

Empirical Study on the Effect of Flexibility on Machinery Manufacturing

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Abstract. This article select 30 listed companies in machine,equipment and instrument manufacturing as study object.AHP is used to created a hierarchical network model about company flexible, Catastrophe progression method and regression analysis prediction method is uesed to analysis the degree that how flexibility infuence business performance.The conclusion of this article tell us that: The ordering of flexibility is research and development flexiblity,marketing flexibility,resource flexibility,operations flexibility and capital flexibility.

Introduction

Flexibility is the ability to response effectively (Mandelbaum,1978) .Flexibility decision has a positive effect on business performance. However, the kind of literature with empirical analysis is not very common to be observed, which focuses on the flexibility factors and the impacts of flexibility decision.

The establishment and basic assumptions of enterprises' flexibility strategy

Based on previous researchachievement and current situations of Chinese manufacturing industry, 5 main flexibilities are used to build an enterprise's flexibility system. And the 5 flexibilities are resources flexibility, operation flexibility,, R&D flexibility and market flexibility.

1. Basic assumption

H0: Flexibilities of enterprises' resources, operation, capital structure, R&D and market have remarkable effect on business performance.

H1:Flexibilities of enterprises' resources, operation, capital structure, R&D and market do not have remarkable effect on business performance.

Empirical study

Model Specification

These factors above are used to construct a regression equation, and the business performance is regarded as the explained variable while the enterprise flexibility as the explaining variable. The details is shown in Table 1.

Table 1 Variable Definition

Property	Name	Symbol	Description
Explained variable	Business performance	NPG	Net profit growth rate
Explaining variable	Resources flexibility	RF	Resources occupancy & operation capability
	Operation flexibility	OF	Capital operation ability
	Capital structure flexibility	CSF	The ability of capital structure adjustment
	R&D flexibility	RDF	R&D investment
	Market flexibility	MF	Market adjusted ability

Derived from hypothesis H0, the regression equation is obtained below.

$$NPG = aRF + bOF + cCSF + dRDF + eMF + f$$

The definitions of *NPG*, *RF*, *CSF*, *RDF* and *MF* are listed in the table above, and *f* is a constant term.

Indicator selection and Date processing

The net profit growth rate is used as an indicator to reflect business performance, and a three-hierarchical network model about flexible decision-making is shown in Fig 1.

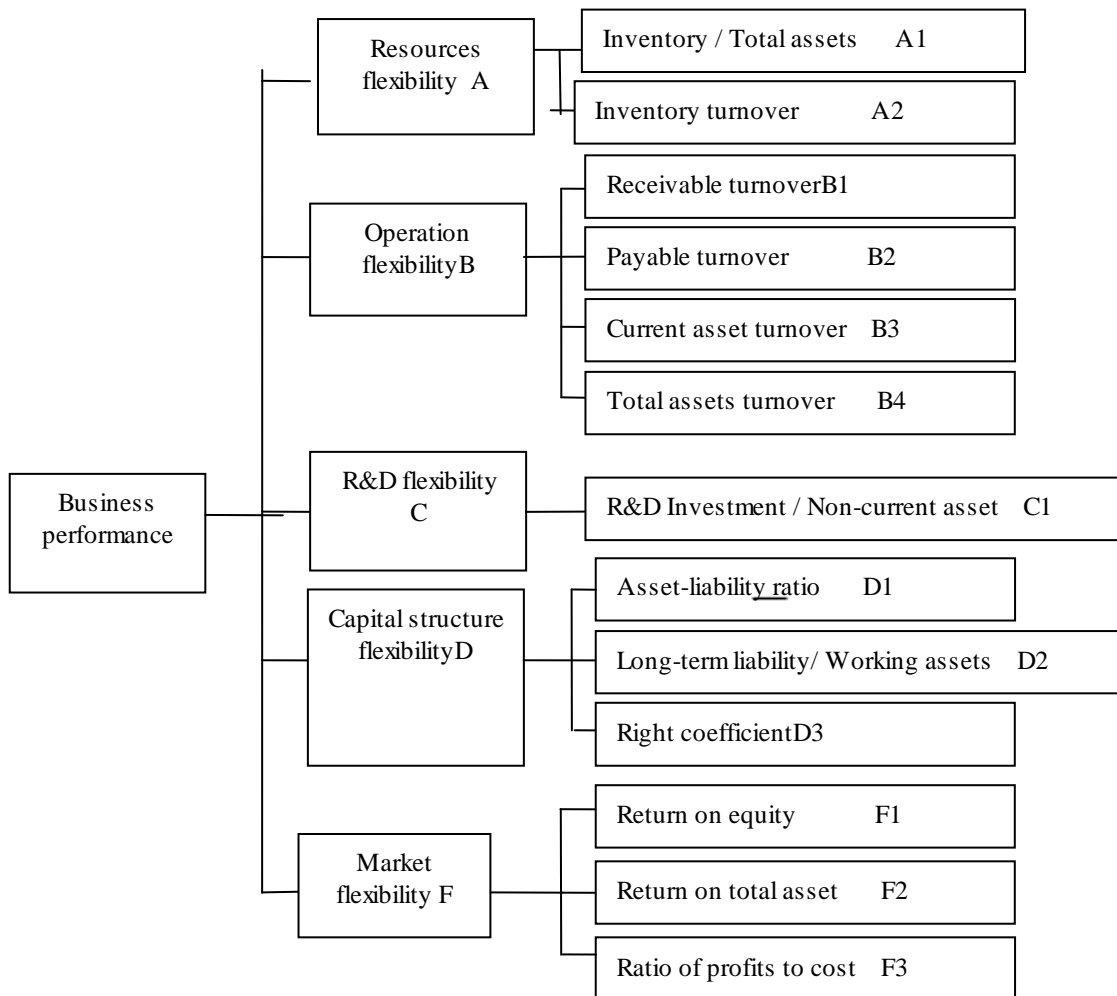


Fig 1 Flexible factor system diagram

There are 3 common mutation coefficient models: (1)The cusp mutation system, which contains 2 sub-indexes.

The model form is $f(x) = x^4 + ax^2 + bx$ and the formula is $xa = a^{(1/2)}$, $xb = b^{(1/3)}$.

(2) The coattail catastrophe model, containing 3 sub-indexes. The model form is

$$f(x) = 1/5x^5 + 1/3ax^3 + 1/2bx^2 + cx$$

and the formula is $xa = a^{(1/2)}$, $xb = b^{(1/3)}$, $xc = c^{(1/4)}$.

(3) The butterfly catastrophe mode, containing 4 sub-indexes. The model form is

$$f(x) = 1/6x^6 + 1/4ax^4 + 1/3bx^3 + 1/2cxc + dx$$

and the formula is $xa = a^{(1/2)}$, $xb = b^{(1/3)}$,

$$xc = c^{(1/4)}, \quad xd = d^{(1/5)}.$$

Take the Shenyang Machine Tool (SMTCL) as an example here, and all data is shown in Table 2.

Table 2 Flexibility factors of SMTCL in 2002

Company name	Shenyang Machine Tool
Deadline	2002
Long-term liability/ Working capital	-1.132556692
Inventory/Total assets	0.092757639
R&D investment/Fixed assets	0
Inventory turnover	1.7821
Asset-liability ratio	0.79307552
Equity multiplier	4.832681
Capital structure flexibility	0.443620376
Net profit growth rate (%)	97.9178
Accounts receivable turnover	2.4259
Payable turnover ratio	1.79
Current asset turnover	0.4962
Total assets turnover	0.2806
Return on equity	0.59
Return on assets	1.1573
Ratio of profits to cost	0.135874

For indicators A1 and A2, the equations are listed below:

$$XA1 = A1^{1/2} = (0.092757639)^{1/2} = 0.304561389, \quad XA2 = A2^{1/3} = (1.7821)^{1/3} = 1.212395,$$

And based on the complementary relationship between the 2 indicators, the average can be reached

$$A = (0.304561389 + 1.212395) / 2 = 0.758478$$

For indicators B1, B2, B3 and B4, the equations are listed below:

$$XB1 = B1^{1/2} = (2.4259)^{1/2} = 1.55753,$$

$$XB2 = B2^{1/3} = (1.79)^{1/3} = 1.214184, \quad XB3 = B3^{1/4} = (0.4962)^{1/4} = 0.839294,$$

$$XB4 = B4^{1/5} = (0.2806)^{1/5} = 0.775564$$

And based on the complementary relationship between the 2 indicators, the average can be reached

$$B = (1.55753 + 1.214184 + 0.839294 + 0.775564) / 4 = 1.096643$$

R&D flexibility $C = C1 = 0$

For D1, D2, and D3, the equations are listed below:

$$XD1 = D1^{1/2} = (0.79307552)^{1/2} = 0.890548$$

$$XD2 = D2^{1/3} = (-1.13255669)^{1/3} = -1.04236539$$

$$XD3 = D3^{1/4} = (4.832681)^{1/4} = 1.482679$$

For indicators F1, F2 and F3, the equations are listed below:

$$XF1 = F1^{1/2} = (0.0059)^{1/2} = 0.076811$$

$$XF2 = F2^{1/3} = (0.011573)^{1/3} = 0.226194$$

$$XF3 = F3^{1/4} = (0.001359)^{1/4} = 0.191992$$

The average F can be reached, $F = (0.076811 + 0.226194 + 0.226194) / 3 = 0.164999$

Based on the above, one can draw a conclusion that, in 2002, the resources flexibility is 0.758478, the operation flexibility is 1.096643, the capital structure flexibility is 1.482679 and the market flexibility is 0.191992. Part of the sample indexes is shown in Table 3.

Table 3 Part of the sample indexes

Company name	Year	RDF	RF	CSF	OF	MF	NPG
SMTCL	2002	0.0000	0.758478	0.443620376	1.096643	0.164999	0.979178
JND Engine	2002	0.0000	0.808475	0.711189258	1.249054	0.497609	1.023254
CQCA Auto	2002	0.0000	1.051438	0.841825114	1.903565	0.541978	2.777757
FC Co.	2002	0.0000	0.90116	0.560619463	1.93064	0.372925	6.379875
Yinhe Co.	2002	0.0000	0.738368	0.946748986	1.263202	0.423483	-0.263399
JH Engine	2002	0.0000	1.009685	0.63902844	1.388828	-0.38086	-2.684566

Regression results analysis

The regression results and analysis. Using Eviews6.0 to estimate the variable parameter equation and part of the results is shown in Table 4:

Table 4 Part of the regression results

Variables	Coefficient	Error statistics	T-Statistic	P-Value
C	-7.936338	9.665277	-0.821119	0.4128
CQCA AutoRDF	1381.865	471.8971	2.928319	0.0039
CASC RDF	41.92755	109.9309	0.381399	0.7034
KMYNRDF	87.21979	104.0062	0.838602	0.4030
CQCA AutoRF	-33.15372	48.46590	-0.684063	0.4950
CASC RF	17.73258	33.91437	0.522863	0.6018
KMYNRF	239.6451	58.25184	4.113949	0.0001
CQCA AutoCSF	68.64005	7.904289	8.683899	0.0000
CASC CSF	-25.78008	78.17447	-0.329776	0.7420
KMYNCSF	0.428999	25.49208	0.016829	0.9866
CQCA AutoOF	3.299243	3.872609	0.851943	0.3956
CASC OF	-14.45928	38.65623	-0.374048	0.7089
KMYNOF	-78.67891	33.20964	-2.369159	0.0191
CQCA AutoMF	73.13290	33.77779	2.165118	0.0319
CASC MF	29.06673	10.95160	2.654108	0.0088
KMYN MF	-36.62990	20.82525	-1.758917	0.0806
CQCA AutoC	-59.02292			
CASCC	17.96708			
KMYN C	-67.85254			

The results of the regression estimation is shown in Table 5.

Table 5 Regression estimation results

Inspection	Observed value
R square	0.782190
Adjusted R square	0.520536
F-statistic	2.989400
P-value (F-statistic)	0.000000
Durbin-Watson statistic	3.010380

R square is 0.782190, which shows that the equations have a high credibility 78.22%; and the P-value 0.000 is below 0.05, so the null hypothesis is accepted at the 5% level. The Durbin-Watson statistic, D=3.01, is close to non-autocorrelation critical value, so the equations don't have heteroscedasticity. In conclusion, all the test values show that the equations have high credibility, without heteroscedasticity.

Conclusion

This article selects 31 companies in engineering and electronic manufacturing as study object and we can come to the conclusion that the business flexibility factors contribute to business performance, in all the factors, RDF and MF are the most two factors while CSF is the least one. The conclusion not only enriches the business performance and enterprise strategy theory but also supplies the empirical support for the

development of most manufacture enterprises of construction machinery, and has a great significance for the development of Chinese manufacturing industry.

It is a new attempt to quantify the flexibilities by catastrophe progression method, which is very important to the long-term development and strategy adjustment of enterprises. However, the credibility of the equation is not high enough, and whether there is a more complicated relationship between flexibilities and business performance and how should the enterprise adjust the strategy are remained to be solved.

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