PLYWOOD EXPORTATION FROM TAIWAN: QUARTERLY VARIATION AND FORECASTING

F. H. Rung

Department ofForestry, Southern Illinois University, Carbondale, Illinois 62901, United States of America

&

I. -A. Jen

Division of Forest Economics, Taiwan Forestry Research Institute, Taipei 10728, Taiwan, Republic of China

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KUNG, F.H. & JEN, I.-A. 1991. Plywood exportation from Taiwan: quarterly variation and forecasting. The quarterly figures of plywood exported from Taiwan during the period of 1965-88 were studied. Differences between the current and the next quarters were positive from the first to the second quarter but were negative from the fourth quarter to the next first quarter. The seasonal fluctuations may be linked to the United States residential construction as a whole. Correlations among quarters were high, the closer the two quarters in time, the higher was the correlation. Regression model for the next quarter export was successful in all quarters. Further study on the monthly variation pattern and the factors governing such variation may be desirable.

Key words: Seasonal variation - quarterly prediction - correlation - plywood industry

Introduction

The plywood industry has been playing an important role in Taiwan during the economic development of the last four decades. The exportation of plywood started with a mere $64,000.00 in 1953 and expended to a peak of $421 million in 1979. It was an increase of six thousand fold in a quarter of century. The amount and value of plywood export from Taiwan began its decline since Indonesia developed her plywood industry and the SEALPA (Southeast Asia Log Producers Association) restricted their veneer logs export. However, according to the Taiwan Statistical Data Book 1988, more than $300 million worth of plywood were still exported in that year (CEPD 1988).

The general trend of plywood export from Taiwan follows closely the stages of growth in United States imports of South Sea tropical hardwood plywood (Cengel & McKillop 1990). However, the seasonal export trend from 1965 to 1988 was not a smooth curve but had many prominent ups and downs within the

expansion stage and the maturation-transition stage (Figure 1). The objective of this study was to investigate whether a seasonal pattern exists for plywood export. If the amount of export for the next season could be predicted from this season, planning for inventory of the raw material and for scheduling of manpower and facilities could be improved.

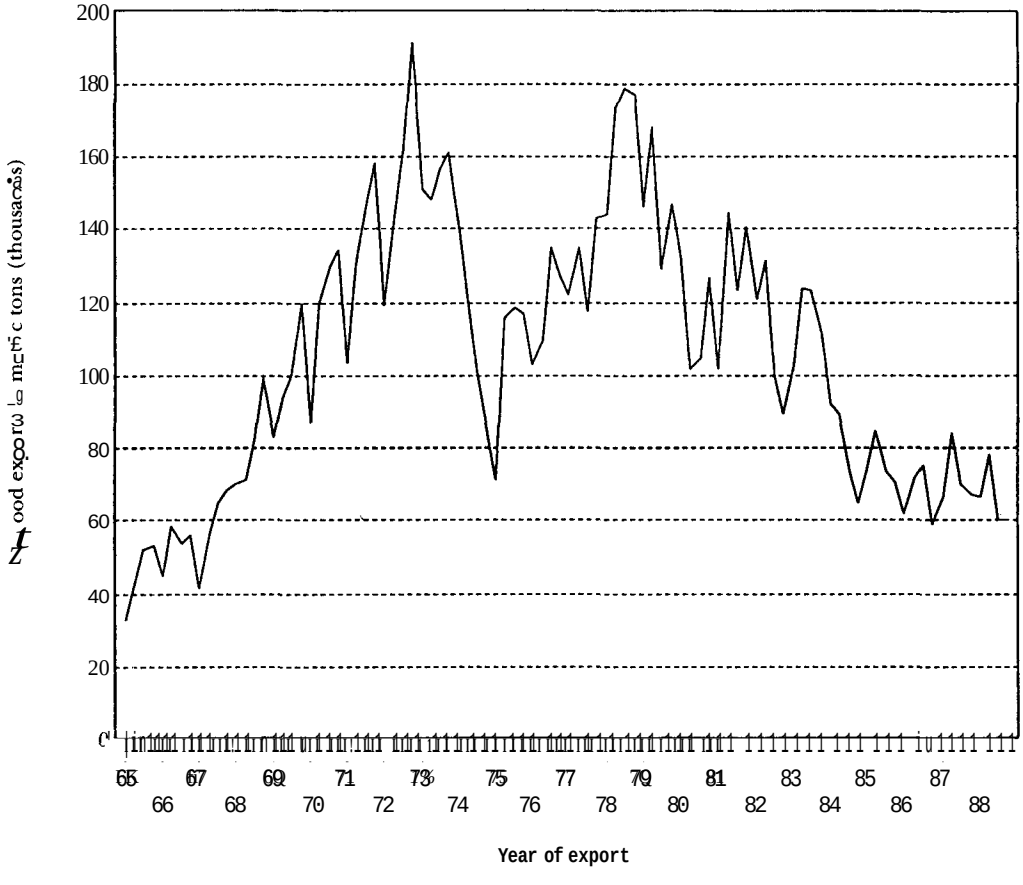

Figure 1. Quarterly plywood exports from Taiwan (1965 - 1988)

Materials and methods

The quarterly figures of exported plywood in metric tons (M.T.) were compiled from 1965 through 1988 (Table 1). We then calculated the difference between quarters. A positive difference shows growth increase and a negative difference decline.

Furthermore, four subsets of data base were extracted from Table 1. Each subset included three columns: (i) current quarters, (ii) difference, and (iii) next quarter. For example, the first subset was extracted from column 2 to 4, and

the second was from column 4 to 6, and so on. Each subset of data base was further sorted into two files, one with positive difference and the other one with negative difference. We were interested to see the probability of export increase or decrease from quarter to the next quarter.

Table 1. Plywood export in metric tons, by year and by quarter

Year	Qt=l	diff	Qt=2	diff	Q:=3	diff	Qt=4	diff	Next Qt=l
1965	32578	10117	42695	9132	51827	1643	53470	-8653	44817
1966	44817	13845	58662	-4927	53735	2224	55959	-14305	41654
1967	41654	14449	56103	8527	64630	3532	68162	2223	70385
1968	70358	930	71315	10857	82172	17242	99414	-16709	82705
1969	82705	11166	93871	6034	99905	20030	119935	-32813	87122
1970	87122	32568	119690	9916	129606	4522	134128	-30901	103227
1971	103227	27176	130403	16650	147053	11496	158549	-39387	119162
1972	119162	25151	144313	17217	161530	30059	191589	-40307	151282
1973	151282	-3072	148210	8105	156315	4893	161208	-21537	139671
1974	13967	-19924	119747	-18812	100935	-16613	84322	-13027	71295
1975	71295	44203	115498	2881	118379	-1618	116761	-13890	102871
1976	102871	6520	109391	25309	134700	-7142	127558	-5637	121921
1977	121921	12970	134891	-17742	117149	26038	143187	1281	144468
1978	144468	10117	173358	5038	178396	-1272	177124	-30612	146512
1979	146512	21609	168121	-38957	129164	18005	147169	-15046	132123
1980	132123	-30571	101552	3149	104701	22003	126704	-25271	101433
1981	101433	43422	144855	-21474	123381	17567	140948	-19785	121163
1982	121163	9996	131159	-31385	99774	-10557	89217	13436	102653
1983	102653	21095	123748	-594	123154	-11786	111368	-19079	92289
1984	92289	-2734	89555	-15541	74014	-8976	65038	9145	74183
1985	74183	10621	84804	-11391	73413	-2624	70789	-9052	61737
1986	61737	10340	72077	3555	75632	-16829	58803	7875	66678
1987	66678	17233	83911	-13748	70163	-3114	67049	-518	66531
1988	66531	11728	78259	-18234	60025	42	60067	-	-
Mean	94936	12456	108174	-2768	105406	4115	109521	-13432	97674
Std.	34682	16815	35590	16299	35982	13431	41952	15129	32038

Simple linear regression analysis was used to predict the next quarter export from the current quarter export. We found this one-lag time series easy to understand. The intercept of the regression may be interpreted as the absolute quarterly growth, and the slope as the ratio of upcoming quarter exports to the current quarter exports. The value of (slope - 1.0) then may be regarded as the relative preceding period growth rate. If the intercept is positive, there would be a fixed amount of increase. Similarly, if the slope is greater than 1.0, there would be a variable amount of increase based on the previous size of exports. For example, let x = current quarter export, y = next quarter export, a=intercept, b=slope, in the regression y = a + bx, the five illustrative patterns in Table 2 could be interpreted as follows:

Pattern 1: a=5, there would be a fixed growth of five units given from the current quarter to the next quarter, independent of the current size of exports.
b=l, There would be no variable growth, relative preceding period growth rate= 0.

Pattern 2: a=0, There would be no growth in the absolute scale.

b=l.l, There would be a 10 % growth in the relative scale.

Pattern 3: a=5, b=l.l, There would be increase both in fixed growth and in relative preceding period growth.

Pattern 4: a=5, b=0.9, There would be across the board five units of increase and a 10% reduction from the current quarter. The larger the current quarter exports, the greater is the loss in the upcoming quarter.

Pattern 5: a=-5, b=l.l, There would be a reduction of five units in the absolute scale, but a larger current quarter exports would be better than a smaller one because of a relative preceding period growth rate of 10%.

The above five patterns were drawn from the total of nine possible patterns, to give the three values for a as 5, 0, and -5 and for b as 1.1, 1.0 and 0.9 respectively. The other four patterns are not presented here in order to limit the length of this paper.

Table 2. Five patterns of simple linear regression y=a+bx to forecast the upcoming quarter export (y) from current quarter export (x) with a=across the board increase or decrease, and b-l=relative preceding period growth rate

Current quarter exports (x)	Upcoming quarter exports (y)				
	Pattern				
	1	2	3	4	5
100	105	110	115	95	105
200	205	220	225	185	215
300	305	330	335	275	325
400	405	440	445	365	435
500	505	550	555	455	545
Coefficient	**Coefficient value**				
a	5	0	5	5	- 5
b	1	1.1	1.1	0.9	1.1

Correlations between quarterly exports within the same year were calculated based on quarterly exports in Table 1. This correlation analysis will enable us to see the interrelationship among quarters in a year, notjust two neighbouring quarters. Thus, the quarter with the highest overall correlation would be the most important quarter to watch in the whole year.

Correlations between quarterly difference in Table 1 were also calculated. We would like to know if the quarterly differences were interrelated or independent. For example, what changes from the third to the fourth quarter exports could we expect if there were some changes from the first to the second quarters? Such information is valuable for future planning.

Results and discussions

Results and discussions are first presented quarter by quarter; an overview of four quarters is given later.

Quarterly difference and prediction for the next quarter

In this section we will present the difference between the current quarter and the upcoming quarter, and a simple linear regression to forecast the upcoming quarter from tthe current quarter. The order of presentation will start with the first quarter (January, February and March) being the current quarter, followed by the second, the third and the fourth quarters in turn being the current quarter. When the current quarter is the fourth quarter, then the next quarter is the first quarter of the coming year.

From first to second quarters

Over the last 24 years, 20 had positive difference or increase, and only four (in the years 1973, 1974, 1980 and 1984) had decrease (Figure 2a). Continuous positive runs were found in four segments: 1965-1972, 1975-1979, 1981-1983, and 1985-1988. Noticeable were the two cycles of wide back and forth swings from 1972 to 1976, and from 1978 to 1982. The largest increase was in 1975, and the largest decrease, 1980. The change from peak to bottom in two consecutive years could be as wide as 74,000 metric tons. On the average, there was a significant increase of 12,456 metric tons from the first to the second quarters (Table 1). During the up years, the export in the second quarter, Q2, could be predicted from the first quarter export, Ql:

$$Q2 = 9580 + 1.1035\ Ql.$$

During the down years, the regression was:

$$Q2 = 4592 + 0.8551\ Ql.$$

The regression for the up years may be comparable to Pattern 3, while the down years may be comparable to pattern 4 of Table 2. Both regression models were significant and the r^2 was 0.91 and 0.74 respectively. Thus , if the export history repeats itself in the future, we would expect the second quarter to have a 10% increase over the first quarter, in addition to the 9,580 metric tons gain, with a 5/6 probability. We would also expect the second quarter to have a decrease of 14% under the first quarter, but to have a counterbalance of 4,592 metric tons gain, with 1/6 probability. Because the probability of gain outweighs the loss, a wise plywood manufacturer should be able to anticipate the market expansion and plan ahead to meet the increased demand.

From the second to the third quarters

There were 13 positive and 11 negative differences between two quarters.

The largest increase was found in 1976, while the largest decrease was in 1979. Before 1974, the positives outnumbered negatives by a ratio of 8 to 1, but after 1980, the negatives outnumbered positives by a ratio of 7 to 1. Beyond a positive trek from 1967 to 1973, the oscillation cycle with a wave length of two to three years was clearly visible (Figure 2b). On the average , export was reduced by 2,768 metric tons from the second to the third quarters (Table 1).

When there was a positive increase, the regression was:

$$Q3 = 7300 + 1.0228\ Q2.$$

But for years in which the third quarter was less than the second quarter, the regression was:

$$Q3 = 5752 + 0.7897\ Q2.$$

The models for the positives increase and that for the negatives increase may be classified as pattern 3 and pattern 4 of Table 2 respectively. Again, both models were significant and accounted for 97 and 91% of the variation.

The relative growth rate for the up years was only 2%, while the rate of decline for the down years was more than 21%; the plywood exporters and manufacturers should be prepared for the lean season as production moves towards the third quarter. Furthermore, we found a significant negative correlation (r=-0.73) between the calendar year and the quarterly difference; so we would expect more and harder reduction between second and third quarters in the years to come.

From third to fourth quarters

A small rebuilding from depression was found in this time transition. On the average, an increase of 4115 metric tons was exported (Table 1). Although the ratio of positive differences to negative differences was 14:10 over the 24 years study period, or roughly about even in number, the positives and the negatives were aggregated. There were nine consecutive positives year from 1965 to 1974, as well as six consecutive negatives years from 1982 to 1987 (Figure 2c). The regression during the years of increase was:

$$Q4 = -1889 + 1.1389\ Q3$$

During the down years, the regression was:

$$Q4 = -13208 + 1.0492\ Q3$$

These two regressions were different from all of the other regression models in this study in having a negative intercept, similar to pattern 5 of Table 2. In other words, although there was increase in the relative scale, because of the sizeable decrease in the absolute scale, the gain may turn to loss if the productivity was low in the third quarter. The r^2 for the above two models was 0.96 and 0.98 respectively.

From the fourth to the next first quarters

There was an average reduction (-13,432 metric tons) in plywood export from the fourth to the upcoming first quarters. The largest drop (-40,307 metric

tons) between two consecutive quarters was found in 1972. During the whole study period, the frequency ratio of export's expansion to export reduction was 5:18. Noticeable were the two deep valleys from 1968 to 1976, and from 1978 to 1981, where no positive differences were observed. However, in the last seven years, the cycling became smaller (Figure 2d).

The regression model for those years with positives differences was:

$$Q1 = 11969 + 0.9390 \times Q4, \text{ with } r^2 = 0.98.$$

with negative difference, the model was:

$$Q1 = 4550 + 0.7955 \times Q4, \text{ with } r^2 = 0.95.$$

These two regressions were opposite to those in third to fourth quarters. Here the intercepts were positive and the slopes were less than one, similar to pattern 4 in Table 2. Thus, while there was increase in the absolute scale from the fourth to the first quarters, it was counterbalanced by a decrease in the relative scale. Although the reduction was evident in the past, the trend in the last seven years shows that the exports oscillation has contracted and stabilized toward zero. Therefore, in the future we would expect changes in the production plan between these two quarters may become unnecessary.

To summarise the variation in quarterly difference, there was a strong seasonal pattern: exports were up from the first to the second quarters but were down from the fourth quarter of the current year to the first quarter of next year. The reason for such quarterly pattern may be due to the seasonal demand of the housing industry in the United States. United States was the largest importer of Taiwan's plywood. Plywood imports from South Korea were linked to the residential remodelling and mobile home sectors of the United States economy, while those from Taiwan were linked to the United States construction sector as a whole (Cengel & McKillop 1990). Since the construction industry had been active during the warm seasons and inactive during the winter month, the cyclic changes on the demand of Taiwan plywood would cause a cyclic exports pattern in Taiwan.

There may be other factors causing the export fluctuation. Recently, Cengel and McKillop (1990) studied structural equations of plywood supply to United States by South Korea, Taiwan and Japan. They found that exports from Taiwan were related to the following variables: average export price of Taiwan plywood shipped to the United States market, average import cost of South Sea hardwood log by Taiwan, and average selling price of urea and formalin in Taiwan. However, since their data were based on annual reports, whether the same relation exists for our quarterly data will need further validation. On the other hand, it is unlikely that the seasonal pattern is the outcome of international market competition between Taiwan and other plywood export countries. Chou and Buongiorno (1983) found that a rise of 1 % in plywood price of Korea, Japan, Philippines and the rest of the world, would have a substitution effect of 0.42% and a market expansion effect of the -0.53%, on the United States import from Taiwan. We have not seen a seasonal trend in plywood price in the United States market comparable to the seasonal pattern in this study. Furthermore, from an analysis of international trade of plywood in terms of

excess demand and excess supply in Taiwan, Taiwan plywood export market has no apparent pattern of shifts in excess supply and excess demand (Jen 1990). Thus, we do not think the international competition in plywood trade would cause the quarterly variation pattern.

Correlation between quarters

All correlations between quarters in Table 3 were significant at the 1% level. In general, the closer the two quarters, the higher is the correlation. On the average, the second and the third quarters had the highest average correlation with all other quarters (r=0.8753 and 0.8727 respectively) while the first quarter had the lowest (r=0.7916). This is unfortunate, because if the first quarter had the highest average correlation, we could use the first quarter performance to guide the production for the rest of the year. Now we have to wait for the second or the third quarter report.

Table 3. Correlation between quarters within a year

Quarter	Quarter			
	First	Second	Third	Fourth
First	1.0000	0.8814	0.7703	0.7231
Second	0.8814	1.0000	0.8964	0.8482
Third	0.7703	0.8964	1.0000	0.9520
Fourth	0.7231	0.8482	0.9520	1.0000

Correlation among differences

The correlations of quarterly difference are listed in Table 4. There were two significant negative correlations, both were related to the difference going from the fourth quarter to the upcoming first quarter. It suggests that the increase of exports from the second to the third quarter, or the increase of exports from the third to the fourth quarter, may have been an impact on the decrease of exports from the fourth quarter to the next year first quarter. Besides these two, there were no relationships between one difference to the other. For example, the amount of increase of exports from the first to the second quarter gives no useful information about the changes from the second to the third quarter, because the correlation between these two differences is zero.

Table 4. Correlation among quarterly difference

Difference	Difference			
	D12	D23	D34	D41
D12	1.0000	0.0055	0.1426	-0.1802
D23		1.0000	0.1089	-0.4746*
D34			1.0000	-0.5339**
D41				1.0000

* and ** are significant at the 5 and 1% level respectively

Summary and recommendations

The analysis showed notable quarterly pattern in plywood exports from Taiwan. Exports were up from the first to the second quarters but were down from the fourth quarter of the current year to the first quarter of next year. The cyclic pattern may be explained by the seasonal demand of the housing industry in the United States. It remains to be tested whether the cyclic pattern is caused by other variables such as: average export price of Taiwan plywood shipped to the United States market, average import cost of South Sea hardwood logs by Taiwan, and average selling price of urea and formalin in Taiwan. Further investigations are worth initiating and supporting in order to establish the factors behind the quarterly variation of plywood exports. The plywood industry in Taiwan then could become adapted to those factors, and could have more effective and efficient production control.

Quarterly reports of plywood from 1965 to 1988 were used in this study. Although it may be a bit naive to ask governments to adjust their statistical service for the benefit of academics, we believe that the monthly reports are more desirable than quarterly reports. One of the problems in the interpretation of the quarterly pattern is the discrepancy between calendar quarter and the climatic season. The first quarter includes the months of January, February and March but the months of spring in the United States are March, April and May. March in the only month that is common to both the first quarter and the spring season. Using monthly figures certainly would be more compatible. Monthly reports for time series study and for fine tuning industry production are also advantageous. Finally, it is possible to gather quarterly or annual reports from monthly figures, but not the other way around. As we are now entering the "computer age" and "information revolution", change from quarterly report to monthly report should be put in place as soon as possible.

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