

Research Article

The Risk Assessment of China's Timber Import Based on SWI Index

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Abstract: Derived by the demand of domestic economy and forest products export, timber import shows the features of high concentration and strong dependence. Thus the risk of China's timber import significantly increases. Based on SWI Index, we construct the short-term and long-term timber risk index from resource risk, country risk, market risk, transportation risk etc. Using this index, we make a more comprehensive risk assessment and find out the trend and factors of risk. The results of index construction and estimation indicate that China's timber import generally shows the trend from high risk to low risk. Besides, it also points out that the majority of new timber-importing countries are those developing countries with high country risk and high resources risk. These factors may cause considerable potential risks. Finally, the study gives policy recommendations for reducing the risk of timber import.

Keywords: RTML, RTMS, SWI index, timber import

INTRODUCTION

Timber import is an effective way to deal with the contradiction of supply and demand of timber as well as the problem caused by insufficient timber resources in China. Since 2000, given the implementation of zero-tariff-rates policy of timber import, the amount of timber import has grown rapidly, leading to the increasing proportion of import timber among the whole supply of timber in the country, which increases from 35.1% in 2002 to 51.5%. The safety of timber import therefore becomes an important factor in the aspect of sustainable development of the industry and even becomes important for the economy development of the country.

At the same time, in the purpose of protecting local timber resource as well as ecological security and promoting the development of domestic timber industry, timber-exporting-countries around the world carry out various policies to restrict timber exportation. As for China, the main country we import timber from is Russia. Since 2006, the Russian government has been raising the import tariff of raw timber. In 2007, the tariff has once been up to 20%. Gabon started to adapt export quota system of raw timber in 2007. Meanwhile, Oceania district and South-east Asia as traditional places of timber export also developed a series of policies to restrict timber export and to further protect domestic timber resource. Because of the trade barriers set by the timber-exporting-countries, global supply of timber was reduced significantly, resulting an evident increase of timber price in the international market. The timber price in the international market is \$175.29 /m³

in 2007, which increases by 21.5% compared with the price in 2006. Obviously the rising import price increases the risk of China's timber import and in turn affects the sustainable development of the downstream industries of forestry industry. In a sentence, to secure the domestic timber import and promote the stable development of the industry, searching for an effective way to reduce the risk of timber import is of significant importance.

Current researches of China's timber import mainly concentrates on the domestic influential factors (Zhang *et al.*, 2011), structure of timber import (Yang and Nie, 2008), legal requirements on timber import (Zeng *et al.*, 2012), international illegal timber logging (Wenming, 2009) and so on. None of them has ever reached the field of risk assessment of timber import.

Most of foreign researches on security of resource supply adapt simple index algorithms to measure the risk, among them, the Herfindahl-Hirschman index and Shannon-Wiener Index are the most widely-adapted indexes. For example, Grubb *et al.* (2005), conducted a research of diversity of energy supply by using SWI. Neff (1997) studied the energy supply problem in the Asia-pacific by utilizing HHI. IEA (2004) chose HHI and SWI as fundamental indexes, adding other factors such as the degree of dependence on energy imports, the degree of political stability of energy-exporting-countries and the degree of resource consuming, to create a complex index and study the diversity of energy supply. APERC (2007) studied the degree of dependence on energy imports of different countries based on the modified SWI. Lin (2003) added the

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degree of stability and the productivity level of a district in the long term to the diversity of the index.

THE STRUCTURE OF CHINA'S TIMBER RISK INDEX

The definition of China's timber risk index: In this study, according to IEA's definition of energy supply risk, the timber import risk is defined as the risk which could lead to the disruption of the timber import (Jansen *et al.*, 2004). Along with other resources, timber resource is regarded as one of the strategic resources in the economic development. Timber import supply risk could happen in any part of the supply chain. Meanwhile, the characteristics of the risk are also diversified, complex and heterogeneous.

Based on the analysis of the timber import risks that may occur in the resource supply chain, China's timber import risk includes the following aspects: firstly, risk of import disruption due to the timber import sole structure of origin and excessive dependence of the timber-importing-countries; secondly, import risk caused by the political, economic or social environment of the timber-exporting-countries and bilateral trade friction caused by uncertainty; thirdly, the international timber market risk, which mainly caused by the fluctuation of the international timber supply and the exchange rate fluctuations; fourthly, timber transport route risk, generally considered that the longer the transportation route, the greater the uncertain risks (security, climate and other factors); fifthly, resource risk of timber-exporting-countries, which refers to whether the timber-exporting-countries can provide sustainable resources. Generally, for countries with richer resources, the more sustainable its ability to provide resources. Since the timber import sole structure of origin and excessive dependence of the timber-importing-countries are the main factors directly affect timber import, once these risks occur, it will directly lead to supply disruptions, affecting the supply of the security situation and thus the stable development of the domestic economy and other industries will be seriously affected, that is why we regard these risks as direct risks. We regard other risks as indirect risks. However, the effect of indirect risks on timber import is reflected in the direct risks first.

Meanwhile, according to the scope and the speed of influences caused by different risks, timber import risks are divided into two categories: short-term timber import risk and long-term timber import risk. Short-term timber import risk is inclined to short-term supply of imported timber availability and therefore subject to price fluctuations in the international market greatly and will lead to a significant change in the amount of timber supply in the short term. Long-term timber import risk focuses on long-term supply sustainability of imported timber, long-term risk mainly depends on the sustainable supply of domestic resources and the country's overall stability of the timber-exporting-countries.

Timber import risk index structure is based on direct risks and the indirect risks are modulating factors (Jansen *et al.*, 2004; JRC, 2010; IEA, 2004). Direct risks are measured through SWI Index, which was first applied to study biodiversity and later was introduced into the study of energy supply security by foreign scholars. SWI measures the risk of importing supplies from a quantitative point of view through evaluating the geographical diversity of sources of supply. SWI index consists of three elements: quantity of species, equilibrium and discrepancy. Due to the lack of quantitative analysis towards discrepancy, the influence of discrepancy to diversity cannot be accurately reflected. So, in this study, the diversity index uses the first two elements to measure the timber import supply risk. According to the purpose and significance of the index structure, the short-term timber import risk is measured by the diversity of the timber import structure. When the structure of timber import becomes sole and over concentrated, it may increase the risk rate of short-term timber import risk, which will affect the short-term timber import safety. Long term timber import risk is measured through the diversity of timber supply dependence. When the timber supply dependence is too high, it may increase the risk rate of long-term timber supply risks, affecting the stable development of the industry.

The structure of China's timber import risk index: According to definition of short-term risk and long term-risk, short term timber import risk factors mainly consist of the concentration risk, political risk, transportation routes risk and market risk. In terms of the risk of transportation routes, the study divides the transportation routes into two kinds: land transportation and marine transportation. Land transportation mainly serves for border trades, the main source of imports are from Russia, Kazakhstan and other land-locked countries. Based on the locations and regions of the exporting countries, we divide the transportation routes as follow: Southeast Asia route, Australia route, the Americas and Africa route, the risk of land transportation is lower than the marine transportation. Market risk is mainly caused by the timber price fluctuations in the timber-importing-countries, due to the dual demands of domestic economic growth of the timber-exporting-countries and the need for forest products exports, the influence of the former demand is greater, so the rising price of the imported timber will lead to an increase in raw material costs in the forest industry, further increasing pressure on short-term timber import, increasing the risk rate of short-term timber import risk.

Short-term timber import risk as follows:

$$RTMS = -\sum_i^n c_i m_i \ln(m_i) \tag{1}$$

$$c_i = r_i^p (1 - p_i / p_i^{\max})(1 - d_i m_i) \tag{2}$$

The proportion of the timber import quantity of China from country i accounts for China's total import is: $m_i = q_i/q$, q_i = total import quantity of a certain timber from country i , q = total import quantity of a certain timber.

Political risk index: $r_i^p = ICRG_i^p/100$, $r_i^p \in [0, 1]$, r_i^p approaches 0 as high risk, approaches 1 as low risk, ICRGPi is the political risk index of ICRG index.

Transportation risk: $d_i = l_i/l_{max}$, l_j is the distance between China and the main harbor of the timber-exporting-country j , l_{max} is the farthest distance of the timber trade transportation; P_i = price index for China to import timber from country i , p_i^{max} is the maximum of the timber price index during the calculation period.

RTMS index approaches 0 as the highest risk, RTMS approaches 1 refers to absolute stability.

Long-term timber import risk differs from short-term timber import risk, the long-term risk tends to focus on resource factors and changes in the country's overall risk in the long term. In IEA (2004) and JRC (2010) studies of energy supply safety, researchers added a country's political risk, resource risk, import dependence and other factors to SWI index, to analyze the overall energy supply risk, but it lacks the of accuracy targeted to specific resources. Forest resource is a renewable resource. Except the country's risks and the differences between countries, the sustainability of the forest resource also directly influences the safety of China's timber import. Sustainability risk of forest resources is measured by the gross production of raw timber and forest stock volume, so the resource consumption index is revised as Eq. (6).

Long-term timber import risk as follows:

$$RTML = -\sum_i^n c_i p_i \ln(p_i) \tag{3}$$

$$c_i = 1 - m_i(1 - s_i^m / s^{m,max}) \tag{4}$$

$$s_i^m = -r_i h_i m_i \ln(m_i) \tag{5}$$

$$r_i = \text{Min} \left[\left(\frac{RS_i / PR_i}{\max(RS / PR)} \right)^\alpha, 1 \right], (\alpha \geq 0) \tag{6}$$

Among the equations, the proportion of the net import of a certain timber from country i to China's aggregate consumption is:

$$p_i = \frac{q_i}{TC}$$

TC is China's aggregate consumption of a certain timber; h_i = country risk index of timber-exporting-

countries. The proportion of the net import from country i to China accounts for country i 's aggregate export: $m^i = \frac{q_i}{TI}$; resource consumption index:

$$r_i = \text{Min} \left[\left(\frac{RS_i / PR_i}{\max(RS / PR)} \right)^\alpha, 1 \right], (\alpha \geq 0)$$

Generally speaking, the value for α is 2 (Lin, 2003), RS is the stock volume of forest resource, PR is the timber output.

RTML index approaches 0 as the highest risk, RTMS approaches 1 refers to absolute stability.

THE EMPIRICAL ANALYSIS OF CHINA'S TIMBER IMPORT RISK

Short-term risks of China's timber import data sources and results:

Data description: Because of the lack of some specific data and some data is not accessible, the research of the short-term import risk of timber is confined to 2000-2012. The political risk index is from ICRG's annual political risk index.

Shown in Fig. 1, short-term risk rate of China's timber import gradually rose after 2000 and after the sharp fluctuations in 2008 and 2009, the situation was improved after the year of 2011. From 2000 to 2008, the short-term risk of China's timber imports increased due to the increase of China's timber import structure's centralization. In the year 2007, the centralization of China's import of Russian timber was up to approximately 69%, resulting in the further increase of the short-term risk of China's timber import.

Figure 1, the SWI curve shows the structure risk of timber import. Since 2008, China's timber import market was affected by the rising tariff and quota policy by part of the main timber-exporting-countries. So we turn to import timber from those timber-exporting-countries which did not implement trade barriers. In such a way, the situation of high short-term risk caused by the high centralization of the import structure was changed. In 2009, the average timber import price fell after rise in the market. The import concentration moved from Russia which has medium political risk to other medium political risk countries or less risky ones. For instance, Canada, New Zealand, Indonesia and so on. Consequently, in Fig. 1, the increase of short-term risk RTMS index is higher than that of SWI index over the same period. In 2010, short-term timber import risk rose sharply and RTMS index fell in the vicinity of 0.05. The structure risk of timber import was adjusted and reduced in the importing market, import share of Russia decreased from 60 to 41%. However, the transfer of timber import mainly distribute in ocean routes and countries have high transportation risk. For

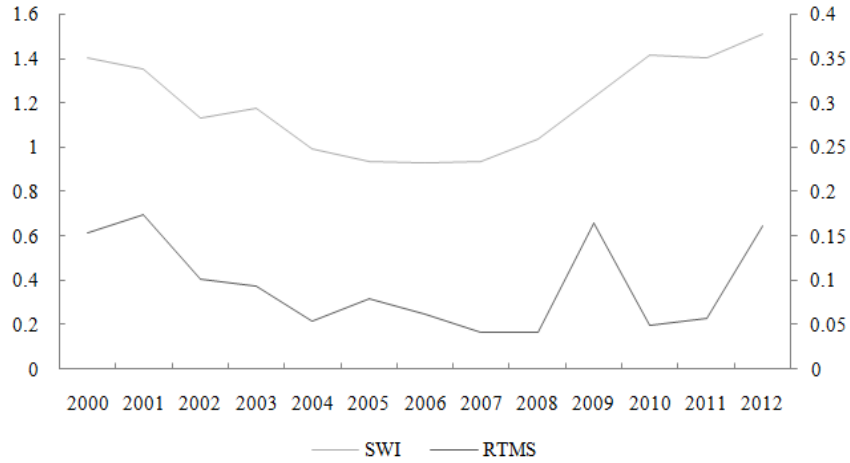


Fig. 1: Short-term risks of China's timber import from 2000 to 2012

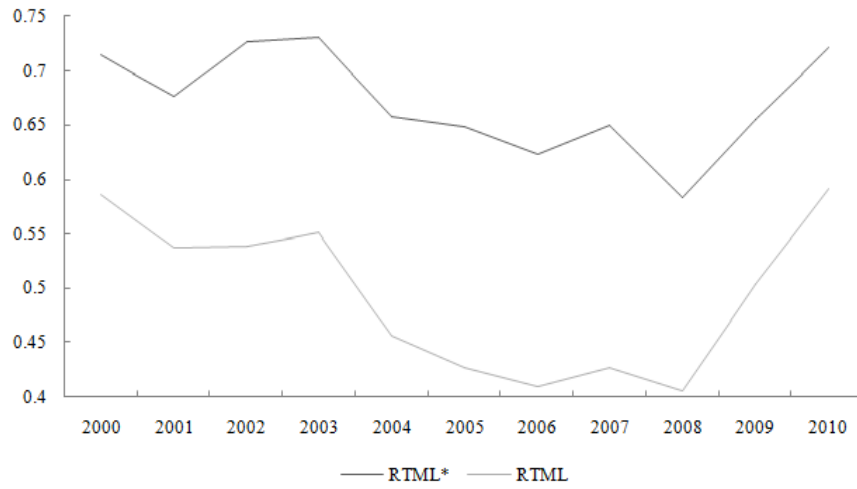


Fig. 2: Long-term risk of China's timber import from 2000 to 2012

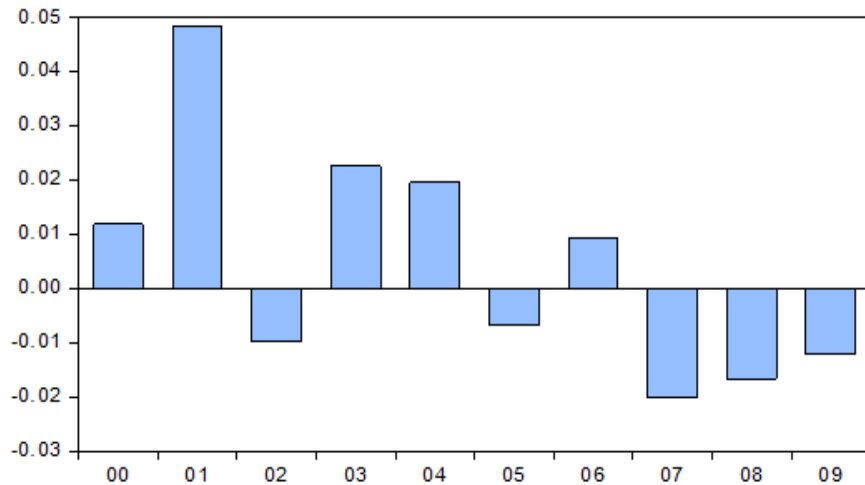


Fig. 3: Other factors' influence on timber import

example, Australia, New Zealand and Papua New Guinea. Meanwhile, the average timber exporting price

of the main timber-exporting-countries rose, for example, the exporting timer price of New Zealand and

Malaysia rose about 20 and 38%, resulting in a significant reduction of the adjustment factors in RTMS, the short-term timber import risk index, so the short-term timber import risk RTMS index was significantly reduced as measured.

Since 2011, the proportion of China's timber imports from new timber-exporting countries is increasing, such as France, Congo, Myanmar and Australia. In the top ten countries in the import volume index calculation, the total proportion of its share of imports kept decreasing. In 2012, it dropped to 76%. The improvement of the import structure averaged the political risk, transportation risk and other indirect risks, thus the timber import risk was gradually decreasing.

Long-term risks of China's timber import data sources and results:

Data description: Because of the lack of some specific data and some data is not accessible, the research of the long-term import risk of timber is confined to 2000-2012. The research selected 10 timber exporting countries which occupy more than 80% of China's total import of timber, namely the United States, Russia, Canada, Malaysia, New Zealand, Papua New Guinea, Indonesia, Germany, Gabon and Vietnam. The stock volume of resource consumption index of these countries are based on the State of World's Forests by FAO, part of the data is derivate according to the annual growth rate in the report.

The research analyzed the changes in long-term risk of China's timber import through calculating the import risk from 2000 to 2010. In order to better display the contrast and instruction, the situation when the adjustment factor was 1 was introduced in the research, that referred to the idle situation, when $RTML^*$ index only includes the import dependency risk, in which the value $RTML^*$ is greater than $RTML$. We can see from Fig. 2 that the real and the ideal $RTML$ indexes basically share the same trend during 2000 to 2010. Import dependency risk is the main factor influencing China's import risk. The risk increases first and then rises again after fall. Because since 2000, China's import dependence on Russia gradually increases, once reached around 23.7% in 2007, increasing the long-term timber supply risk. With all the major timber exporting countries restrict timber exports, the transfer of import structure of China's timber import and increase of domestic timber supply gradually ease the long-term timber supply risk.

It is worth noting that during 2004 to 2008, the long-term risk is high, affected by the trade barriers set by the timber-exporting-countries, China's timber import dependence is further increased, leading to the increase of long-term risk of timber import. After 2008, China turned to the new timber-exporting-countries, such as New Zealand and Congo, the timber import dependence decreased, easing the risk caused by the

concentration of timber import. To further analyze the impact of other factors to the risk index, we further analyze these two indexes in the first phase and subtract them, from the results shown in Fig. 3, we can see that during phase 01, i.e., 2001 to 2002, the influence of other factors towards the long-term risk is relatively more significant. Based on the analysis of the raw data, the import dependence risk in 2002 is lower than that in 2001, but in the same period, the concentration of China's timber import is higher in 2002 comparing to that in 2001, increasing the structure risk of import. Meanwhile, the domestic supply cannot meet domestic demand, the demand for timber import increases about 44% comparing to the year of 2001. This part was provided by traditional timber exporting countries and countries with high consumption of forest resources and relatively high country risk, resulting in an actual increase in long-term timber import risk $RTML$.

CONCLUSION AND RECOMMENDATIONS

According to different research purpose and direction, this study makes a more comprehensive and objective evaluation on the state of China's timber import through the analysis of long-term and short-term risks. By measuring the short-term and long-term timber import risk indexes, we can find that China's timber import risk is gradually reduced in recent years. However, when China's timber import is faced with risks, it is passive and has low adjustment, it lacks early warning and response system and lacks risk reduction measures. Although in recent years the structure risk of China's timber import is decreasing, but now as the whole world is paying attention to the protection of the ecological environment and the national forestry processing industry, restrictions on timber exportation will be further expanded. Meanwhile, in recent years, China imports timber from many emerging market countries which have higher country risk and resource risk, such as Burma and the Solomon Islands, therefore the situation is not optimistic.

Based on the above research evaluation results, China's timber import risk can be reduced by the following approaches. Firstly, as our general principle, we should choose less risky and more resourceful countries as our importing countries. Actual decision-makers will seek for the best timber exporting countries complying with their conditions based on the comprehensive analysis of other factors. Secondly, the Government shall strengthen its cooperation in the development of forest resources with neighbor countries and encourage enterprises and individuals to participate in forest resource development and conservation projects. Last but not least, we shall build and improve the timber import risk warning mechanism to make timely and effective risk assessment of timber import, to ensure the information symmetry of the

relevant risk factors that contribute to the evaluation and predication of the future timber import, in order to ensure the smooth development of the forestry industry.

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