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China's wood import transport market and choice of ship size

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CHINA'S WOOD IMPORT SHIPPING MARKET AND CHOICE OF LOG VESSEL

By

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China

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Declaration

I certify that all the material in this research paper that is not my own work has been identified, and that no material is included for which a degree has previously been conferred on me.

The contents of this research paper reflect my own personal views, and are not necessarily endorsed by the university.

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(Date):

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Abstract

With the rapid development of the national economy, the continuous improvement of people's living standards, Chinese society needs more supply of wood. But due to the paucity of China's forest resources, and the national implementation of the Natural Forest Protection Project since 1998, these are making the domestic wood supply far unable to meet the increasing demand. The Chinese government canceled the import tariffs of wood to encourage wood import. China's wood import market will continue to expand in the next few years, as one of the importer, China National Building Materials (CNBM) Forest Products LTD started business form the end of 2007 and has made a remarkable performance. As the business continues to grow, the company faces a growing pressure from the market competition. The company needs to choose best vessels to achieve best financial benefits and to maintain the strategy of development through analysis and forecast the market.

This dissertation analysis and forecast both the wood import market and shipping market, after that, supply the theoretical basis of choosevessels based on the current situation and the strategy of CNBM Forest Products LTD.

Keywords: log lumber wood chip market analysis forecast vessel crane

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1. Introduction

1.1 Research background and significance

With the rapid development of the national economy, the continuous improvement of people's living standards, Chinese society needs more supply of wood. But due to the paucity of China's forest resources, and the national implementation of the Natural Forest Protection Project since 1998, these are making the domestic wood supply far unable to meet the increasing demand. China harvested about 64.8 million m^3 logs in 2009 and 75.1 million m^3 logs in 2010, meanwhile China imported about 28.1 million m^3 logs in 2009 and 34.4 million m^3 logs in 2010. The Foreign-trade Dependence both in 2009 and 2010 were nearly 30%. Depended on the environment and native forest protection, Chinese government canceled the import tariffs of wood to encourage wood import. Due to the increasing demand and the support of Chinese government, China's log import increased to 42.3 million m^3 in 2011 from 13.6 million m^3 in 2000, and lumber import increased to 21.5 million m^3 in 2011 form 4.0 million m^3 in 2000.

In 2010, China imported 36.6% of total wood import from Russia. China is now trying to import wood from more countries, the market share of wood import from Russia is decreasing, but Russia is still the largest supplier to the China's wood import market, both in lumber import market and log import market. Another research shows that China's log import transport by sea increased from 36% in 2005 to 67% in 2010[19].

These data shows the increasing demand and the policy strongly affect to China's

wood import market and its shipping market. As part of the importers, CNBM Forest Products LTD import logs from Europe, New Zealand, Australia and North America, it also imports lumbers from Canada and America. Now the company is trying to develop woodchips trading as its new business. As part of the costs, shipping expense plays a very important role in the trading. It is necessary to minimize the shipping cost and reach the maximum profit. This research will provide theoretical basis for the management of the company's own fleet.

1.2 Main research contents

Analysis and forecast China's wood import market.

Analysis China's wood import shipping market.

Choose log vessel for CNBM Forest Products LTD.

2. China’s wood import market and its shipping market

2.1 Characteristic of all kinds of wood

According to the different varieties of tree, wood can be divided into hardwood and softwood. Hardwood harvested from broad-leaved trees, they are more difficult to processing and always used to make furniture, plywood and decoration. Softwood harvested from needle-leaved trees, they are easier to processing and used to ship building, they are also the main materials in building.

According to the different processing degree, wood can be divided into log, lumber, woodchip pulpwood and so on.

In shipping, logs are shipped by bulk carrier, lumbers can be shipped by bulk carrier and container, and woodchipsare shipped by woodchip carrier. Wood has some characteristics during shipping, wood have large stowage factor, hygroscopicity, flammability and so on.

2.2 Supply and demand in China’s wood import market

China is not only a super country in wood products producing, but it is also a super country in wood consumption. But the China’s per capital possession of forest resources remains at a low level. The gap between supply and demand began to expansion since Natural Forest Protection Project 1998 in the domestic wood market. An increasing imported wood are throw into the expanding gap to meet the domestic demand.

China’s log import kept increasing from year 2000 to 2007, the increasing rate is

about 24.7% every year during this period. The market suffered from the finical crisis and it went down to 28.1 million m^3 in 2009, just below the level of year 2005. But the market got better immediately after 2009 and kept growing at a rate about 25.4% every year, until 2011, it hit the top about 42.3 million m^3.

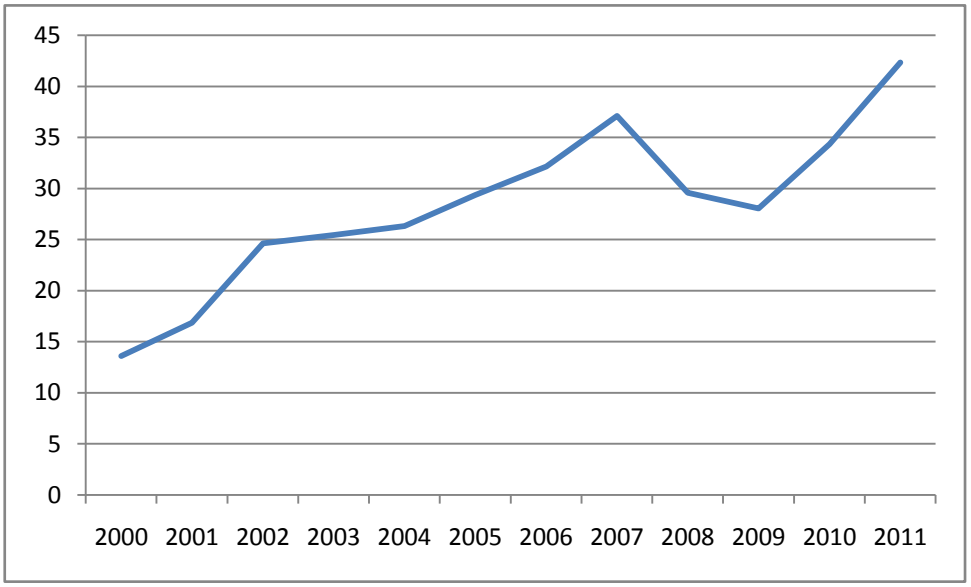

Figure 1 – China's Log Import (million m^3)

Source: Development Report of China Timber and Wood Products Market (2010)

China's lumber import kept a low volume and increasing rate before 2008, but it began developing rapidly after 2008; the volume imported in 2011 is nearly three times of the volume imported in 2008. Compared with log import market after 2009, lumber import quantity increased faster, it increased at a rate of 59% every year, more than two times of the log import market.

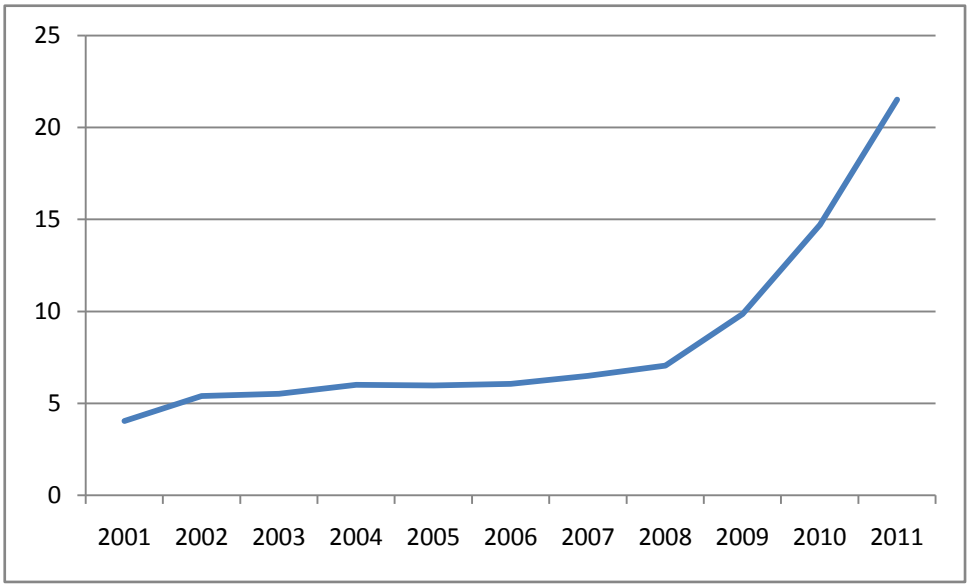

Figure 2 – China's Lumber Import (million m^3)

Source: Development Report of China Timber and Wood Products Market (2010)

China now import logs from many countries. Logs from Russia hold 41% of the total market share in 2010, although this market share has kept decreasing for the past few years, but Russia is still the main supplier of China's wood import market. With the decreasing of Russia's log supply, America took the opportunity to propagandize its wood. Logs from America exported to China increased 266.3% in 2010 compared with 2009. Another huge increasing was the logs from Canada; it increased 216.8% in 2010 compared with 2009. Same as Russia, Gabon reduced its log exported to China in 2010.

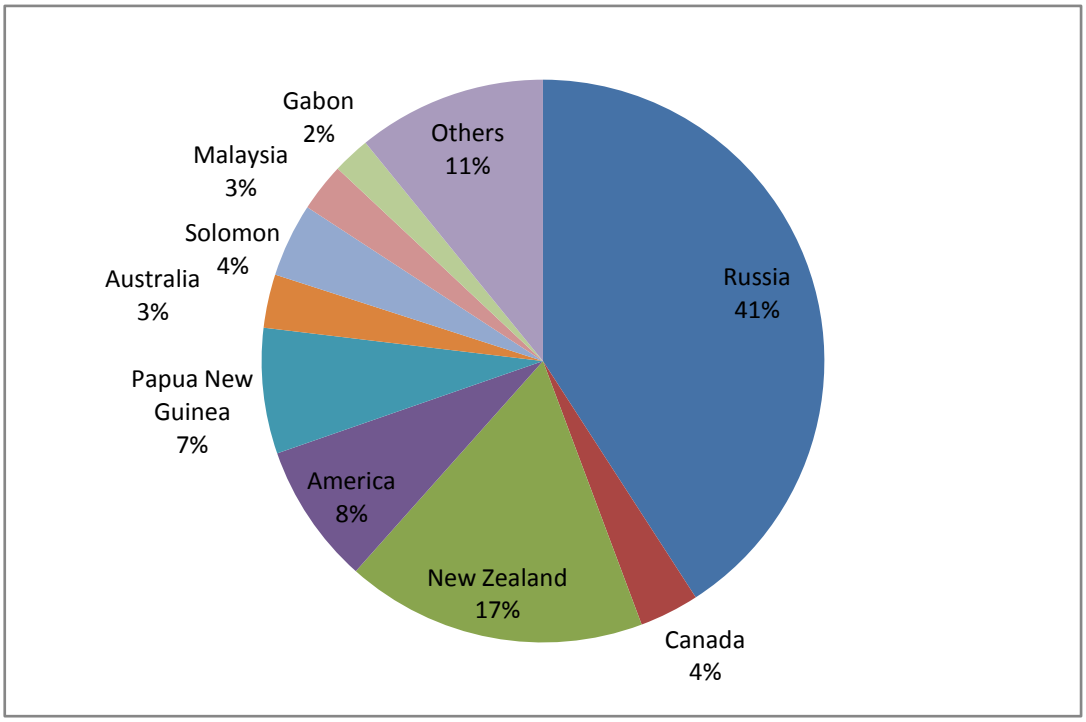

Figure 3 –Suppliers to China's log import market 2010

Source: Development Report of China Timber and Wood Products Market (2010)

Different from log import market, lumber import quantity from each supplier countries increased steady, from 38% to 85% during 2009 to 2010. Among them, lumber imported from Philippines has a largest increasing rate about 85% from 2009 to 2010.

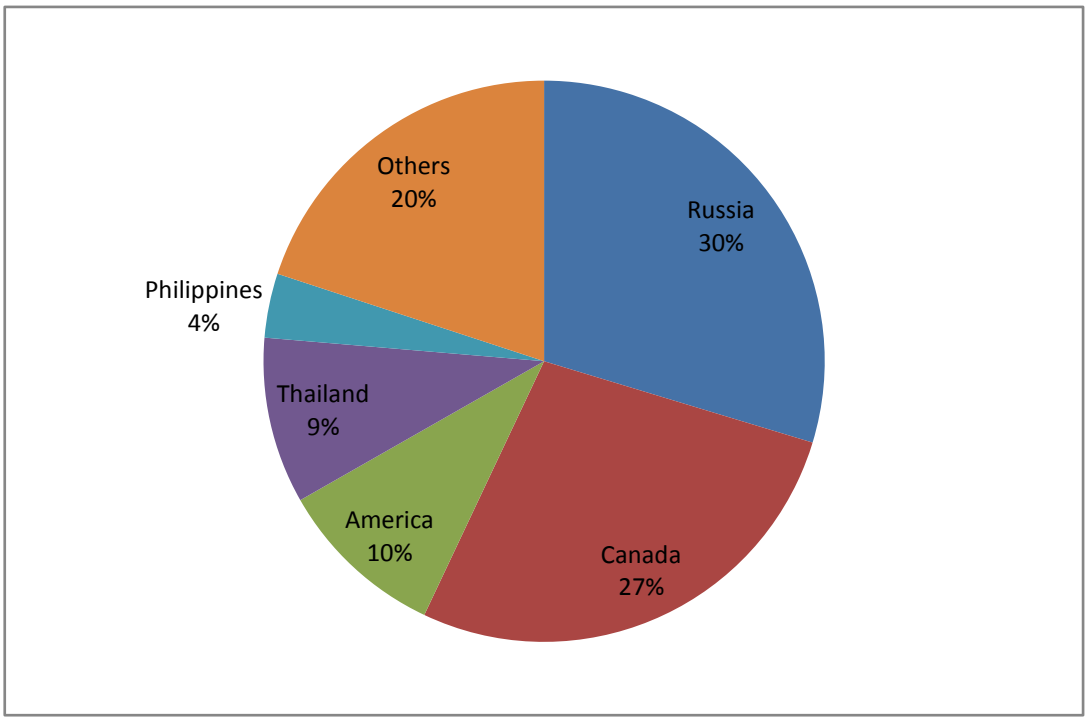

Figure 4 – Suppliers to China's lumber import market 2010
Source: Development Report of China Timber and Wood Products Market(2010)

China began to expand its woodchip import market after 2008, most of the woodchips that China imported was hardwood. China's woodchip import market experienced a leap in 2009. Import of hardwood chips increased 1608000 BDMT to 2660000 BDMT compared with the previous year; the increasing rate was about 152.9%. China's imports of softwood chips increased to 105000 BDMT in 2009 from only 3000 BDMT in 2008; China's imports of softwood chips more than doubled in volume in 2011 from theprevious year, to 301,000 BDMT, although this volume represents less than 5% of China's total woodchip imports[18].

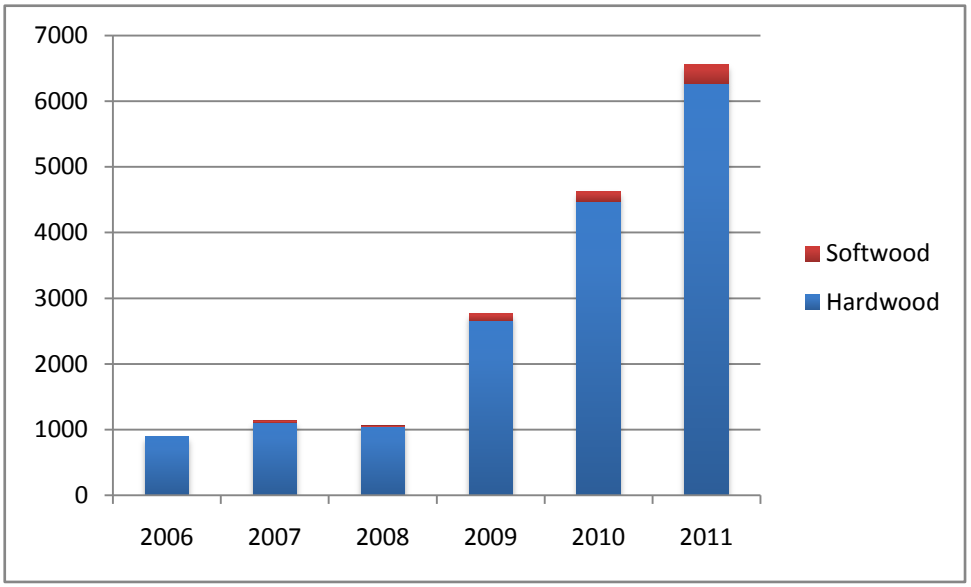

Figure 5 –China: Woodchip Import by Source, 2006-2011 (1000BDMT)
Source: International Pulpwood Trade Review, (2012)

Vietnam controlled 56% share of Chinese hardwood chip market in 2010, but it declined to 50% in 2011.Thailand's share increased 3% in 2011. Australia controlled 53% share of Chinese softwood chip market in 2010, different from Vietnam, its volume increased 27%, almost control the whole Chinese softwood chip market. Most of the hardwood chips were imported by APP and APRIL. APP was the largest importer until 2011; APRIL started up a new hardwood pulp line at Rizhao in 2010 and became the largest importer in 2011[6].

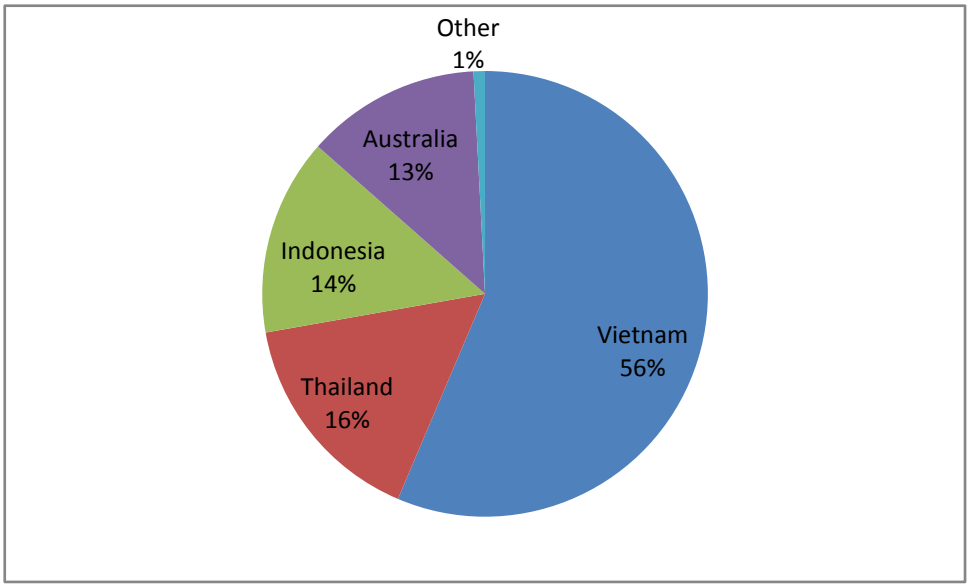

Figure 6 – China: Hardwood Chip Import by Source, 2010

Source: International Pulpwood Trade Review, (2012)

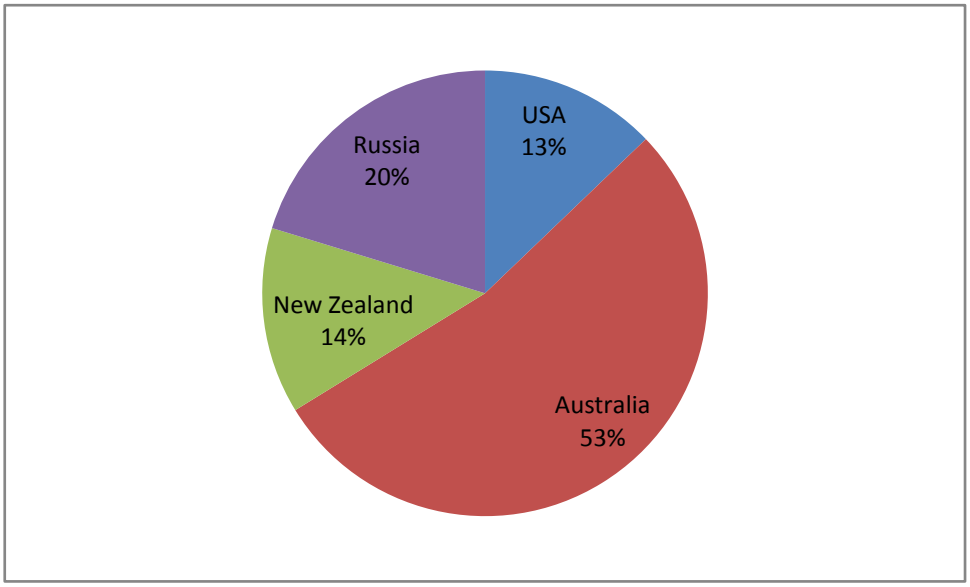

Figure 7 – China: Softwood Chip Import by Source, 2010

Source: International Pulpwood Trade Review, (2012)

2.3 Analysis of fleet capacity in wood import shipping market

In wood import shipping market, logs and lumbers are shipped by bulk carriers, lumbers in small quantity can shipped by containers, woodchips are shipped by woodchip carriers.

Due to the difficulty of log vessel operating, damage to the vessel when loading and discharging logs and the high capital cost of log vessel, ship owners prefer to use single deck bulk carrier. This kind of vessel is widely used in wood shipping market, and it is also the main ship type in bulk carriers.

Logs from Russia and Asia are shipped by small vessels with less than 10,000 DWT; most of them are about 5,000 DWT. This dissertation below mainly discusses vessels from USA, Canada and New Zealand. By statistics of the vessels exported logs and lumbers from USA, Canada and New Zealand from 2012 to March 2013, it shows that 30,000 to 35,000 DWT vessels are the main size in these routes. Vessels from 25,000 DWT to 35,000 DWT controlled 84% of market share in USA and Canada, and 79% of market share in New Zealand. This statistics based on the vessels' name, the same vessel count only once no matter how many times it load logs and lumbers in these countries. If the total export quantity of log divides by total number of vessels loading logs in USA and Canada, the average capacity of vessel would be about 33,378 DWT. The main DWT of log vessels in the market expand fast. In 1997, the most new delivered log vessels are about 28,000 DWT, in year 2000 it increased to about 32,000 DWT, and until 2010, the main DWT of the log vessels delivered was about 35,000. In 2014, most of the new delivered log vessels will reach a DWT about 37,000 to 38,000.

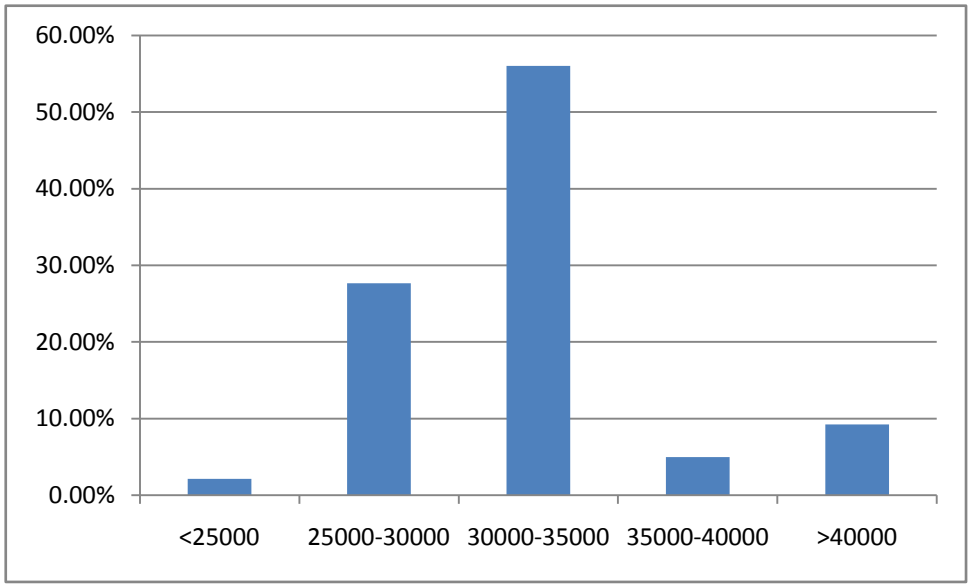

Figure 8 – Vessel size from USA and Canada January 2012 to March 2013
Source: CNBM Forest Products LTD.

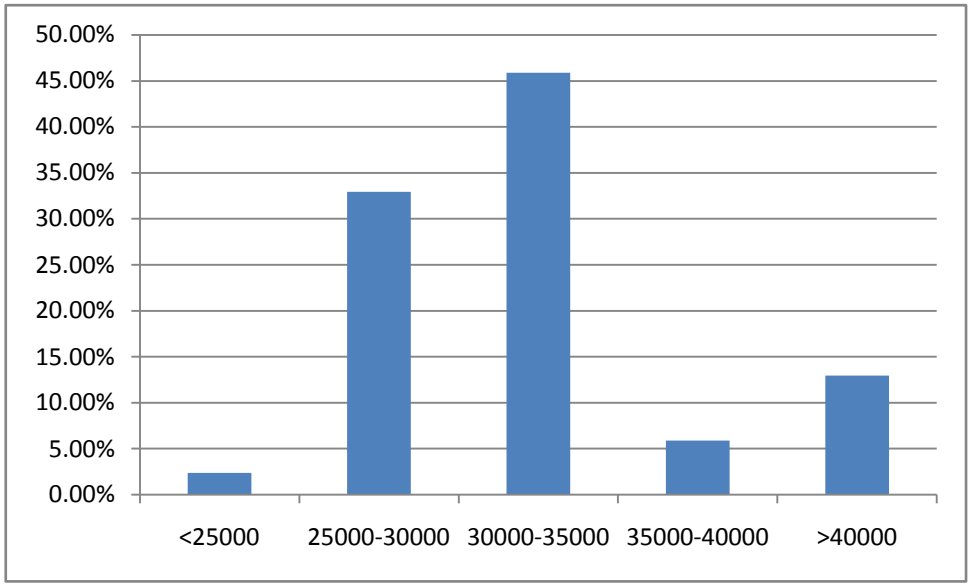

Figure 9 – Vessel size from New Zealand January 2012 to March 2013
Source: CNBM Forest Products LTD.

Woodchip carriers are specialized vessels designed to carry woodchips, these vessels has larger load factor compared with bulk carriers, for example, woodchip carriers with 40,000 DWT has 3-3.6 million CFT, bulk carriers with 40,000 DWT has only 1.8 million CFT, and bulk carriers has 3 million CFT can reach the DWT about

70,000. According to International Pulpwood Trade Review, 2012, there were 168 woodchip carriers in the active fleet worldwide in 2011, four of them were planted for scrapping in 2012 and no new building woodchip carriers were delivered in 2011[6]. Vessels over than 20 years are typically considered marginal, older vessels are often used to carry other cargos like soya, but there are still several active woodchip carriers with 25 years old[6]. The research below calculates woodchip carriers with less than 25 years old (about 157 vessels). Most woodchip carriers' DWT are about 45,000 to 55,000, this size of woodchip carrier accounting for over 60% of the total available woodchip carriers in 2012.We understand that 8 to 12 vessels will be built in China with 70,000 DWT (the largest size in the history), and they are scheduled to deliver in 2014[6].

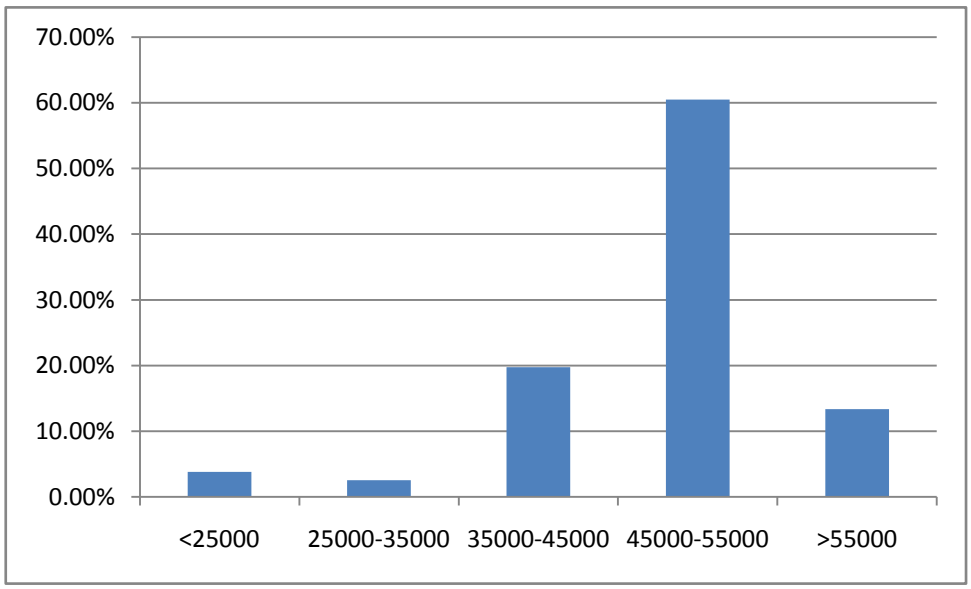

Figure 10 – Size of woodchip carriers, 2011
Source:International Pulpwood Trade Review, 2012.

2.4 Ship age in the current market

Some dissertations talked about log vessel age, like Analysis on Timber Import Market and Timber-Ship Type Demonstration written by Liu Jian, and The Research on Log Import Shipping Market of Our Country and Ship Type Evaluation written by

Lin Zhen. These dissertations figured out the log vessels' age by calculating the average age of all the available single deck bulk carriers in the market. But I think this method is not available, at least for the current market. As we know, single deck bulk carriers can be used to carry logs, but there are two very important factors they did not consider: damage to the vessel when loading and discharging logs, and the efficiency of the crane on the vessel. These two factors are highly influenced by the age of the vessels, the damage may easily stop an old vessel's working, but a yang vessel can easily handle the damage, and it may not affect the working. The efficiency of the crane on the vessel affect the efficiency of loading and discharging, yang vessels always has better cranes and save costs. Due to these reasons, charterers always look for yang vessels with less than 7 years old. A vessel over 10 years old can hardly accepted by charterers only if it has a strong competitive advantage in freight. The figures below shows 82% of the vessel loading logs in USA and Canada have the age less than 11 years old, 56% of the vessel loading logs in New Zealand were less than 6 years old. Single deck bulk carriers with yang age can used to carry logs, after they became old; they were suggested to carry other cargos like ore, grain and coal.

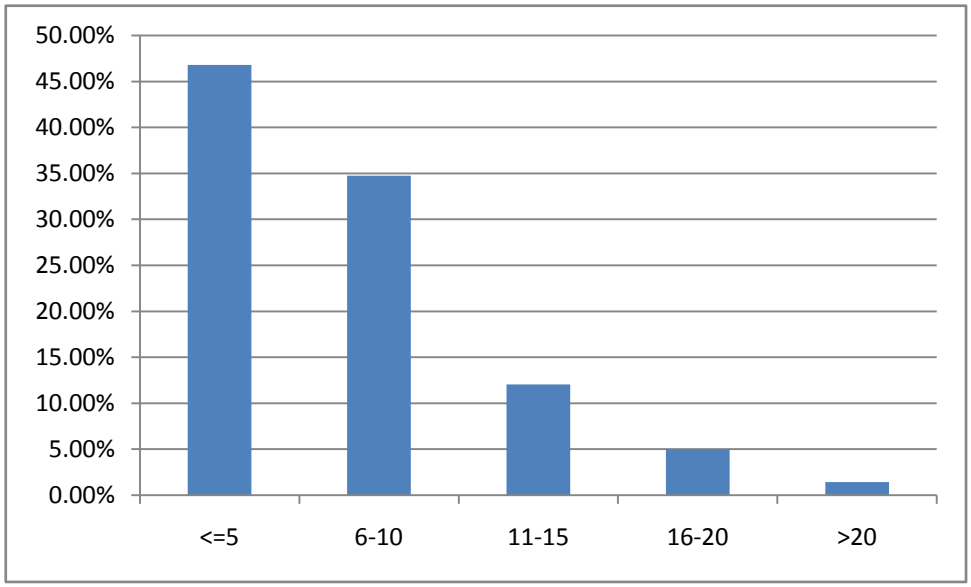

Figure 11– Vessel age from USA and CanadaJanuary 2012 to March 2013

Source: CNBM Forest Products LTD.

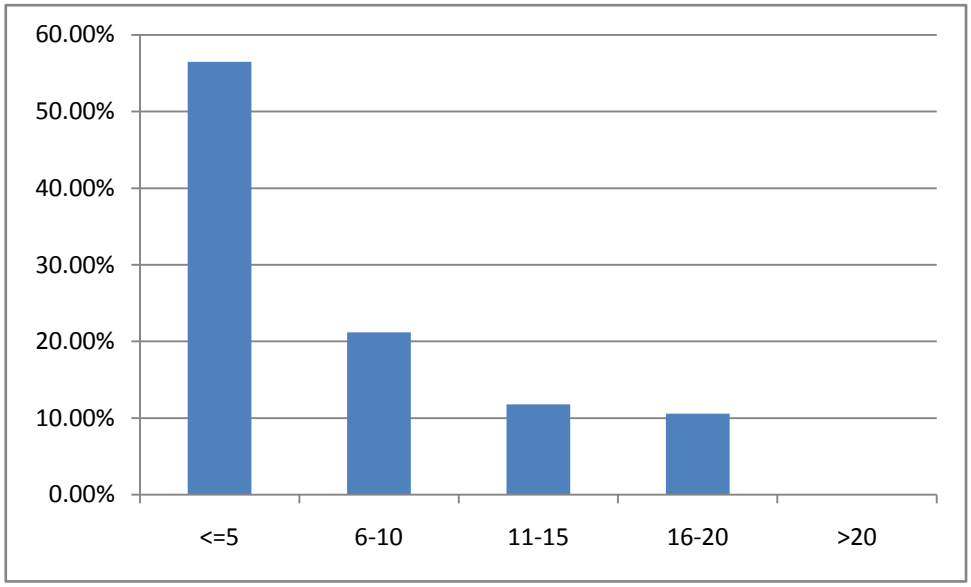

Figure 12– Vessel age from New Zealand January 2012 to March 2013

Source: CNBM Forest Products LTD.

The research below is about the age of woodchip carriers in the current market. This research count the vessels built from 1988 to 2011, totally 157 vessels. The figure below shows the number of new building vessels every 5 years has a steady decline about 3 to 4 vessels, except the year from 1998 to 2002. The number of new building

vessels sharply decreased during 1998 to 2002, with no vessel delivered in year 2000. The only other year with no vessel delivered was the year 2011.Woodchip carriers were all been built in Japan, and most of them were under control of Japanese companies. MOL controlled 34% numbers of woodchip carriers, NYK controlled 30% and K Line controlled 10%. The vessels carry woodchips to China are comparatively older. Most of the new delivered vessels are under long contract with Japanese companies, but with the decreasing of Japanese woodchip import market, many Japanese ship owner are willing to operate their carriers in Chinese woodchip market.

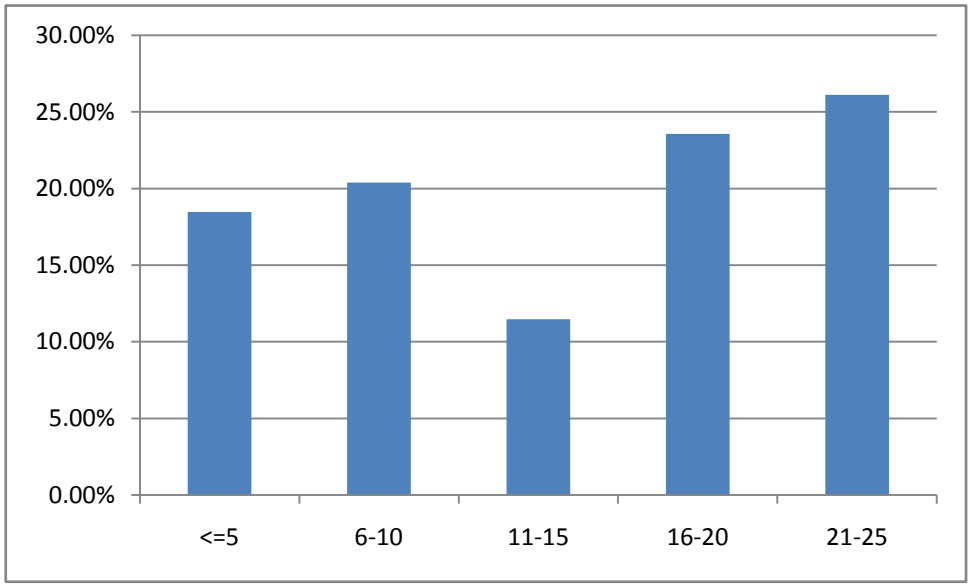

Figure 13–Age of woodchip carriers in the current market

Source:International Pulpwood Trade Review, 2012.

3. Forecast of China's wood import market

3.1 Prediction model

There are many kinds of prediction model; some of them are widely used. Here I cite the method in Analysis on Timber Import Market and Timber-Ship Type Demonstration, written by Liu Jian, 2003. This method includes trend moving average forecasting model and index moving forecasting model.

3.1.1 Trend Moving Average Forecasting Model

Build model

$Y_t = X_t + (N-1)/2 * b_t$

$Y_{t+1} = Y_t + b_t$

$X_t = (y_t + y_{t-1} + \cdots + y_{t-n+1})/N$

$b_t = (N+2)/N/(N*N-1)*\{(N-1)/2*y_t + (N-3)/2*y_{t-1} + \cdots + (N-N*2+1)/2*y_{t-n+1}\}$

3.1.2 Index Smoothing Forecasting Method

Build model

Here I use smoothing constant a = 0.6 and the average of first three years as initial value.

$s_0^{[1]} = 1/3*(Y_1 + Y_2 + Y_3)$

Single exponential smoothing formula: $s_t^{[1]} = a*y_t + (1-a)s_{t-1}^{[1]}$

Double exponential smoothing formula: $s_t^{[2]} = a*s_t^{[1]} + (1-a)s_{t-1}^{[2]}$

And $s_0^{[2]} = s_0^{[1]}$

Build linear prediction model: $Y^{*}_{t+T} = a_t + b_t*T$

For this model, $a_t = 2*s_t^{[1]} - s_t^{[2]}$;$b_t = s_t^{[1]} - s_t^{[2]}$

3.2Data collection

The table below shows the basic data of log import quantity from year 1993 to 2011.

Table 1 – China: Log Import Quantity 1993-2011 (million m^3)

Year	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Q	3.5	3.3	2.6	2.6	4.5	4.8	10.1	13.6	16.9	24.6
Year	2003	2004	2005	2006	2007	2008	2009	2010	2011	
Q	25.5	26.3	29.4	32.2	37.1	29.6	28.1	34.4	42.3	

Source: Customhouse Statistic Yearbook

Table 2 – China: Lumber Import Quantity 2001-2011 (million m^3)

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Q	4.04	5.40	5.51	6.00	5.97	6.07	6.49	7.05	9.86	14.71	21.52

Source: Customhouse Statistic Yearbook

3.3 Analysis

3.3.1 Trend Moving Average Forecasting for Log Import

Here I build model with N=19 (19 years from 1993 to 2011)

Firstly, calculate X_t and b_t

$X_{t=19}$=(3.5+3.3+2.6+2.6+4.5+4.8+10.1+13.6+16.9+24.6+25.5+26.3+29.4+32.2+37.1

+29.6+28.1+34.4+42.3)/19

= 19.55

$b_t = 21/N/(N*N-1)*\{(N-1)/2*y_t + (N-3)/2*y_{t-1} + \cdots + (N-37)/2*y_{t-18}\}$

= 4

$Y_{t=19} = 19.55 + (19-1)/2 * 4$

= 55.55

Forecast the import quantity in 2015:

$$Y_{t=19+4} = 19.55 + 4 * 4 = 35.55 \text{ (million } m^3\text{)}$$

Forecast the import quantity in 2020:

$$Y_{t=19+9} = 19.55 + 4 * 9 = 55.55 \text{ (million } m^3\text{)}$$

3.3.2 Index Smoothing Forecasting for Log Import

$s_0^{[1]}= 1/3*(3.5+3.3+2.6) = 3.13$

According to single exponential smoothing formula: $s_t^{[1]} = a*y_t + (1-a)s_{t-1}^{[1]}$

$s_1^{[1]} = a*y_1 + (1-a)s_0^{[1]}=3.32$ $s_2^{[1]} = a*y_2 + (1-a)s_1^{[1]}= 3.33$

$s_3^{[1]} = a*y_3 + (1-a)s_2^{[1]}=2.87$ $s_4^{[1]} = a*y_4 + (1-a)s_3^{[1]}= 2.72$

$s_5^{[1]} = a*y_5 + (1-a)s_4^{[1]}=3.77$ $s_6^{[1]} = a*y_6 + (1-a)s_5^{[1]}= 4.40$

$s_7^{[1]} = a*y_7 + (1-a)s_6^{[1]}=7.84$ $s_8^{[1]} = a*y_8 + (1-a)s_7^{[1]}= 11.30$

$s_9^{[1]} = a*y_9 + (1-a)s_8^{[1]}=14.64$ $s_{10}^{[1]} = a*y_{10} + (1-a)s_9^{[1]}= 20.63$

$s_{11}^{[1]} = a*y_{11} + (1-a)s_{10}^{[1]}=23.53$ $s_{12}^{[1]} = a*y_{12} + (1-a)s_{11}^{[1]}= 25.20$

$s_{13}^{[1]} = a*y_{13} + (1-a)s_{12}^{[1]}=27.70$ $s_{14}^{[1]} = a*y_{14} + (1-a)s_{13}^{[1]}= 30.38$

$s_{15}^{[1]} = a*y_{15} + (1-a)s_{14}^{[1]}=35.40$ $s_{16}^{[1]} = a*y_{16} + (1-a)s_{15}^{[1]}= 31.50$

$s_{17}^{[1]} = a*y_{17} + (1-a)s_{16}^{[1]}=29.44$ $s_{18}^{[1]} = a*y_{18} + (1-a)s_{17}^{[1]}= 32.39$

$s_{19}^{[1]} = a*y_{19} + (1-a)s_{18}^{[1]}=38.35$

According to double exponential smoothing formula: $s_t^{[2]} = a*s_t^{[1]} + (1-a)s_{t-1}^{[2]}$

And $s_0^{[2]}=s_0^{[1]}$

$s_1^{[2]} = a*s_1^{[1]} + (1-a)s_0^{[2]}= 3.24$ $s_2^{[2]} = a*s_2^{[1]} + (1-a)s_1^{[1]}=3.29$

$s_3^{[2]} = a*s_3^{[1]} + (1-a)s_2^{[2]}= 3.04$ $s_4^{[2]} = a*s_4^{[1]} + (1-a)s_3^{[1]}=2.85$

$s_5^{[2]} = a*s_5^{[1]} + (1-a)s_4^{[2]}= 3.40$ $s_6^{[2]} = a*s_6^{[1]} + (1-a)s_5^{[1]}=4.00$

$s_7^{[2]} = a*s_7^{[1]} + (1-a)s_6^{[2]}= 6.31$ $s_8^{[2]} = a*s_8^{[1]} + (1-a)s_7^{[1]}=9.31$

$s_9^{[2]} = a*s_9^{[1]} + (1-a)s_8^{[2]}= 12.51$ $s_{10}^{[2]} = a*s_{10}^{[1]} + (1-a)s_9^{[1]}=17.38$

$s_{11}^{[2]} = a*s_{11}^{[1]} + (1-a)s_{10}^{[2]}= 21.07$ $s_{12}^{[2]} = a*s_{12}^{[1]} + (1-a)s_{11}^{[1]}=23.55$

$s_{13}^{[2]} = a*s_{13}^{[1]} + (1-a)s_{12}^{[2]}= 26.04$ $s_{14}^{[2]} = a*s_{14}^{[1]} + (1-a)s_{13}^{[1]}=28.64$

$s_{15}^{[2]} = a*s_{15}^{[1]} + (1-a)s_{14}^{[2]} = 32.10$ $s_{16}^{[2]} = a*s_{16}^{[1]} + (1-a)s_{15}^{[1]} = 31.74$

$s_{17}^{[2]} = a*s_{17}^{[1]} + (1-a)s_{16}^{[2]} = 30.36$ $s_{18}^{[2]} = a*s_{18}^{[1]} + (1-a)s_{17}^{[1]} = 31.58$

$s_{19}^{[2]} = a*s_{19}^{[1]} + (1-a)s_{18}^{[2]} = 35.64$

So: $a_{19} = 2*s_{19}^{[1]} - s_{19}^{[2]} = 41.06$ $b_{19} = s_{19}^{[1]} - s_{19}^{[2]} = 2.71$

$Y_{19+T} = a_{19} + b_{19}*T = 41.06 + 2.71*T$

Forecast the import quantity in 2015:

$$Y_{19+4} = 41.06 + 2.71*4 = 51.90 \text{ (million } m^3\text{)}$$

Forecast the import quantity in 2020:

$$Y_{19+9} = 41.06 + 2.71*9 = 65.45 \text{ (million } m^3\text{)}$$

3.3.3 Trend Moving Average Forecasting for Lumber Import

Here I build model with N=11 (11 years from 2001 to 2011)

Firstly, calculate X_t and b_t

$X_{t=11} = (4.04 + 5.40 + 5.51 + 6.00 + 5.97 + 6.07 + 6.49 + 7.05 + 9.86 + 14.71 + 21.52)/11$

$= 8.42$

$b_t = 13/N/(N*N-1)*\{(N-1)/2*y_t + (N-3)/2*y_{t-1} + \cdots + (N-21)/2*y_{t-10}\}$

$= 1.38$

$Y_{t=11} = 8.42 + (11-1)/2 * 1.38$

$= 15.32$

Forecast the import quantity in 2015:

$$Y_{t=11+4} = 15.32 + 1.38 * 4 = 20.84 \text{ (million } m^3\text{)}$$

Forecast the import quantity in 2020:

$$Y_{t=11+9} = 15.32 + 1.38 * 9 = 27.74 \text{ (million } m^3\text{)}$$

3.3.4 Index Smoothing Forecasting for Lumber Import

$s_0^{[1]} = 1/3*(4.04 + 5.40 + 5.51) = 4.98$

According to single exponential smoothing formula: $s_t^{[1]} = a*y_t + (1-a)s_{t-1}^{[1]}$

$s_1^{[1]} = a*y_1 + (1-a)s_0^{[1]} = 4.42$ $s_2^{[1]} = a*y_2 + (1-a)s_1^{[1]} = 5.00$

$s_3^{[1]} = a*y_3 + (1-a)s_2^{[1]} = 5.31$ $s_4^{[1]} = a*y_4 + (1-a)s_3^{[1]} = 5.73$

$s_5^{[1]} = a*y_5 + (1-a)s_4^{[1]} = 5.87$ $s_6^{[1]} = a*y_6 + (1-a)s_5^{[1]} = 5.99$

$s_7^{[1]} = a*y_7 + (1-a)s_6^{[1]} = 6.29$ $s_8^{[1]} = a*y_8 + (1-a)s_7^{[1]} = 6.75$

$s_9^{[1]} = a*y_9 + (1-a)s_8^{[1]} = 8.62$ $s_{10}^{[1]} = a*y_{10} + (1-a)s_9^{[1]} = 12.27$

$s_{11}^{[1]} = a*y_{11} + (1-a)s_{10}^{[1]} = 17.82$

According to double exponential smoothing formula: $s_t^{[2]} = a*s_t^{[1]} + (1-a)s_{t-1}^{[2]}$

And $s_0^{[2]} = s_0^{[1]}$

$s_1^{[2]} = a*s_1^{[1]} + (1-a)s_0^{[2]} = 4.64$ $s_2^{[2]} = a*s_2^{[1]} + (1-a)s_1^{[1]} = 4.86$

$s_3^{[2]} = a*s_3^{[1]} + (1-a)s_2^{[2]} = 5.13$ $s_4^{[2]} = a*s_4^{[1]} + (1-a)s_3^{[1]} = 5.49$

$s_5^{[2]} = a*s_5^{[1]} + (1-a)s_4^{[2]} = 5.72$ $s_6^{[2]} = a*s_6^{[1]} + (1-a)s_5^{[1]} = 5.88$

$s_7^{[2]} = a*s_7^{[1]} + (1-a)s_6^{[2]} = 6.13$ $s_8^{[2]} = a*s_8^{[1]} + (1-a)s_7^{[1]} = 6.50$

$s_9^{[2]} = a*s_9^{[1]} + (1-a)s_8^{[2]} = 7.77$ $s_{10}^{[2]} = a*s_{10}^{[1]} + (1-a)s_9^{[1]} = 10.74$

$s_{11}^{[2]} = a*s_{11}^{[1]} + (1-a)s_{10}^{[2]} = 14.88$

So: $a_{11} = 2*s_{11}^{[1]} - s_{11}^{[2]} = 20.76$ $b_{11} = s_{11}^{[1]} - s_{11}^{[2]} = 2.94$

$Y_{11+T} = a_{11} + b_{11}*T = 20.76 + 2.94*T$

Forecast the import quantity in 2015:

$$Y_{11+4} = 20.76 + 2.94*4 = 32.52 \text{ (million } m^3\text{)}$$

Forecast the import quantity in 2020:

$$Y_{11+9} = 20.76 + 2.94*9 = 47.22 \text{ (million } m^3\text{)}$$

3.3.5 Log Import Forecast Result Analysis

The forecast get two results through two different forecast methods. Through trend moving average forecasting method, the import quantity in 2015 decreased, but through index smoothing forecasting method, the import quantity in 2015 increased. The result of trend moving average forecasting shows the import quantity will

decrease in 2012 and keep growing with 4 million cubic meters every year, the result of index smoothing forecasting shows the import quantity will keep increasing in 2012 and grow with 2.71 million cubic meters every year. In order to combine both of the two results and make the forecast more approach to reality, here I take the average value of these two results.

Forecast the import quantity in 2015:

$$Y_{2015} = (35.55+51.90)/2 = 43.73 \text{ (million } m^3\text{)}$$

Forecast the import quantity in 2020:

$$Y_{2020} = (55.55+65.45)/2 = 60.50 \text{ (million } m^3\text{)}$$

The result showsthe market will fall in 2012 to a level about 34 million cubic meters and keep growing with 3.36 million cubic meters and the market will restore to the level of 2011 in 2015 (about 43.7 million m^3).

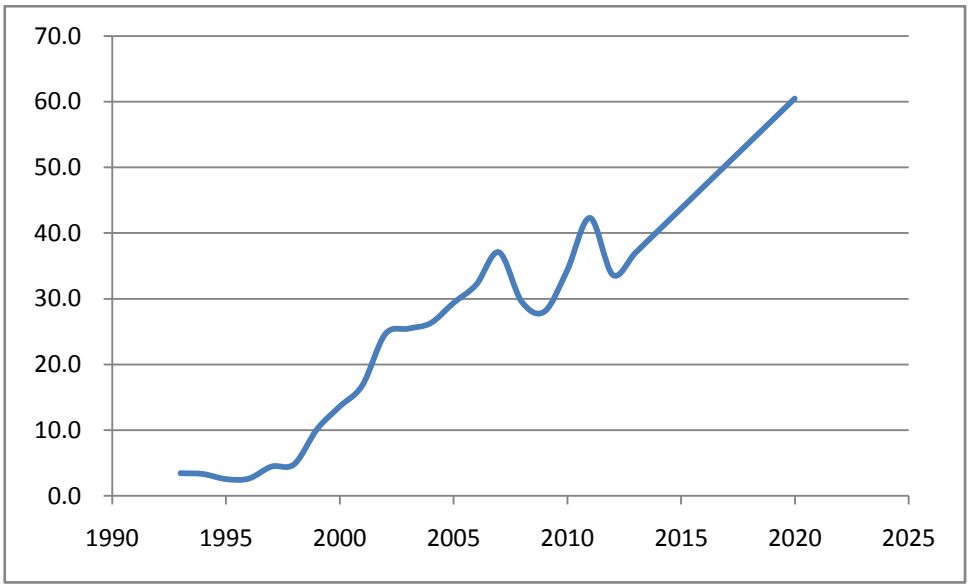

Figure 14 – Forecast Log Import Quantity

3.3.6 Lumber Import Forecast Result Analysis

Same as forecast of wood import quantity, the forecast get two results through two different forecast methods. The result of trend moving average forecasting shows the

import quantity will decrease in 2012 and keep growing with 1.38 million cubic meters every year, the result of index smoothing forecasting shows the import quantity will keep increasing in 2012 and grow with 2.94 million cubic meters every year. In order to combine both of the two results and make the forecast more approach to reality, here I take the average value of these two results.

Forecast the import quantity in 2015:

$$Y_{2015} = (20.84+32.52)/2 = 26.68 \text{ (million } m^3\text{)}$$

Forecast the import quantity in 2020:

$$Y_{2020} = (27.74+47.22)/2 = 37.48 \text{ (million } m^3\text{)}$$

The result shows the market will fall in 2012 to a level about 20.2 million cubic meters and keep growing with 2.16 million cubic meters and the market will restore to the level of 2011 in 2013 (about 22.36 million m^3). Compared with log import market, both of them will decrease in 2012, but lumber import market will regain the level of 2011 faster.

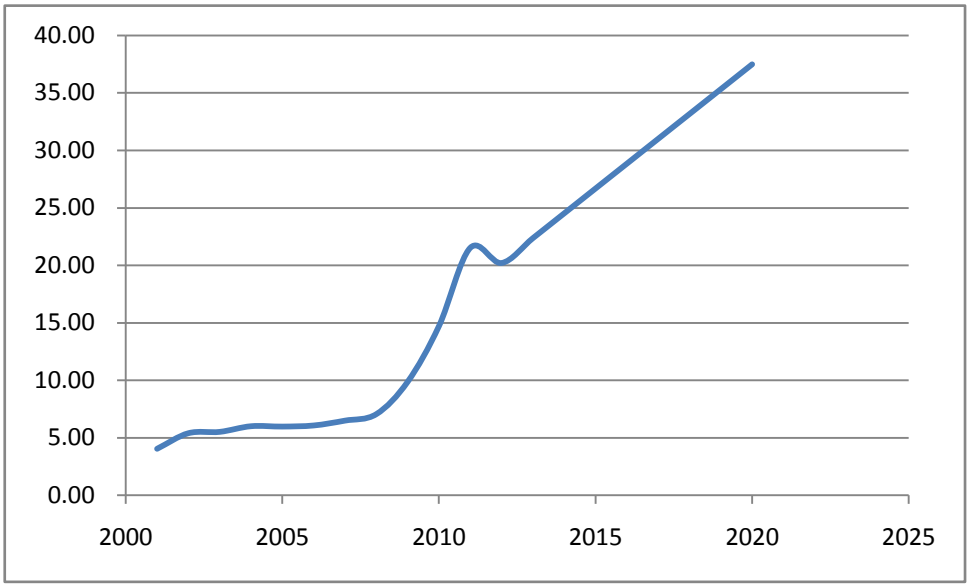

Figure 15 – Forecast Lumber Import Quantity

3.4 Conclusion

Quantity of China's log import and lumber import is increasing. This increasing is mainly pushed by the demand of domestic wood market. Firstly, Natural Forest Protection Project since 1998 made a fruitful effect and limited the domestic supply of wood. Secondly, Chinese government invested more capital in infrastructure construction and many priority projects had begun, these huge projects increased the demand of wood. Thirdly, with the rapid development of the national economy, the continuous improvement of people's living standards, people require higher quality of house renovation; this stimulated the demand of high-grade lumber. One other factor stimulated the demand came from the WenChuan earthquake 2008, this earthquake expose the problems in building industry, buildings were required to use better materials with better building craft. The forecasting result shows both the quantity of China's log import and lumber import will keep growing, with a little decreasing in 2012. According to this forecast, wood import companies can keep expanding their business. My suggestion for CNBM Forest Products LTD. is to increase import quantity, keep good relationship with suppliers in America and Canada, insist its vertical integration.

4. Selection of log vessel

4.1 Background and information

CNBM Forest Products LTD. is one of the players in China's wood import market. The company import logs and lumbers, logs are shipped by single deck bulk carriers and lumbers are shipped by containers. CNBM Forest Products LTD. is a large cargo owner and chart vessels. Because the quantity of lumber is low, the company book slot from shipping company, only several containers a month. The research below is about single deck bulk carriers chartering. With adequate supply of logs, the company charts about one vessel per month, but the choice of vessel is far different from ship owners' method. For ship owners, they have to take many index into account, for example, they have to calculate total annual income, total annual cost, annual cash flow, payback period, NPV, profit and so on. These indexes can help ship owners making decisions. To calculating these indexes, ship owners have to know all the costs (like ship building price, speed, depreciation, port charge, oil cost, manage cost and so on), and make an acceptable freight. This method can optimize ship size in a certain route for shipping companies. But as an importer, CNBM Forest Products LTD. does not think in that way. The company also facing problems in chartering vessels, a good decision can save many costs.

For the company, it mainly consider following factors: time period available, age of the vessel, DWT, classic, flag, freight, crane, log shipping experience, ship yard, stanchion height and the location of the vessel.The most important factor is available time for vessel; the first thing that charterer has to do is find the vessels which are

available to the lay/can. After that, charterer takes all the details of the vessel into account and finally chooses a best one in current situation. The purpose of choosing a best vessel is to reach a lowest unit cost of log. In America, the unit of measurement of wood is MBF, the unit cost will be $/MBF. In China, the price unit of wood is $/m^3, it is different from $/MBF, but there is a unit conversion between these two price unit: 1MBF = 2.36 m^3. This unit conversion can be used in the measurement of lumber, but it is meaningless for log measurement because logs are irregular geometrical. Before the vessel arrived, the charterer will prepare all the logs and stack in the port. Different vessel has different stowage factor, the same as logs. Hemlock is much heavier than spruce, with different collocation of hemlock and spruce the vessel can reach different level of loading. As the log is prepared and the collocation is constant, the cost for the charterer can be simplified as $/ton.

CNBM Forest Products LTD. is facing problems in choosing log vessels. There is a plenty of logs in Astoria, over 60% of them are hemlock. This collocation will easily make the vessel fully loaded and reach the summer load line. There are six vessels available in the market.

4.2 Prediction model

From charterer's point of view, lumpsum is not the only cost of chartering a vessel. The different condition of a vessel brings different level of risk. In order to deal with this problem, I use Analytic Hierarchy Process (AHP) model which is widely used.

Objective: select vessel

Criterion: vessel age, classic, flag, experience, built in, stanchion height, lifts, location and unit cost.

Project: the six vessels

This model includes three steps:

Determine each criterion's weight

Checking for consistency

Determine the scores of each alternative on each criterion

At last, choose the best one according to the final scores

4.3 Data collection

Table 3 shows the every details of each vessel which will be mainly considered by charterer.

Table 3 – Six Vessels' Detail

	MAPLE APUS	**ECO DISCOVERY**	**LILY OLDENDORFF**
Vessel age	1	14	10
Classic	NK	NK	GL
Flag	HONGKONG	MALAYSIAN	LIBERIA
Lumpsum (USD)	1.45 million	1.38 million	1.39 million
Crane	Electric	Electro-Hydraulic	Hydraulic
Experience	No	Rich	High
Built in	China 2012	Japan 1999	Japan 2003
Summer Draft (m)	10.5	9.865	10.568
DWT on Summer load line	37,076	33,164	32,262
Stanchion height (m)	7.5-8.5	9	7-8
Lifts (per crane per hour)	8	10	12
Location	Japan	America	China
Unit cost (USD/ton)	39.11	41.61	43.08
	MAPLE AMETHYST	**VANCOUVER**	**YANGTZE GRACE**
Vessel age	1	3	2
Classic	GL	KR	LRS
Flag	HONGKONG	Marshall Island	HONGKONG
Lumpsum (USD)	1.295 million	1.42 million	1.285 million
Crane	Electric	Electro-Hydraulic	Electro-Hydraulic
Experience	No	Low	Low
Built in	China 2012	China 2010	China 2011
Summer Draft (m)	10.12	10.116	10.15
DWT on Summer load line	32,354	35,191	32,500

Stanchion height (m)	7.5-8.5	8	8
Lifts (per crane per hour)	7-8	8	11
Location	Canada	America	China
Unit cost (USD/ton)	40.03	40.35	39.54

Source: CNBM Forest Products LTD.

4.3Analysis

4.3.1 Determine each criterion's weight

The objective is to select vessel with lowest cost, unit cost is the most intuitive performance, but it is not the only factor influence the cost. In log shipping, lumpsum is the most common form; load more means a lower cost. Lifts per crane per hour reflect the efficiency of crane, a vessel with bad cranes can generated a lot of additional costs. A vessel without any experience can cause a serious of problems, and slow down the loading or discharging operation. According to the charter experience, vessels built in Japan are more reliable, but vessels built in China are not welcomed by stevedores. The other factors are not so important, but they have to be considered.

Built pairwise comparison matrices:

Table 4 –Pairwise comparison matrices

	Age	Classic	Flag	Ex	Built in	Stanchion	Lifts	Location	Unit cost
Age	1	2	3	1/5	1/4	1/3	1/6	1/2	1/8
Classic	1/2	1	2	1/6	1/5	1/4	1/7	1/3	1/9
Flag	1/3	1/2	1	1/7	1/6	1/5	1/8	1/4	1/10
Ex	5	6	7	1	2	3	1/2	4	1/4
Built in	4	5	6	1/2	1	2	1/3	3	1/5
Stanchion	3	4	5	1/3	1/2	1	1/4	2	1/6
Lifts	6	7	8	2	3	4	1	5	1/3
Location	2	3	4	1/4	1/3	1/2	1/5	1	1/7
Unit cost	8	9	10	4	5	6	3	7	1

The entry in row i and column j of A, labeled a_{ij}, indicates how much more (or less)

important objective i is than objective j. Importance is measured on an integer-value 1-10 scale, 1 means objective i and j are equally important, 10 means objective i is absolutely more important than j.

$$A = \begin{pmatrix} 1 & 2 & 3 & 1/5 & 1/4 & 1/3 & 1/6 & 1/2 & 1/8 \\ 1/2 & 1 & 2 & 1/6 & 1/5 & 1/4 & 1/7 & 1/3 & 1/9 \\ 1/3 & 1/2 & 1 & 1/7 & 1/6 & 1/5 & 1/8 & 1/4 & 1/10 \\ 5 & 6 & 7 & 1 & 2 & 3 & 1/2 & 4 & 1/4 \\ 4 & 5 & 6 & 1/2 & 1 & 2 & 1/3 & 3 & 1/5 \\ 3 & 4 & 5 & 1/3 & 1/2 & 1 & 1/4 & 2 & 1/6 \\ 6 & 7 & 8 & 2 & 3 & 4 & 1 & 5 & 1/3 \\ 2 & 3 & 4 & 1/4 & 1/3 & 1/2 & 1/5 & 1 & 1/7 \\ 8 & 9 & 10 & 4 & 5 & 6 & 3 & 7 & 1 \end{pmatrix}$$

Normalized pairwise comparison matrices A to get A*

$$a_{ij}{}^{*} = \frac{a_{ij}}{\sum_{i=1}^{n} a_{ij}}$$

$$A^{*} = \begin{pmatrix} 0.0335 & 0.0533 & 0.0652 & 0.0233 & 0.0201 & 0.0193 & 0.0291 & 0.0217 & 0.0515 \\ 0.0168 & 0.0267 & 0.0435 & 0.0194 & 0.0161 & 0.0145 & 0.0250 & 0.0144 & 0.0457 \\ 0.0112 & 0.0133 & 0.0217 & 0.0166 & 0.0134 & 0.0116 & 0.0219 & 0.0108 & 0.0412 \\ 0.1676 & 0.1600 & 0.1522 & 0.1164 & 0.1606 & 0.1736 & 0.0874 & 0.1733 & 0.1029 \\ 0.1341 & 0.1333 & 0.1304 & 0.0582 & 0.0803 & 0.1157 & 0.0583 & 0.1300 & 0.0823 \\ 0.1006 & 0.1067 & 0.1087 & 0.0388 & 0.0402 & 0.0579 & 0.0437 & 0.0866 & 0.0686 \\ 0.2011 & 0.1867 & 0.1739 & 0.2328 & 0.2410 & 0.2314 & 0.1749 & 0.2166 & 0.1372 \\ 0.0670 & 0.0800 & 0.0870 & 0.0291 & 0.0268 & 0.0289 & 0.0350 & 0.0433 & 0.0588 \\ 0.2682 & 0.2400 & 0.2174 & 0.4655 & 0.4016 & 0.3472 & 0.5247 & 0.3032 & 0.4117 \end{pmatrix}$$

Estimate the weight for criterion i, as average of the entries in row i of A*

$$W_i = \frac{\sum_{j=1}^{n} a_{ij}{}^{*}}{n}$$

Table 5 –Weight of criterion

Age	Classic	Flag	Ex	Built in	Stanchion	Lifts	Location	Unit cost
0.0352	0.0247	0.0180	0.1438	0.1025	0.0724	0.1995	0.0507	0.3533

4.3.2Checking for consistency

AW = A * W

$$AW = \begin{pmatrix} 0.3197 \\ 0.2254 \\ 0.1671 \\ 1.4066 \\ 0.9804 \\ 0.6758 \\ 1.9830 \\ 0.4637 \\ 3.5120 \end{pmatrix} \qquad W = \begin{pmatrix} 0.0352 \\ 0.0247 \\ 0.0180 \\ 0.1438 \\ 0.1025 \\ 0.0724 \\ 0.1995 \\ 0.0507 \\ 0.3533 \end{pmatrix}$$

$$\lambda_{max} = \sum_{i=1}^{n} \frac{(AW)_i}{nW_i}$$

$$\lambda_{max} = \frac{0.3197}{9 \times 0.0352} + \frac{0.2254}{9 \times 0.0247} + \frac{0.1671}{9 \times 0.0180} + \frac{1.4066}{9 \times 0.1438} + \frac{0.9804}{9 \times 0.1025} + \frac{0.6758}{9 \times 0.0724} + \frac{1.9830}{9 \times 0.1995} + \frac{0.4637}{9 \times 0.0507} + \frac{3.5120}{9 \times 0.3533}$$

$$= 9.4698$$

Compute the constancy index (CI)

$$\text{CI} = \frac{\lambda_{max} - n}{n - 1} = \frac{9.4698 - 9}{8} = 0.0587$$

Compute the constancy ratio (CR)

Table 6 – RI

n	2	3	4	5	6	7	8	9	10
RI	0.00	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.51

CR = CI/RI = 0.0587/1.45 = 0.0405

CR < 0.10

This shows matrix A does not exhibit any serious inconsistencies.

4.3.3 Determine the scores of each alternative on each criterion

Table 7 – Score of each vessel on each criterion

	Age	Classic	Flag	Ex	Built in	Stanchion	Lifts	Location	Unit cost
MAPLE APUS	8	8	7	2	5	7	4	6	8
ECO DISCOVERY	2	8	6	9	9	8	8	9	6
LILY OLDENDORFF	4	8	5	8	9	7	9	7	5
MAPLE AMETHYST	8	8	7	2	5	7	3	8	7
VANCOUVER	6	8	6	5	5	7	4	9	7
YANGTZE GRACE	7	8	7	5	5	7	8	7	8

4.4 Conclusion

Score of each vessel on each criterion multiply weight is the total score of each vessel.

Table 8 – Total score of each vessel

MAPLE APUS	5.8400
ECO DISCOVERY	7.3432
LILY OLDENDORFF	6.9244
MAPLE AMETHYST	5.3886
VANCOUVER	5.9817
YANGTZE GRACE	7.0848

Table 8 shows the final score of each vessel, from this result; Eco Discovery is the best one and its anticipated loading and lashing time will be 7-8 days.

Yangtze Grace is a vessel with high comparative advantage, compared with Eco Discovery, the major disadvantages are low experience and it was built in China. Eco Discovery is empty in America; the freight will be a little bit higher than vessels empty in China. Different from Yangtze Grace, Eco Discovery was built in Japan, as we know, Japanese ship yards have more mature techniques, the vessels built in Japanese ship yard are more reliable. The experience in loading logs in America also

plays a very important role; it can influence the capacity, for example, how much water-absorbing should be taken, 10% or 3%, this percentage can be different according to different seasons, an experienced captain will ignore this factor in summer. The efficiency of cranes is another important factor, it influences the laytime, and many problems may happendue to the bad performance of cranes. In America, the cost of hiring one gang is about 10,000 USD/day and it will be 2,800USD/day higher in weekends and holidays, we usually hire 3 gangs per day during log loading and hire 4 gangs in the last day; the usual loading time will be 7-8 days (with over 10 lifts/hour) for a log vessel with 33,000 DWT, if the cranes are in bad performance (under 8 lifts/hour), the loading time will last over 10 days, and the cost in loading port will be much higher. Lily Oldendorff is a well-designed vessel; her cranes are the best among these vessels and her combination property is outstanding; the anticipated loading and lashing time is only 7 days; the only disadvantage for Lily Oldendorff is the high lumpsum. If the company charter Lily Oldendorff, the extra charges will be very low but the freight will be high.

The three vessels mentioned above have strong comparative advantages, but under the purpose of reducing cost, Eco Discovery is suggested to charter. Yangtze Grace was built in China, although her cranes have the speed about 11 lifts per hour but many other equipment are in alarming condition like steel wire. Lily Oldendorff is a good vessel with higher freight, if the freight can be lower after further negotiations, she will be the first choice.

5.Summary and conclusion

Compared with other dry bulk freight market like iron ore and coal, China's wood import market is fresh. Both the import quantity and the tonnage of the vessel are smaller. But with the rapid development of the national economy, the continuous improvement of people's living standards and the effect on national implementation of the Natural Forest Protection Project, China's wood import market will keep growing.

The analysis of China's log import market shows that logs from America and Canada are becoming popular. Russia once increased the log export tariff and America took the opportunity to control more market share, the export tariff in Russia decreased only after Russia joined the WTO.

China's lumber import market developed later than log market, but it expands faster. Compared with logs, lumbers are regular, easier to measure and easier to transport. Lumbers with small quantity can be shipped by containers, this make lumber import operate easier.

China's woodchip import market is also fresh, only few companies are operating this business and most of the woodchip carriers are controlled under Japanese companies and many of them are under log time contracts. CNBM Forest Products LTD. is now developing woodchip import business, but with the low profit of pulp mills, we don't know whether the new project can bring good profit.

CNBM Forest Products LTD. is always facing problems in charting vessels. The latest trip from America to China is unfavorable, all the four cranes were refused by

stevedores, the captain wasn’t on the vessel during the loading time and he refused to berth outside the Yangtze River because the dispute of bunker expenses between shipowner and disponent owner. From the experience of chartering, choose a better vessel in the beginning is a very important task. The choice determines the extra cost directly. The company hopes to avoid too much extra cost and minimize the shipping cost, but many extra costs are unpredictable at the beginning, the only certain cost is the freight. This dissertation helps the company make decision on choosing vessels under the current situation and the strategy of the company.

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