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Ragnar Jonsson's paper is included in this version, but is missing from the paper copy.

The Japanese Pulp and Paper Industry An Analysis of Financial Performance 1991-2001

Lars Lönnstedt

Swedish University of Agricultural Sciences
Department of Forest Products and Markets
Sweden

Hans-Olof Nordvall

Swedish University of Agricultural Sciences
Department of Forest Products and Markets
Sweden

Abstract

The purpose is to find differences in return on capital for Japanese pulp and paper companies. The hypothesis is that return on capital can be explained by mill size, productivity, production line, financial data and use of wood resources. Return on capital is measured as income before tax related to stockholders' equity. This variable can be split into profit margin and asset utilization rate. The dataset from 1991-2001 consists of 13 larger Japanese pulp and paper companies. The best model fit is found when using asset utilization rate as dependent variable. Significant variables are asset utilization rate lagged one time period, labor productivity, capital productivity, paper production as a share of total paper and board production, total value of assets on the books and solidity. Among these variables, lagged dependent variable, capital productivity, and total value of assets on the books are negatively correlated with asset utilization rate; the others are positively correlated.

Keywords: return on capital, profit margin, asset utilization rate, vertical integration, timberland ownership

Introduction

In 1937 the Nobel Prize winner R.H. Coase published his famous article "The Nature of the Firm". Since then vertical integration has attracted the interest of many researchers. Some other renowned researchers are Williamson (1985) and Perry (1989). Against this background it is interesting to note the discussion about forestland ownership. It started during the 1990s, not the least by economic journalists that raised the question about forest based companies' rate of return, investments and financing. In the US some companies have soled or made other structural changes for the forestland. The same development has happened in the Nordic countries. Will this contribute to increased profitability for the companies? We are interested in this question. When Lars Lönnstedt was invited as guest professor to Kyoto University an opportunity to study Japanese forest companies arose. As these companies more or less operate without owning forestland our intention is to compare the financial performance of pulp and paper companies in Japan, the US and Sweden. However, this report deals only with

Japanese companies and the purpose is to give information in English about the companies and also try to find reasons for differences in return on capital. Of course, profitability for the forest-based companies depends on several factors; timberland ownership is only one factor and probably not the major explanation. The hypothesis is that return on capital can be explained by mill size, productivity, production line, financial data and use of wood resources. Return on capital is measured as income before tax related to stockholders' equity. This dependent variable can be split into profit margin and asset utilization rate.

The dataset consists of thirteen larger Japanese pulp and paper companies listed in Pulp & Paper Statistics. For the period 1991-2001 data about financial performance, production and use of wood fibers has been collected. The major source is an annual consultancy report bought by The Japanese Federation of Pulp and Paper Industry (Kami Parupu Sangyou Hakusyo). The individual companies have also checked and supplemented the dataset. Table 1 presents some data about the companies for 2001.

A full length report can be found in Lönnstedt and Nordvall (2004).

Table 1. Data about the companies, 2001

	Production (1,000 tons)			Use of wood raw material (1000m ³)	Use of Waste paper (1,000 tons)	Number of employees	Assets (billion Yen)	Stockholders' equity (billion Yen)	Net sales (billion Yen)	Income before tax (billion Yen)
	Paper	Paperboard	Pulp							
1. OJI PAPER	4,305	1,636	2,741	12,040	2,819	7,646	1,209	407	744	-29.0
2. NIPPON PAPER	3049	6	1,938	5,043	0	5,721	813	330	575	44.1
3. DAISHOWA PAPER	1,867	618	1,097	4,331	0	2,547	525	74	282	6.0
4. DAIO PAPER	1,680	544	1,028	3,936	956	2,976	468	114	322	20.4
5. RENGO	0	1,883	0	0	1,890	3,355	333	99	259	10.8
6. MITSUBISHI PAPER	901	46	683	2,005	0	2,373	309	93	175	4.4
7. HOKUETSU PAPER	821	290	650	1928	0	1,104	205	86	129	13.5
8. CHUETSU PULP & PAPER	821	31	659	1,263	154	1,142	151	49	98	6.0
9. JAPAN PAPERBOARD INDUSTRIES	48	983	117	343	0	943	120	17	77	0.1
10. TOKAI PULP	156	459	192	780	450	549	64	15	46	1.1
11. NIPPON KAKOH SEISHI	356	0	97	310	92	805	69	12	49	1.2
12. LINTEC	134	0	0	6	12	2,593	166	72	142	5.7
13. KISHU PAPER	312	0	200	620	0	859	62	35	45	0.7

Model frame

Our model frame is general, i.e. the thinking is not based on a particular region or country. When we are referring to consumption or capacity we have in mind the total of the region or the globe.

One basic relationship is between return on capital, investments and lower production costs. The thinking is that *return on capital* will in a first step positively influence investments in new production capacity and in next step *productivity* and production costs. Later the return on capital will be effected and so on. Let us try more in detail explain the relationship between investment and production costs. New investments (and closing down of old facilities)

mean that new, the latest technology will be installed. All experience shows that this means higher productivity and with unchanged factor costs lower production costs per ton. New investments may also mean increase of the production capacity and thus increased economies of scale. The effect will be reduced production costs per ton. Disregarding financial matters and interest rates the conclusion is obvious, rapid investments are positive for the development of return on capital. However, in the long run some “counter balancing forces” exist. High return on capital for the forest industry, for example due to high product prices, usually means that more or less at the “same time” many company boards decide to invest in new capacity. During a relatively short same time span this capacity will come on line. It is very rare that demand or consumption has increased with the same rate. The consequence will be increasing stocks that will put a downward pressure on market prices and on return on capital. Investments will be cancelled or delayed. Sooner or later prices and return on capital will be affected and once again investments will increase and so on. (In the short run the business cycle through the variation in demand will have the same influence on price and return on capital.) The market influence on prices depends on type of product. Generally the price variations are much more obvious for bulky products than for more developed products. In summary, intense competition among pulp and paper manufacturers result in a vicious industry cycle of “demand boom – production increase – capital investment – excessive production – recession - market stagnation – profit deterioration – curtailment of operations and abandonment of excessive equipment.”

Another relationship has to do with financial matters and interest rates. The return on capital will have an impact on companies’ ability to finance an investment from own sources. However, it will also have an impact on the possibility for companies to get external financing. The amounts of debt related to equity and return on capital influence both the opportunity of getting new loans and their price (interest rate). Companies with low solidity will have high costs for interest rates, which have a negative impact on return on capital. Besides, repayments influence cash flow and ability to finance investments from own sources.

Still another relationship of special interest in this case is the roundwood, chip and waste paper markets. At least to some extent high return on capital reflects the ability of the company to pay for fibers. High return on capital may also reflect high demand for forest industrial products and thus need of fibers. One-way for the company to signal this need and to increase supply of fibers is to increase the offered prices. The choice between roundwood, chips and waste paper is a matter of price but also of structure and traditions of the forest sector.

An increasing number of forest industrial products can totally or partly be produced from waste paper. Since long waste paper has been used in countries with limited supply of wood raw materials. Japan is an example of this. Waste paper has been cheaper to use than importing wood. Technological development has also meant that it has become possible to use or mix waste paper with virgin fibers for more and more products. For the last decades another reason for using waste paper is consumers environmental concern. Recycling has become an important issue for the general public. In addition forest, forestry and forest industry may play an important role for assimilating carbon dioxide and decrease the use of fossil fuels.

Hypothesis

The introduction indicates that *return on capital* is central for the study. This is the dependent variable. The difference between different companies (and countries) should be explained from a set of independent or explanatory variables. Our model frame shows that *mill size* and *productivity* may explain the differences. Another explanatory variable is *solidity*. Also the *production line* may be of importance. Use of wood resources, as wood raw material (roundwood and chips) and waste paper will also be included in this study. However, we do not expect to find that timberland ownership is of importance. It may be that use of waste paper has an influence. However, this may also be reflected in production line.

In short, we expect that the following relationship exists:

$$(1) \quad \text{Return on capital} = f(\text{mill size, productivity, solidity, production line, use of waste paper})$$

+ + + +/- +

Mill size is supposed to indicate economies of scale, which is for example reflected in productivity. High solidity means less payment of interests and thus higher profit for the shareholders. If production line or type of production indicates specialized well-priced paper products the effect on the profit level and return on capital will be positive. However, if the production line means bulky products where the competition is high the opposite may be the case. Waste paper is in general lower priced and has lower processing costs than roundwood, which as a consequence will generate higher profit and also higher return on capital.

Financial performance

The Japanese pulp industry produces annually about 10 mill. Tons and the paper and paperboard industry about 30 mill. tons. The customers can be found on the domestic market. Import is marginal but increasing for paper and paperboard.

In 1955 pulpwood was equal to logs, today chips are totally dominating. Today the total pulpwood supply is about 36 mill. m³. Another major change that has taken place is the dramatic increase of import. At the beginning of 2000s about 70% was imported. Another important papermaking raw material is wastepaper. More than half of the fiber material used by the paper and paperboard is wastepaper.

For return on equity and profit margin the business cycle can easily be seen (Figure 1). The studied period starts with a decrease in the cycle. The bottom seems to be reached just before the middle of the decade. The following peak occurred around 1996-1997 and is once again followed by slowing businesses.

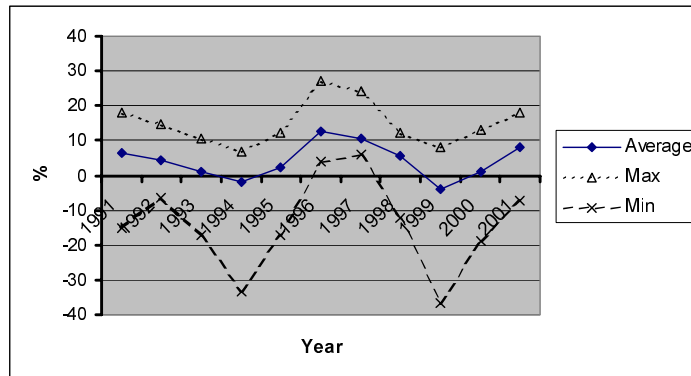


Figure 1. Return on equity.

As the maximum and minimum values shows the difference in profitability between the companies is large. This reflects that management has chosen different strategies or business niches. A major task for this paper is to try to explain the differences in profitability of the companies. Could it be explained by differences in product lines, economies of scale or something else? In the following sections we will come back to this question.

Solidity has been quite stable. The average value of assets on the books is 320 billion Yen. The range is very large with a maximum average value of 1,085 billion Yen and a minimum of 56 billion Yen. The average standard deviation is 324 billion Yen. The average value of assets on the books have been quite stable but an effect from the merges around the middle of the decade can be noticed. Another measure of company size is number of employees. The average for the thirteen studied companies and for the studied period is 3,000 with a standard deviation of 2,688. The number has been quite stable. However, once again the influence from merges can be seen. During the later part of the period a slow decrease can be noticed.

The average mill size varies depending on the production line for the company. Companies with both paper and paperboard production has the highest average mill sizes while the smallest mill sizes can be found among companies only producing paper. Probably some of these companies have quite specialized paper products. For companies only producing paperboard the average mill size decreased quite dramatically after 1996, because of merges. In 2001 the average was back at the same level as in 1996. The average pulp mill size has slowly increased. The companies own production of pulp, measured as pulp production related to paper and paperboard production, has slowly decreased from 52 % in 1991 to 42 % in 2001.

As could be expected, labor productivity has increased from 600 tons in 1991 to 970 tons per employee and year in 2001. Capital productivity measured, as tons per mill. Yen of value of assets on the books has been fairly stable.

The import share of wood raw material related to total use has decreased quite substantially, from 36 % in 1991 to 48 % in 2001. The use of wood raw material per ton of paper and paperboard has described the opposite development, from 1.43 to 0.88 m³ per ton. Use of waste paper per ton of paper and paperboard has increased, from 32 % in 1991 to 39 % in 2001. Table 2 summarizes some of the results.

Table 2. Summary of some key measures for the studied variables measured as averages for all the studied companies and for the studied years (1991-2001).

VARIABLE	AVERAGE	STANDARD DEVIATION
PROFITABILITY		
Return on equity	4.2 %	7.7 %
Return on equity after tax	-0.1 %	8.4 %
Profit margin	2.0 %	2.9 %
Asset utilization rate	2.1	1.6
SOLIDITY	32 %	12 %
SIZE OF COMPANY		
Value of assets on the books	320 billion Yen	324 billion Yen
Number of employees	3,000	2,688
AVERAGE MILL SIZE		
Paper and paperboard	414,000 tons/year	209,000 tons/year
Paper (only)	184,000 tons/year	76,000 tons/year
Share of only paper product.	71 %	38 %
Paperboard (only)	277,000 tons/year	60,000 tons/year
Pulp	322,000 tons/year	274,000 tons/year
Share of pulp production	45 %	29 %
PRODUCTIVITY		
Employee	0.75 tons/employee	0.39 tons/employee
Capital	7.0 tons/mill. Yen	3.0 tons/mill. Yen
USE OF FIBRES		
Import share of wood & chips	43 %	29 %
Use of wood & chips	1.43 m ³ /ton	0.88 m ³ /ton
Use of waste paper	34 %	32 %

Grouping of the companies

When trying to group the studied Japanese pulp and paper companies the main purpose has been to explore if differences in return on equity, profit margin and asset utilization rate could be found when making a logical grouping of the studied companies? We have looked at time series for averages of the total material but also at individual companies. In the text we will mainly present averages for all companies and for the whole period (1991-2001). We have tried to identify clusters of companies having distinctive features, i.e. that differ from each other. Clusters have been identified depending on type of production, size, use of waste paper, mill size and productivity. A comparison between the different clusters shows that companies with higher profitability than the average are characterized by

- A mixture of pulp, paper and paperboard production. (Two companies with only paper and paperboard production, respectively have also high profitability.)
- Low or high use of waste paper
- High average pulp mill size
- High labor and capital productivity

The clusters depending on company size and paper mill size showed profitability below the average.

Based on the result a hypothesis was formulated that “middle sized” companies were more efficient and had a higher profitability than “large” and “small” companies (Table 3).

Table 3. Return on equity, profit margin and asset utilization rate as an average for two clusters of companies depending on number of employees and value of assets on the books.

Cluster: Number of employees and value of assets	No. of companies	Return on equity	Profit margin	Asset utilization rate
>4,000 & 600 billion Yen	3	2.5	1.3	2.5
<1,000 & 100 billion Yen	3	1.3	0.4	3.2
Total	13	4.2	2.0	2.5

It should be remembered that the used dataset covers quite a short time span; a time span that from some aspects was quite special for Japan. It could be argued that the time span is too short for showing the effect of the merges during the 1990s. In that respect it may not give justice to big companies. Another type of criticism is that the analysis is based on averages for the whole period. Differences or a tendency in the development for an individual company is not reflected. In next chapter, we will base the analysis on time series.

Statistical analysis

Economic theory often suggests relations between variables in the long run and in levels. The theory provides little evidence about the underlying processes, which determine the observed data, i.e. the features of the data we have to work with (Charemza & Deadman, 1992; Harris, 1995).

Often (close to always) there are stochastic trends present in economic time series. If not considered, these trends may result in spurious regression, i.e. results that are based on correlated time trends. This is an old problem, which has been discussed for many years (Yule, 1926; Wold, 1953; Granger & Newbold, 1974). A common way of dealing with this is to transform the levels of the variables into first order differences (i.e. $\Delta y_t = y_t - y_{t-1}$). The drawback is that some information may be lost and that the connection to economic theory may become a bit loose or strained.

Economic modeling can have static or dynamic approach. Due to the commonly presence of inertia or adjustment in economic time series, reflecting technological development, institutional factors and psychological reasons (cf. Gujarati, 1988) a dynamic approach may be preferred. Dynamics can be modeled in different ways, i.e. by lagging one or all explaining variables. The most common way is to sum up the dynamics by lagging the dependent variable one or more time periods (Wonnacott & Wonnacott, 1979).

A study of each company with respect to the relations in eqv. (1) presupposes a large number of observations (i.e. at least 50-60 observations). Available observations in this study are yearly observations 1991-2001. This excludes studies of each company. However, the relations in (1) may be studied with respect to common features of all companies by applying a time series cross section model (cf. Hsiao, 1986; Baltagi, 2002):

$$y_{it} = \beta X_{it} + u_{it}, \quad i = 1, \dots, N; \quad t = 1, \dots, T \quad (2)$$

where y_{it} is the dependent variable; X_{it} is a vector of explaining variables; u_{it} is a residual term which is presumed to be random; i = the observed companies; t = the observed time period.

This type of model has two types of estimators (fixed and random effects estimators) to handle a tendency of u_{it} to be higher for some i and t (RATS, 2000). Fixed effects do this by using a separate intercept for each i or t . Due to the fact that there is often a scarcity in observations/data, these intercepts are often eliminated by subtracting individual and/or time means before the regression. Random effects is based on the following decomposition:

$$u_{it} = \varepsilon_i + \lambda_t + \nu_{it} \quad (3)$$

where ε is the individual effect, λ the time effect and ν the purely random effect.

There are advantages and disadvantages with the two types of estimators, e.g. fixed effects cannot estimate a coefficient on a time-invariant explanatory variable; ε (and λ) are parts of u in random effects and may be correlated to the explanatory variables (cf. Hausman & Taylor, 1981).

There are two qualified statistical packages that can be used in this kind of analysis: PcGive (Doornik & Hendry, 2001a, 2001b and 2001c) and RATS (RATS, 2000a and 2000b). PcGive has the advantage of being interactive and thereby user friendly. RATS has the disadvantage of assuming a certain amount of programming skills by the user, and the advantage of being successively updated by the latest econometrical progresses. Another advantage of RATS is that it has a larger flexibility in effects estimators. Taken together, RATS is preferred and chosen to carry out the statistical analysis in this study.

The analyses tested which of the following dependent variables (y_{it}):

Profitability:

RET = Rate of return: profit before tax related to stockholders' equity

RETX = Profit after tax related to stockholders' equity

PMARG = Profit before tax related to total sales

CAPT = Asset utilization rate: sales related to value of assets on the books

that best could be explained by the following variables (X_{it}):

APBP = Average paper and paperboard mill size: total production of paper and paperboard divided by total number of mills

APUP = Average pulp mill size: total production of pulp divided by total number of mills

PROE = Labor productivity: total production of paper, paperboard and pulp divided with total number of employees

PROC = Capital productivity: total production of paper, paperboard and pulp divided with total value of assets on the books

PASH = Paper share: production of paper related to total production of paper and paperboard

PUSH = Pulp share: production of pulp related to total production of paper and paperboard

ASSE = Total value of assets on the books

SOLI = Stockholders' equity related to total value of assets

- RWCT = Use of virgin fibers (roundwood and chips) related to total production of paper and paperboard
WAPR = Use of waste paper related tot total production of paper and paperboard
IMPW = Import of virgin fibers related to total use of virgin fibers

Due to the fact that some of the explaining variables contained time-invariant sequences, the random effects estimator (3) was applied.

Before the statistical analysis was carried out, the economic time series were deflated by the GDP deflator with 1995 basis (Bank of Japan, Statistics). This was done to avoid any inflationary effects on the results. GDP deflator is prices in the calculation of the Gross Domestic Product; 1995 basis = 100.

All dependent and explanatory variables were tested successively, including different combinations of levels and first differences. The best model fit had asset utilization rate as dependent variable. The best model fit required that all variables that not were expressed in (%) or (1), had to be transformed to (%) and into their first differences (Δ). Other dependent variables (profit before tax related to stockholders' equity; profit after tax related to stockholders' equity; profit before tax related to total sales) could not be explained in this model context and was therefore excluded from the analysis.

Explanatory variables that did not improve the model fit were: employment and debt degree. Employment was not significant and is not motivated in (1); debt degree was excluded due to high correlation with solidity. This is no surprise as debt degree can be deducted from solidity and the other way around. We did not found any significant model fit by grouping the companies. This may be due to a scarcity in observations/data.

The best model fit is shown in Table 4; Table 5 shows analysis of variances for the residuals with respect to differing means regarding i , t and joint. Table 6 shows test of equal variances for the residuals. In the following, the number in brackets give the order of time delay (i.e. lags); i.e., $\Delta\text{CAPT}\{1\}$ indicates that the variable is lagged one time period.

Table 4. Panel regression – estimation by random effects

Dependent variable: ΔCAPT

Panel of annual data: $i = 1, \dots, 13$; $t = 1991, \dots, 2001$

Usable observations: 117; DF: 104

R^2 (adj.): 0.57506

Std error of estimation: 0.06097

Variable	Coefficient	Std. error	T-stat	Significance Level
1. Constant	-0.00971	0.01277	-0.76067	0.44685
2. $\Delta\text{CAPT}\{1\}$	-0.17699	0.05914	-2.99276	0.00277
3. ΔAPBP	-0.08825	0.05621	-1.57004	0.11641
4. ΔAPUP	0.03765	0.02261	1.66526	0.09586
5. ΔPROE	0.19275	0.08351	2.30828	0.02098
6. ΔPROC	-0.21910	0.09563	-2.29114	0.02196
7. ΔPASH	-0.00313	0.00183	-1.71028	0.08721
8. ΔPUSH	0.00328	0.00233	1.40984	0.15859
9. ΔASSE	-0.59571	0.09642	-6.17806	0.00000
10. ΔSOLI	0.00567	0.00243	2.33140	0.01973
11. ΔRWCT	-0.07430	0.04900	-1.51614	0.12949
12. ΔWAPR	0.02046	0.02773	0.73799	0.46052
13. ΔIMPW	-0.00158	0.00132	-1.19447	0.23229

Table 5 Analysis of variance for residuals

Source	Sum of Squares	Degrees	Mean Square	F-stat	Significance Level
INDIV	0.00359	12	0.00030	0.08280	0.99998
TIME	0.03562	8	0.00445	1.23050	0.28978
JOINT	0.03921	20	0.00196	0.54180	0.94074

Table 6. Test of equal variances for residuals

$\chi^2(12)$	= 86.95033
Significance Level	= 0.00000

The first table (Table 4) indicates a low but acceptable R^2 . The low R^2 may be due to the difference transformation. Table 4 also indicates reasonable model features with respect to dynamics, signs and size of the coefficients. Table 5 underlines this by not indicating any significant individual, time or combined effects. The spread of the residuals are also acceptable (Table 6). The model may therefore be regarded as acceptable.

Conclusions and further research

Profitability

Asset utilization rate (CAPT) is significant and has a negative lagged effect in correlation with asset utilization rate; the coefficient indicates that close to 18% of the model behavior is explained by inertia (of one time period) in the adjustment of the time series.

An acceptable fit between observed and estimated time series could be observed. It is possible that more information about some companies could have improved the model fit for these companies. Dummies or trend dummies could have modeled this information. On the other hand, the model is constructed to capture common features of the companies and thus, it will always be individual discrepancies.

Asset utilization rate is relatively low (0,5-1,0) and constant for most of the companies. Only a few companies have a decreasing asset utilization rate. No company has an increasing asset utilization rate. It is interesting to note that there is a limited impact from business cycles to asset utilization rate.

Mill size

Average paper and paperboard mill size (APBP) and average pulp mill size (APUP) are significant or close to be significant, respectively, but have opposite signs. The negative sign for average paper and paperboard mill size indicates that an increase of average mill size of paper and board is not correlated with an increase in asset utilization rate but with a decrease. This may indicate an increased importance of production of special paper and paperboard. Smaller and more numerous mill sites can be located closer to consumer markets and this closeness to consumer demand may be more important than economies of scale in production of bulky products. The situation is reversed for average pulp mill size: an increased average mill size is correlated with an increased asset utilization rate. In this case economies of scale is important.

A conclusion that may be drawn is that paper and paperboard companies focusing on producing special qualities will continue to increase its purchases of market pulp and waste paper, rather than expand its internal pulp production, whereas producers of bulky paper and paperboard products needs to be more efficient in economies of scale.

Productivity

Labor productivity (PROE) and capital productivity (PROC) are both significant but with different signs. It is interesting to note that labor productivity is positively correlated with asset utilization rate, but a bit surprising that capital productivity is negatively correlated with asset utilization rate, i.e. there is profitability in labor productivity but not in capital productivity. The reason and the implication of this are not obvious; it needs to be subject to further research.

Production line

Paper share (PASH) has (cf. average paper and board mill size (APBP)) a negative effect in correlation with asset utilization rate; paper share is also significant but the effect is minor compared with the effect of average paper and paperboard mill size. The similar can be said regarding pulp share (PUSH) and average pulp mill size (APUP); pulp share has a positive (but not significant) effect in correlation with asset utilization rate, but the effect is rather minor compared with the effect of average pulp mill size. This indicates that there is profitability in pulp production (mill size and production line) but not in paper and paperboard production (mill size and production line).

Financial data

Total value of assets on the books (ASSE) has a major negative and significant effect on asset utilization rate. This indicates that size (measured as total value of assets on the books) is not automatically correlated with increased profitability. Solidity (SOLI) is on the other hand significant and positively correlated with asset utilization rate. The effect is minor, which may be due to large differences between the companies and that these differences taken together result in a minor effect.

Use of wood resources

Use of roundwood and chips related to total production of paper and board (RWCT) is close to having significant negative effect in correlation with asset utilization rate. Use of waste paper related to total production of paper and board (WAPR) has positive but no significant effect. This may reflect that roundwood and chips have become more expensive and this has been replaced by wastepaper. An increased wastepaper use with a not significant effect in correlation with asset utilization rate may indicate that this has been done without significant effect on profitability. Import of roundwood and chips related to total use on roundwood and chips (IMPW) has a minor negative, but not significant effect. The minor effect may reflect large differences in import rates among the companies. Different companies may import in different ways; i.e. from importing from whole- or part-owned forest plantations combined with purchasing by long/short term contracts, to importing mainly by short term contract on the spot-market. Adding to this complexity in different ways of importing are local and regional price differences, which may differ quite substantially from time to time. This is a complex field, which may need to be subject to further research.

Comments

It has to be noted that 1991-2001 is a special time period where the Japanese economy went through a period of stagnation, which may have had a distorting effect on the results. It is possible that prolonged time series backwards may have produced different results. Besides,

the study is based on a sample of companies. If all the Japanese pulp and paper companies had been included in the study, one cannot rule out another outcome of the results.

The results are only preliminary due to lack of similar studies to compare with. However, the results are interesting and encourage further research, i.e. to carry out corresponding studies of Sweden and the US. The countries can be studied country by country, focusing on country specific features, or together focusing on common features. How to proceed will depend on the availability of the data and the stochastic features of the time series (Royal Swedish Academy of Science, 2003).

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