence of autocorrelation. Productivity therefore cannot be regarded as a useful indicator for entrepreneurial risk.

GRAPH 8

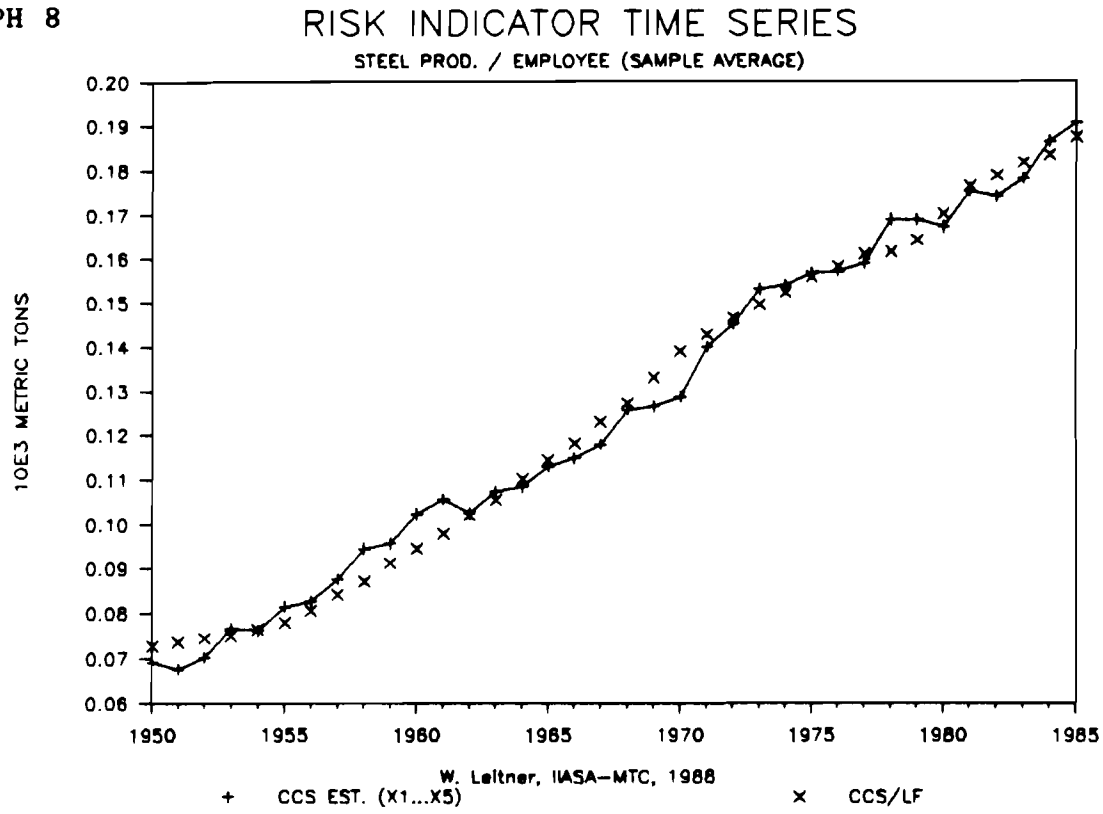


TABLE 4

Regression Output:	Y = STEEL OUTPUT / EMPLOYEE				
Constant	0.18				
Std Err of Y Est	0.005				
R Squared	0.987				
No. of Observations	36				
Degrees of Freedom	30				
	ROI	ROE	P.O.S.	LF	CCS
X Coefficient(s)	0.016	-0.005	-0.019	0.468	-0.269
Std Err of Coef.	0.005	0.001	0.002	0.162	0.088
t-TEST (H1: Coef. < 0):					
a=0.05; t= 1.697	H0	H1	H1	H0	H1
a=0.01; t= 2.457	H0	H1	H1	H0	H1

DURBIN - WATSON TEST: d = 0.81

Diversification activities were suggested as the fifth indicator to describe dynamics of managerial risk attitude. However, graph 9 surprisingly indicates a decrease in diversification activities over time. Thus it turns out that companies extended their range of products more intensively before 1970 than afterwards. According to table 5 all performance indicators are positvely related to DIV except LF. As Durbin Watson test indicates a lot of auto-

correlation, this ratio must be excluded from our group of indicators.

GRAPH 9

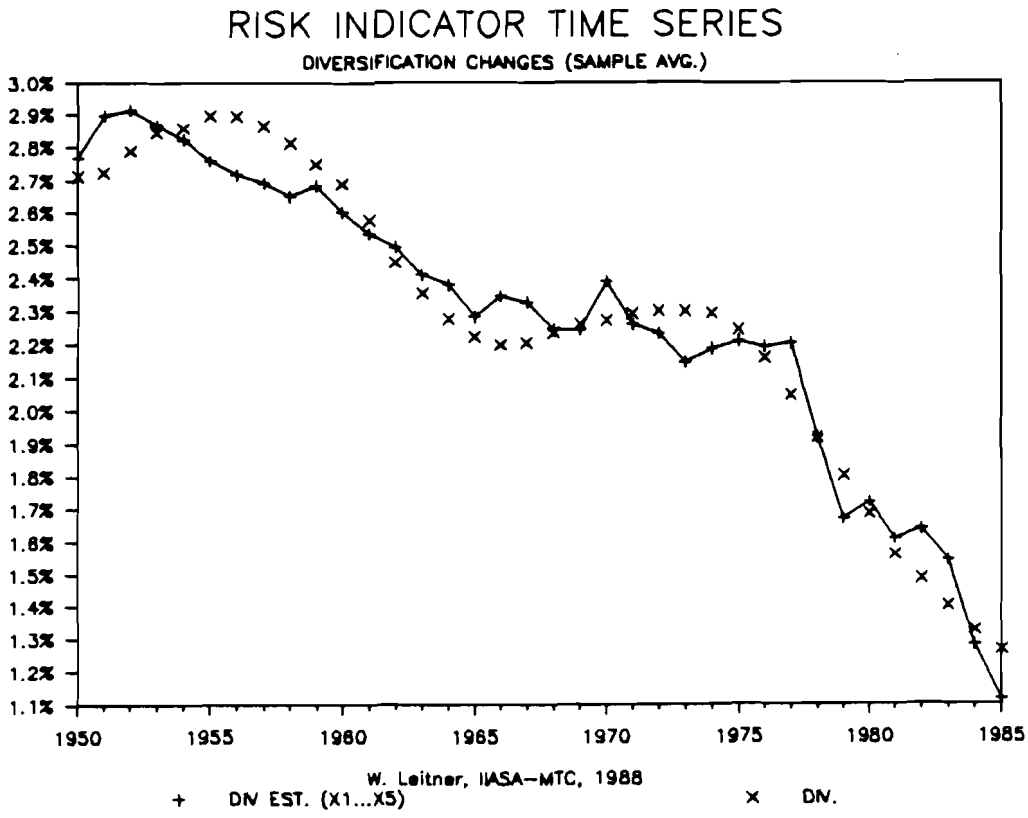


TABLE 5

Regression Output:	Y = ANNUAL CHANGE IN DIVERSIFICATION				
Constant	-0.004				
Std Err of Y Est	0.001				
R Squared	0.949				
No. of Observations	36				
Degrees of Freedom	30				
	ROI	ROE	P.O.S.	LF	CCS
X Coefficient(s)	0.0029	0.0007	0.0009	-0.0208	0.0573
Std Err of Coef.	0.0013	0.0002	0.0005	0.0396	0.0215
t-TEST (H1: Coef. > 0):					
a=0.05; t= 1.697	H1	H1	H1	H0	H1
a=0.01; t= 2.457	H0	H1	H0	H0	H1
DURBIN - WATSON TEST: d =	0.73				

Generally, hypothesis 1 seems to be supported by the data shown above. Ratios on the average performance of our sample declined while risk ratios grew simultaneously. Some significance for the interrelation of both groups of variables was found. For various reasons mentioned, ROI as well as productivity and diversification activities cannot be used to support hypothesis 1 as indicators.

5.2 Empirical Findings on Hypothesis 2

Hypothesis 2 formulated in chapter 2 implicitly says that characteristic deviations from the general trend suggested by hypothesis 1 will be observed. Therefore data have to be disaggregated in two directions in order to test hypothesis 2.

First, companies have to be analyzed separately by comparing their individual ratio values with the sample averages. Thus, deviations can be revealed easily. Second, we have to distinguish between growth and maturity phase of economic development. In chapter 5.1 we found evidence for the assumption that the period of 1950 - 1985 coincides approximately with these phases. Referring to page 10 of this paper we define as growth phase the period lasting from 1950 to 1970. 1971 to 1985 is related to the maturity of the current steel industry cycle.

By calculating averages (AVG_{ijp}) for each phase p (p = 1,2), characterizing the behavior of companies j (j = 1,...,10) according to indicators i (i = 1,...,10) and subsequently aggregating these AVG_{ijp}, we obtained for each company j and each phase p one value R characterizing risk taking behavior and one value P characterizing performance. Those 40 values represent the input for testing hypothesis 2 :

TABLE 6

	R1			P1	
E02	61.26%	HIGH	E02	53.86%	HIGH
E01	52.09%	HIGH	E01	42.88%	HIGH
I04	46.43%	HIGH	A01	25.12%	HIGH
C01	6.25%	HIGH	K02	15.64%	HIGH
S04	4.75%	HIGH	C01	13.67%	HIGH
			I04	8.19%	HIGH
I03	1.24%	LOW			
K02	-27.06%	LOW	S04	-33.32%	LOW
B01	-35.14%	LOW	B01	-41.99%	LOW
A01	-37.93%	LOW	I03	-46.16%	LOW
L01	-48.53%	LOW	L01	-76.95%	LOW
AVG :	2.34%		AVG :	-3.91%	

TABLE 6 (cont.)

	R2			P2	
S04	99.10%	HIGH	E02	175.75%	HIGH
I03	39.16%	HIGH	C01	106.93%	HIGH
B01	4.70%	HIGH	B01	68.44%	HIGH
			S04	67.71%	HIGH
E02	-10.71%	LOW	I04	54.23%	HIGH
K02	-17.66%	LOW	E01	17.47%	HIGH
I04	-17.94%	LOW	A01	6.45%	HIGH
C01	-23.40%	LOW			
E01	-26.79%	LOW	K02	-30.72%	LOW
L01	-26.94%	LOW	I03	-123.90%	LOW
A01	-46.15%	LOW	L01	-330.73%	LOW
AVG :	-2.66%		AVG :	1.16%	

Each value in table 6 is characterized by the code of the company it refers to. By comparing the values of each group with the group average it is possible to characterize each value as 'high' or 'low', relative to the sample of firms. It has to be stressed that these classifications are related to the phase and not to the entire period of observation. According to previous studies, data structured like those in table 6 can be analyzed most easily by application of contingency tables .

In order to test hypothesis 2 risk taking behavior in phase 1 (R1) has to be related to company performance in phase 2 (P2) :

TABLE 7

		P2	
		high	low
R1	high	C01, E01, E02, I04, S04.	-
	low	B01, A01.	I03, K02, L01

According to table 7, 8 of 10 companies seem to support our hypothesis 2. Moreover, X^2-test indicates 85 % probability for the existence of a significant relationship between the two dimensions.

Table 8 provides some more figures derived from our database. The entries characterize the amount of indicator fluctuation between the two phases analyzed. Of course stability of performance is an important goal of strategic management. A high fluctuation, therefore, can be regarded as a result of low resistence against

crisis. PF1 refers to fluctuation of performance indicators, whereas RF1 refers to dynamics of risk ratios.

TABLE 8

	PF1			RF1	
S04	-7.61%	LOW	I04	33.59%	LOW
E02	-29.12%	LOW	E02	48.69%	LOW
K02	-46.20%	LOW	K02	66.99%	LOW
I04	-49.45%	LOW	A01	92.42%	LOW
E01	-49.80%	LOW	E01	417.36%	LOW
C01	-51.54%	LOW	L01	1191.86%	LOW
A01	-58.38%	LOW	C01	1966.71%	LOW
B01	-94.96%	HIGH	S04	4947.71%	HIGH
I03	-100.40%	HIGH	I03	5179.19%	HIGH
L01	-166.21%	HIGH	B01	10027.07%	HIGH
AVG :	-59.43%		AVG :	5011.74%	

TABLE 9

R1 \ PF1	high	low
high	-	C01, E01, E02, I04, S04.
low	B01, I03, L01.	A01, K02.

X^2 again indicates that a relationship exists with 85 % probability. According to table 9, companies that incurred more risk during industrial growth were able to keep their performance more stable later on than companies that were more hesitant during growth. Table 8 shows that all firms suffered more or less from deteriorating performance. The consequences, however, were more severe for those companies that showed a below-average risk-taking attitude in phase 1. Table 10 contains fluctuation values referring to risk ratios (RF1).

TABLE 10

R1 \ RF1	high	low
high	S04	C01, E01, E02, I04.
low	B01, I03, L01.	A01, K02.

7 of 10 companies support the hypothesis saying that relatively high risk taking during phase 1 will result in greater stability under crisis conditions. Nevertheless due to the small sample, significance is only 45 % in this case.

Finally, two contingency tables are presented to test Bowman's Risk-Return Paradox in the traditional sense, under static conditions. Each table refers to one phase only. As above, "high" and "low" are relative judgements, characterizing company deviation from sample phase averages.

TABLE 11

		P1 high	P1 low
R1	high	C01, E01, E02, I04.	S04
	low	A01, K02.	B01, I03, L01.

Regarding the growth phase, no evidence can be found for the Risk-Return Paradox. On the contrary, the idea seems to be supported by 7 companies that high risk is connected with high return in this phase and low risk to low return. Table 12, referring to period 2, shows a different picture.

TABLE 12

		P2 high	P2 low
R2	high	B01, S04.	I03.
	low	A01, C01, E01, E02, I04.	K02, L01.

Here, the Risk-Return Paradox in the static (one period) sense is supported by 6 companies. X^2 - test indicates a rather weak probability of 35 % only. It turns out that consistent statements regarding the relationship between risk attitude and performance cannot be achieved by the static approach. The life cycle has to be regarded as an "intervening variable," influencing significantly the risk measures which have been investigated in this paper.

6. CONCLUSIONS

The results provided in this paper support the idea that the industrial life cycle can serve as a model explaining the Risk Return Paradox. From a methodological point of view, it can be stated that rather consistent results were achieved with the chosen indicators. The main purpose of this paper, that is to develop a methodology for investigating long range dynamics relevant for strategic management, is regaded to be fulfilled.

By means of a longitudinal study covering a major part of the last steel industry cycle, it has been showed that measures for entrepreneurial risk seem to be negatively related to the development of company performance ratios. Particularly, the growth phase of steel industry cycle was characterized by return values higher than the average ratios calculated for the whole period of observation, whereas risk measures were low. On the other hand, performance was low in the maturity phase, whereas risk ratios were higher than the overall average.

The results on hypothesis 2 seem to indicate that a certain linkage between risk attitude and performance exists: companies that were more risk-taking than the average during the growth phase, obtained more favorable results in the phase of maturity. Similarly, companies that took less risk than the average during phase 1 were affected more severely from crisis than the others. We also discovered that a high level of risk attraction during growth was connected with a more stable development of all indicators investigated. Substantial fluctuations, however, could be observed with those enterprises who were relatively risk-averse during growth.

The question has been raised what kind of "intervening variable" creates the fluctuations of entrepreneurial risk attitude along the life cycle. Our empirical findings seem to support the hypothesis that managers usually, and especially under growth conditions, tend to make their decisions on the assumption that this favorable situation will persist. In other words, the economic, social and technological environment of the company is regarded as stable and long-term changes are neglected. By this strategy, the process of decision-making is facilitated (risk is reduced at first glance). The <u>risk of environmental change</u>, however, is taken and must not be neglected.

Our findings on hypothesis 2 indicate that structural change causes more difficulties to the company the longer it is postponed. In order to offset crisis in advance, it seems to be very appropriate to take measures already during the growth phase (technology push strategy). As was mentioned above, such measures can only be justified if the existence of (persistent) environmental change is taken into consideration.

Thus, the following conclusions can be derived, which should be confirmed by further testing of the hypotheses.

* It seems to be reasonable that entrepreneurial risk, measured in the traditional sense, should not only be distributed among several business activities (i.e., diversification), but also especially among time periods referring to different phases of the industrial life cycle.

* Decision-makers should regard the company as an open system which is linked closely with a constantly changing environment.

* In order to smooth the process of structural change, it seems to be necessary to develop promising options for the future as long as resources are easily available for that purpose (i.e., during the growth phase).

* More attention has to be devoted to the strategic part of the planning process, especially under growth conditions. In this respect, the priority of the operative goal of maximizing annual profit has to be challenged.

* Weak signals, documented by a well equipped department for information management, can serve as a guideline for making future decisions under conditions of uncertainty.

* In order to classify the company's strategic position, it is recommendable to analyze its relative risk attitude by comparing it with the respective ratio values of competitors. Thus, the entrepreneurial risk attitude can be used as a variable to control the company's development.

APPENDIX

For the presentation of the results, we use the following abbreviations:

WCS = Percentage of annual world crude steel production change

NCS = Percentage of annual national crude steel production change

ROI = Return on investment

ROE = Return on equity

POS = Profit on sales

LF = Percentage of annual change in number of employees

CCS = Percentage of annual company crude steel production change

LTL = Ltm. liabil. / equity = Ratio of longterm liabilities divided by equity.

DIV = Percentage of annual change in diversification

AVG = Arithmetic mean

EST = data estimated by multiple regression

R = Regression coefficient

H0 = Null hypothesis is accepted

H1 = Null hypothesis is rejected

$x, x_1, \ldots, x_5$ = Independent variables

y = Dependent variable

REFERENCES

Allais, Maurice (1983) Foundations of Utility and Risk Theory with Applications, Dordrecht: D. Reidel Publishing Co.

Ayres, R. U. and Mori, S. (1987) "Time Preference and the Life Cycle: The Logic of Long-term High risk vs. Short-term Low Risk Investment," Laxenburg: IIASA, WP-87-33.

Bowman, E. H. (1980) "A Risk/Return Paradox for Strategic Management," Sloan Management Review, Spring, pp. 17-31.

Bowman, E. H. (1982) "Risk Seeking by Troubled Firms," Sloan Management Review, Summer, pp. 33-42.

Bowman, E. H. (1984) "Content Analysis of Annual Reports for Corporate Strategy and Risk," Interfaces, Vol. 14, No. 1, January-February, pp. 61-71.

Conrad, G. R. and Plotkin, I. H. (1968) "Risk/Return: U.S. Industry Pattern," Harvard Business Review, March-April, p. 90.

Cootner, P. H. and Holland, D. M. (1970) "Rate of Return and Business Risk," The Bell Journal of Economics and Management Science, Autumn, pp. 211-226.

DeBresson, Chris and Lampel, Joseph (1985) "Beyond the Life Cycle: Organizational and Technological Design," Journal of Production, Innovation, Management, No. 3, pp. 170-187.

Gravelle, H. and Rees, R. (1981) Microeconomics, London: Longman.

Hayek, F. A. v. (1968) "Der Wettbewerb als Entdeckungsverfahren," Kieler Vorträge, N.F., No. 56.

IISI. (1972) Projection 1985, Brussels: International Iron and Steel Institute.

Kleinknecht, Alfred. (1987) "Are There Schumpeterian Waves of Innovation?," Laxenburg: IIASA, WP 87-76.

Kondratieff, Nikolai (1926) "Die langen Wellen der Konjunktur," Archiv für Sozialwissenschaft und Sozialpolitik, Tübingen, Vol. 56.

Marchetti, C. and Nakicenovic, N. (1979) "The Dynamics of Energy Systems and the Logistic Substitution Model," Laxenburg: IIASA, RR-79-13.

Marchetti, Cesare (1981) "Society as a Learning System: Discovery, Invention, and Innovation Cycles Revisited," Laxenburg: IIASA, RR-81-29.

Meffert, Heribert (1980) Marketing, Wiesbaden: Gabler.

Mensch, Gerhard O. (1979) Stalemate in Technology: Innovations Overcome the Depression, Cambridge, Mass: Ballinger Publishing Company.

Miller, Danny and Friesen, Peter (1984) "A Longitudinal Study of the Corporate Life Cycle," Management Science, No. 10, pp. 1161-1183.

Mitchel, B. R. (1980) European Historical Statistics 1750 - 1975, London, Macmillan.

Mitchel, B. R. (1983) International Historical Statistics, The Americas and Australasia, London, Macmillan.

Perlitz, M. and Löbler, H. (1985) "Brauchen Unternehmen zum Innovieren Krisen?," Zeitschrift für Betriebswirtschaft, Vol. 55, No. 5, pp. 424-450.

Raiffa, Howard (1968) Decision Analysis, Addison-Wesley.

Ray, George F. (1984) The Diffusion of Mature Technologies, National Institute of Economic and Social Research.

Schumpeter, Joseph A. (1950) Kapitalismus, Sozialismus und Demokratie, Bern, 1st expanded edition.

Schumpeter, Joseph A. (1961) Konjunkturzyklen, Göttingen, Vol. 1.

Seicht, Gerhard (1983) Grundlagen moderner Unternehmungsführung, 5th edition, Vienna: Linde Verlag.

Simon, H. A. (1979) "Rational Decision-Making in Business Organizations," The American Economic Review, Vol. 69, No. 4.

Spurga, Ronald C. (1986) Balance Sheet Basics, New York: New American Library.

Stepan, A. et al. (1988) Entwicklungstendenzen in der Stahlindustrie, study done at the Technical University, Vienna for OPK, Budapest.

Stone, J. K. (1966) "Worldwide Distribution of Oxygen Steelmaking Plants," Iron and Steel Engineer, Nov. 1966, pp 93 - 97.

UNIDO (1976) Draft World-Wide Study of the Iron and Steel Industry: 1975-2000, Vienna: United Nations Industrial Development Organization.