China's wood-based forest product imports and exports: trends and implications

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HIGHLIGHTS

- Restrictions on logging from domestic natural forests and a booming economy have contributed to a surge in China's forest product imports over the past two decades.
- As China has become the largest timber importer in the world, its forest product import mix has been dominated by primary products, i.e. logs, lumber, wood chips, and wood pulp.
- China's imports of softwood have grown faster than hardwood products.
- Imports account for more than half of China's timber supply.
- Trade patterns have largely been impacted by both policies at home and by trade partners, such as the domestic logging ban, timber producing countries' log export bans, and the US-China trade war.

SUMMARY

This paper presents trends in China's forest product imports and exports during 1998–2019, by analyzing trade data from China's General Customs Administration (GCA). It was found that over the past two decades both imports and exports of forest products have experienced huge growth, making China an important player in the global forest products market. China's imports are dominated by raw materials such as logs and lumber, while exports are dominated by processed wood products like plywood and furniture. Sources of imports are diverse among different products. While softwood logs and lumber have been largely from the global north, where forests have mostly been sustainably managed, tropical hardwood have been dominated by unsustainable sources. Changes in the structure of trading products, import sources and export markets, which have been impacted by policies both at home and from the trade partners, have great implications for sustainable forest management and global actions in halting and reversing deforestation.

Keywords: Natural Forest Protection Program (NFPP), forest product imports and exports, sustainable, deforestation, China

Import-export des produits forestiers boisés en Chine: courants et implications

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Ce papier présente les courants dans l'import-export des produits forestiers en Chine pendant la période 1998–2019, en analysant les données commerciales de l'Administration générale des douanes de Chine (GCA). Il transparaît que l'import-export des produits forestiers a connu une croissance monstre au cours des deux dernières décennies, faisant de la Chine un joueur important dans le marché global des produits forestiers. Les importations chinoises sont dominées par les matériaux bruts tels que les bûches et le bois de construction, alors que les exportations sont, elles, dominées par les produits du bois transformés tels que le contreplaqué et le mobilier. Les sources d'importations sont diverses selon les différents produits. Alors que les planches de bois tendre proviennent majoritairement du nord global, où les forêts ont été pour la plupart gérées durablement ; le bois dur tropical a été dominé par des sources non durables. Les changements dans la structure des produits commercialisés, les sources d'importation et les marchés d'exportation, ayant été impactés par les politiques locales et celles des partenaires commerciaux, ont des implications importantes pour la gestion forestière durable et les actions à échelle globale visant à mettre fin à la déforestation et à annuler ses effets.

Importaciones y exportaciones chinas de productos forestales derivados de la madera: tendencias e implicaciones

Y. WANG, X. SUN y C. ZHU

Este artículo presenta las tendencias de las importaciones y exportaciones de productos forestales de China durante 1998–2019, mediante el análisis de los datos comerciales de la Administración General de Aduanas de China (AGA). Se constató que en las dos últimas décadas tanto las importaciones como las exportaciones de productos forestales han experimentado un enorme crecimiento, convirtiendo a China en un actor importante en el mercado mundial de productos forestales. Las importaciones de China están dominadas por materias primas como troncos y madera aserrada, mientras que las exportaciones están dominadas por productos de madera transformada como madera contrachapada y muebles. Las fuentes de las importaciones son diversas entre los distintos productos. Mientras que la procedencia de los troncos y la madera aserrada de coníferas fue en gran medida del norte global, donde los bosques se han gestionado en su mayoría de forma sostenible, las frondosas tropicales han estado dominadas por fuentes no sostenibles. Los cambios en la estructura del comercio de productos, las fuentes de importación y los mercados de exportación, que se han visto afectados por las políticas tanto nacionales como de los socios comerciales, tienen grandes implicaciones para la gestión forestal sostenible y las acciones globales para detener y revertir la deforestación.

INTRODUCTION

In response to the severe floods in 1998, the Chinese government decided to stop logging in the natural forests in the upper reaches of the Yangtze River and the upper and middle reaches of the Yellow River, and reduce logging in the natural forests in Northeast China. China officially launched its Natural Forest Protection Program (NFPP) in 2000. As a result, timber harvesting from natural forests has been largely reduced, mainly in Northeast and Southwest China.

Since 2014, China has entered the era of comprehensive natural forest protection. In addition to the existing logging ban in the upper reaches of the Yangtze River and the upper and middle reaches of the Yellow River, two state-owned forest giants, Longjiang Forest Industry Group and Daxinganling Forestry Group in Northeast China, fully stopped commercial logging in natural forests. A year later, Inner Mongolia, Jilin and Changbai Mountain Forest Industry Group completely stopped commercial logging in natural forests. Subsequently, a full logging ban was enforced in 2017, applying to all commercial logging in natural forests across China (World Economic Forum 2022).

China's booming economy and rise in living standards, and a growing export oriented wood industry, has led to a growing demand for wood-based products (Richards *et al*. 2022). Imports of wood-based forest products have increased to fill the gap between domestic timber supply and demand.

The booming Chinese wood processing industry has made the country a global wood processing hub. Exports of wood-based forest products in China have experienced growth for the past two decades, although at a slower pace compared to the imports. China has become the largest wood importer and second largest wood consumer in the world (Zhang and Chen 2021).

Globally, there is consensus on the role of forests in influencing and mitigating climate change. It is estimated that 25% of the world's total greenhouse gas production comes from deforestation alone (Bennett 2017), with more than two thirds of recent tropical deforestation estimated to have taken place illegally (Uehara 2022). The large and growing trade demand has been blamed by many as a major driver of deforestation and forest degradation in developing regions. International efforts to mitigate these negative impacts have been focused on improving forest governance and reducing illegal logging in timber supplying countries. Given this background, it is clear that understanding the development and dynamic of China's forest products trade will help us to better understand China's role in promoting global forest governance and reduce deforestation.

The objectives of this research are to initially analyze changes in China's wood–based forest products trade between 1998 and 2019 (by examining overall trends of China's wood-based forest product imports and exports, categorized by products mix, major sources of imports and destinations of exports), followed by an investigation into the changes in imports and exports of major products. Reasons behind the changes and potential impacts are discussed, followed by a summary of key trends and policy implications.

METHODS

Scope of wood-based forest products

Wood-based forest products, forest products in short, examined in this paper were divided into two product groups: timber products, and pulp and paper products. Timber products include all products of Harmonized System (HS) codes in Chapter 44 published by China's General Administration of Customs (China's Customs), plus wooden furniture. Pulp and paper products include those HS codes of Chapter 47 and 48. A detailed list of products and their respective HS codes is presented in Table 1.

Data

China's forest product imports started to surge after 1998, when the large forest protection program NFPP was first piloted. Thus, 1998 was selected as the starting point for this analysis. The world trade was heavily impacted by Covid-19

TABLE 1 *Wood-based forest products and HS codes*

Commodity			HS Code
Wood-based forest products	Timber products	Wood chips	4401
		Charcoal	4402
		Logs	4403
		Hoopwood	4404
		Woodwool/woodflour	4405
		Sleeper/crosstie	4406
		Lumber	4407
		Veneer sheet	4408
		Flooring, moulding and strips	4409
		Particleboard	4410
		Fiberboard	4411
		Plywood	4412
		Densified wood	4413
		Frames	4414
		Pallets	4415
		Casks	4416
		Tool handles	4417
		Joinery	4418
		Tableware	4419
		Marquetry	4420
		Other articles of wood	4421
		Wood furniture	940161
			940169
			940330
			940340
			940350
			940360
	Pulp and paper	Wood pulp	4701
			4702
			4703
			4704
			4705
		Recycled and waste paper	4706
			4707
		Paper and paper products	48

during 2020–2022, as were China's economy and imports. To exclude the impacts of the pandemic, this paper focused on analyzing the data for 1998–2019.

The data used in this study were developed using China's Customs statistics published annually. The United Nations Comtrade (https://comtrade.un.org/) carried China's imports and exports data as well. However, it is only detailed to 6-digit HS codes level. For analysis at species level, data at 8-digit HS codes level is needed. Therefore, data from Comtrade were used only for cross-checking.

Reported volumes were either in cubic meters (m^3), or in tonnes. All value estimates have been inflation adjusted to constant 1998 prices using the Consumer Price Index data provided by the U.S. Bureau of Labor Statistics (US Inflation Calculator 2022). To avoid ambiguity by converting volume of different products, when examining aggregated product groups, only total values were examined.

Species groups examined

Timber species were grouped into two categories: softwood and hardwood. This classification was applied when imports of logs and lumber were analyzed. The products in each of these two groups and their respective HS codes are presented in Table 2 and Table 3.

RESULTS AND DISCUSSION

Import trends

Overall trends

China imported US$47.5 billion of forest products in 2019 (or US$30.3 billion, in constant 1998 prices), compared to US$6.7 billion in 1998. China's imports of pulp and paper exceeded its imports of timber products, which grew faster than pulp and paper. Calculated at constant 1998 prices, imports of timber products increased six-fold between 1998 and 2019, while pulp and paper tripled. Among the forest products imported by China in 2019, timber products and pulp and paper were almost equally divided. In 2014, the amount of timber products imported by China exceeded that of pulp and paper, while the ratio of the two was 1:2.4 in 1998 (Figure 1).

The relatively faster growth of timber product imports compared with that of pulp and paper may reflect impacts of the NFPP. The implementation of the NFPP has resulted in reduction in timber production from natural forests, which enlarged the gap between domestic timber demand and supply (Richards *et al*. 2022). Timber product imports have been encouraged by the Chinese government to fill the gap. Starting from 1999, China has applied zero tariff policy on logs, lumber, wood chips, among other primary products (World Economic Forum 2022). As a result, an annual increase of 45% was evident for timber product imports in 1999. A simple comparison of the average annual growth between timber product imports and China's GDP also shed some light on possible impacts of the NFPP. The average annual growth reached 11% between 1998 and 2019, faster than the average annual GDP growth (8.4%). A recent study by Zhang and Chen (2021) has estimated that the logging bans led to a 15% increase in solid wood imports. The additional wood imports are mostly filled by low-income counties with less stable trade relations with China, which raises concern over import sustainability (Zhang and Chen 2021). Some of these countries are reported by international organizations

TABLE 2 *Logs and HS codes*

Category		HS code	Description
Softwood logs		44031100	Treated coniferous wood in the rough…
		44032000	Untreated coniferous wood in the rough...
		44032010	Korean Pine and Mongolian Scotch Pine
		44032020	White Pine (Spruce and Fir)
		44032030	Radiata Pine
		44032040	Larch
		44032050	Douglas Fir
		44032090	Untreated Coniferous wood
		44032110	Korean Pine and Mongolian Scotch Pine, cross-sectional dimension ≥15cm
		44032120	Radiata Pine, cross-sectional dimension ≥15cm
		44032130	Larch, cross-sectional dimension ≥15cm
		44032140	Douglas Fir, cross-sectional dimension ≥15cm
		44032190	Other Pine, cross-sectional dimension ≥15cm
		44032210	Korean Pine and Mongolian Scotch Pine, cross-sectional dimension <15cm
		44032220	Radiata Pine, cross-sectional dimension <15cm
		44032230	Larch, cross-sectional dimension <15cm
		44032240	Douglas Fir, cross-sectional dimension <15cm
		44032290	Other Pine, cross-sectional dimension <15cm
		44032300	Fir (*Abies Spp.*) and Spruce (*Picea Spp.*), cross-sectional dimension ≥15cm
		44032400	Fir (*Abies Spp.*) and Spruce (*Picea Spp.*), cross-sectional dimension <15cm
		44032500	Other Coniferous Wood, cross-sectional dimension ≥15cm
		44032600	Other Coniferous Wood, cross-sectional dimension <15cm
Hardwood logs	Tropical logs	44034100	Dark Red Meranti, Light Red Meranti & Meranti Baka
		44034910	Teak
		44034920	Okoume (*Aukoumed Klaineana*)
		44034930	*Dipterocarpus Spp*. Keruing
		44034940	Kapur (*Dryobalanops Spp.*)
		44034950	Intsia Spp. (Mengaris),
		44034960	Koompassia Spp. (Mengaris Or Kempas)
		44034970	Anisopter Spp.
		44034980	Tropical Rosewood
		44034990	Other Specified Tropical Wood
		44039910	Nan Mu (Phoebe), (Excl. Treated)
		44039920	Camphor, (Excl. Treated)
		44039930	Padauk, (Excl. Treated)
		44039990	Other (Excl. Treated)
	Temperate hardwood logs	44039100	Oak (*Quercus Spp.*), (Excl. Treated)
		44039200	Beech (*Fagus Spp.*), (Excl. Treated)
		44039300	Beech *(Fagus Spp.*), cross-sectional dimension ≥15cm
		44039400	Beech *(Fagus Spp.*), cross-sectional dimension <15cm
		44039500	Birch (*Betula Spp.*), cross-sectional dimension ≥15cm
		44039600	Birch (*Betula Spp.*), cross-sectional dimension <15cm
		44039700	Poplar And Aspen (*Populus Spp.*)
		44039800	Eucalyptus (*Eucalyptus Spp.*)
		44039940	Kiri (Paulownia)
		44039950	Ash
		44039960	North American Hard Wood
		44039980	Other Temperate Non-Coniferous
		44031200	Non-Coniferous Wood, Treated

TABLE 3 *Lumber and HS codes*

Commodity		HS code	Description
Softwood lumber		44071000	Conifers wood sawn or chipped lengthwise……
		44071010	Korean pine and Mongolian scotch pine
		44071020	White pine (spruce and fir)
		44071030	Rediata pine
		44071040	Douglas fir
		44071090	Coniferous wood
		44071110	Wood of Korean pine/Mongolian scotch pine, sawn lenghwise
		44071120	Wood of radiata pine, sawn lenghwise
		44071130	Wood of Douglas fir, sawn lenghwise
		44071190	Wood of other pine, sawn lenghwise
		44071200	Wood of fir (Abies spp.) and spruce (Picea spp.), sawn lenghwise
		44071900	Other Coniferous wood
Hardwood lumber	Tropical hardwood lumber	44072100	Wood of mahogany (Swietenia spp.), sawn lenghwise
		44072200	Wood of Virola/Imbuia/Balsa, sawn lenghwise
		44072400	Baboen, Mahogany, Imbuia & Balsa wood, sawn lengthwise…..
		44072500	Dark Red Meranti,Light Red Metanti and Meranti Bakau
		44072600	White Lauan/Meranti/Seraya, Yelw Meranti&Alan
		44072700	Sapelli wood, sawn lengthwise
		44072800	Iroko wood, sawn lengthwise
		44072910	Teak wood, sawn lengthwise
		44072920	Wood of acajou, sawn lengthwise
		44072930	Wood of Merbau, sawn lengthwise
		44072940	Wood of rosewood, sawn lengthwise
		44072990	Tropical wood, sawn lengthwise
	Temperate hardwood lumber	44079100	Wood of oak(Ouercus spp.), sawn lengthwise
		44079200	Wood of beech(Fagus spp.), sawn lengthwise
		44079300	Wood of maple (Acer spp.), sawn lengthwise
		44079400	Wood of cherry (Prunus spp.), sawn lengthwise
		44079500	Wood of ash (Fraxinus spp.), sawn lengthwise
		44079600	Wood of birch (Betula spp.), sawn lengthwise
		44079700	Wood of poplar and aspen (Populus spp.), sawn lengthwise
		44079910	Non-tropical rosewood, sawn lengthwise
		44079920	Wood of Kiri (Paulownia), sawn lengthwise
		44079930	North American hard wood (incl. cherry/walnut/maple)
		44079980	Other temperate non-coniferous wood, sawn lengthwise
		44079990	Other wood, sawn lengthwise

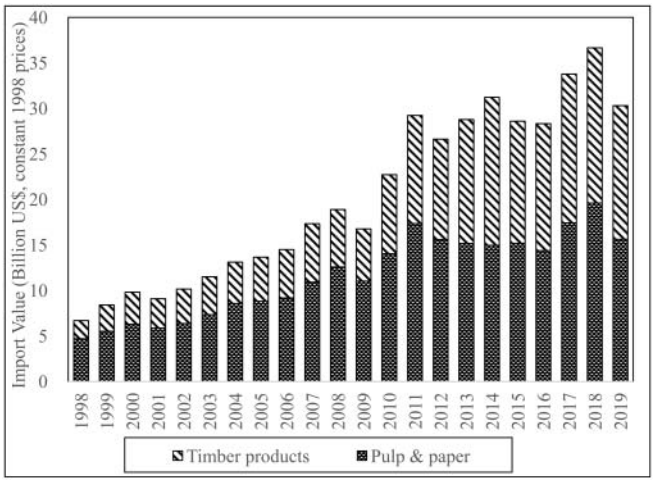
to be high-risk sources with regard to illegal logging and deforestation (e.g. Global Witness 2019).

Import mix of timber products

China's timber product imports have always been dominated by unprocessed wood (Figure 2). Logs, lumber and wood chips accounted for 88% of timber product imports by value in 2019. Among them, logs accounted for 41%, lumber 37%, and wood chips 10%. Over the 1998–2019 period, especially after 2008, lumber imports increased much faster than log imports. Log export restrictions imposed by timber producing countries may have contributed to this shift.

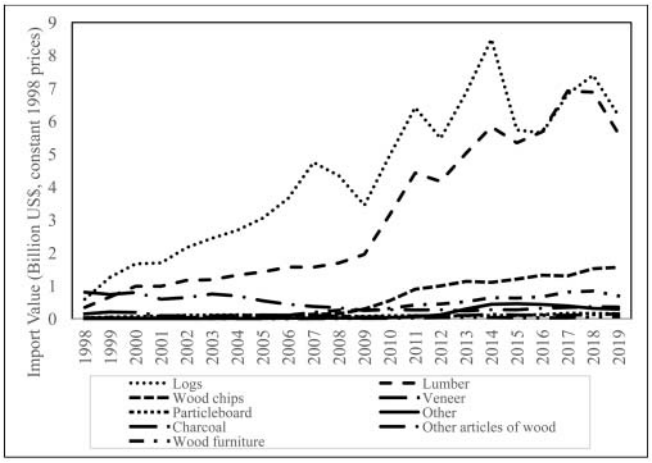
Timber producing countries have increasingly been imposing export taxes and bans to protect forests and develop

FIGURE 1 *China's imports of wood-based forest products*



Source of data: China Customs, compiled by authors

FIGURE 2 *Import mix of timber products*



Source of data: China Customs, compiled by authors

local economies. Forest Trends, a US-based non-governmental organization reported over 70 countries have total or partial log export bans in place (Forest Trends 2022), the majority being tropical timber producers. Many of them are major sources of China's timber imports. Such restrictions on log exports have had impacts on China's timber import structure. For example, Gabon implemented log export restrictions in 2010. As a result, log exports from Gabon to China dropped from its peak of 1.1 million m^3 in 2009 to less than 23 000 m^3 in 2011, and further drops continued towards 2019. At the same time, China's lumber imports from Gabon surged from 36 000 m^3 in 2010 to 131 000 m^3 in 2011 and nearly half a million in 2019. Although it is not an entirely new commitment and sounds ambitious, Papua New Guinea government promised to stop all log exports by 2025 (Filer 2022). As more timber producing countries restrict log exports, it is expected that the growth of China's lumber imports will continue to be faster than logs.

Between 1998 and 2019, the import value of logs, lumber and wood chips increased on average annually by 67%, 108%, and 8812%, respectively. While imports of both logs and lumber fell in 2019, imports of wood chips continued to grow, increasing by 6% in value compared to 2018. This growth may be a result of policy changes in recent years. China began banning the importation of 24 types of recyclable waste beginning at the end of 2017 (Yoshida 2022) including waste paper. Imports of wastepaper experienced a sharp decline simultaneously between 2017 and 2019. In the short term, it is challenging to expand domestic wastepaper recycling capacity to fill the gap caused by reduction of imported wastepaper. Paper companies have turned to other raw materials including wood chips, wood pulp, and recycled pulp to import (Gong *et al*. 2022).

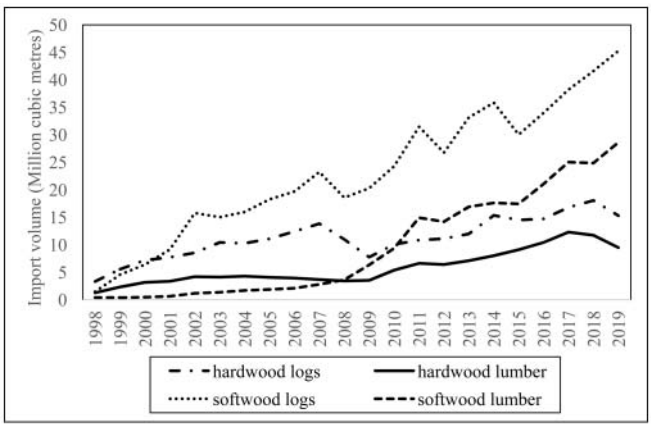
Logs and lumber: hardwood vs. softwood

In 2019, China imported 60.57 million m^3 of logs and 38.11 million m^3 of lumber, valued at US$9.4 billion and US$8.6 billion, respectively. As indicated in Figure 3, China's log and lumber imports have undergone a transition from mainly hardwood to softwood species. In 1998, China imported 4.8 million m^3 of hardwood logs and 1.7 million m^3 of lumber, while imports of softwood logs and lumber amounted to 1.5 million m^3 and 0.4 million m^3, respectively. Rapid growth in imports of softwood logs and lumber reversed the proportion of softwood and hardwood, by 2019, imports of hardwood logs and lumber accounted for 25% of logs and lumber in total, compared to 72% in 1998. This change may be due in part to changing domestic consumers' preference in furniture and interior decoration, as well as increasing demand for softwood as moldings used for the construction industry (Richards *et al*. 2022).

Import mix of pulp and paper

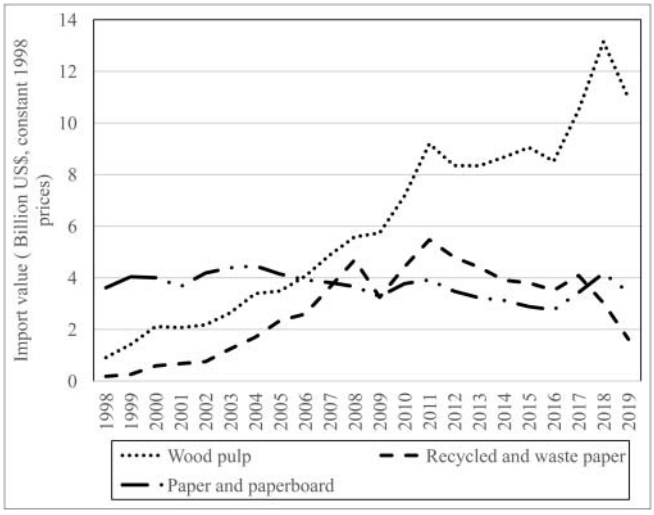
Imports of pulp and paper have been growing steadily due to rising domestic paper demand. Imports grew from US$4.7 billion in 1998 to US$24.5 billion in 2019. Prior to 2003, more than half of China's pulp and paper imports were in the form of finished products, paper and paperboard. In 1998, paper and paperboard imports accounted for as much as 77%. Increases in pulp imports have largely been driven by the vigorous development of the paper industry over years. By 2019, the proportion of paper product imports dropped to 21%, and the proportion of wood pulp was up to 68% (Figure 4).

FIGURE 3 *China's imports of logs and lumber*



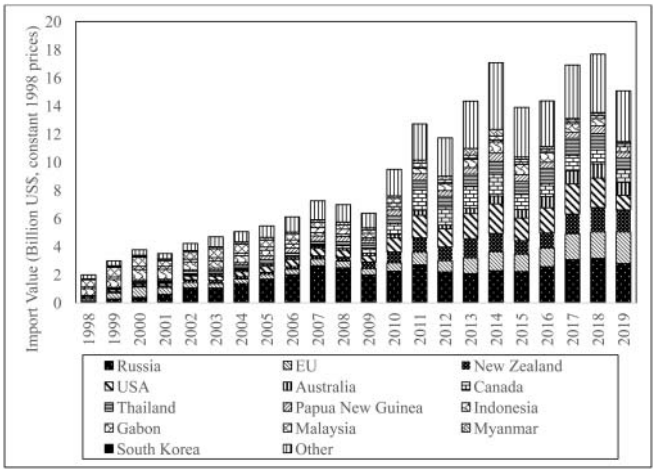
Source of data: China Customs, compiled by authors

FIGURE 4 *Import mix of pulp and paper*



Source of data: China Customs, compiled by authors

FIGURE 5 *China's top five suppliers of timber product imports*



Source of data: China Customs, compiled by authors

Sources of timber products imports

China's top five suppliers of timber product imports by value from 1998 to 2019 are presented in Figure 5. In 1998 the top five were Indonesia, Malaysia, the United States, the European Union, and Russia. Thanks to the rapid growth of imports from Russia, by 2002 Russia had become the largest supplier of timber products to China, a position it has maintained ever since. This may serve as a direct substitution of timber production in Northeast China, due to similarity in timber species. Imports from Russia accounted for 19% of China's total timber product imports in 2019, followed by 15% from the European Union, 10% from New Zealand, 7% from the United States, and 6% from Australia. While Russia remains China's largest source of timber product imports, its share has declined in recent years due largely to changes in its regulatory and tariff policies (Simeone 2012). An export tariff of 25% on logs was announced in 2007 to encourage the development of a domestic wood processing sector. Nonetheless, following its accession to WTO in 2012, Russia has instituted an elaborate set of tax rates for log exports and introduced volume tariff rate quotas (TRQs) for certain timber species (Simeone and Eastin 2012). Tariffs on exports of out-of-quota timber rose from 25% in 2007 to as high as 80% in 2021 (Guan and Zhang 2022). As a result, there has been a dramatic decline in Russia's total log exports, and Russia's share in China's total timber product imports has decreased to 19% in 2019, after the peak of 37% in 2007. The shares of Indonesia and Malaysia have also dropped, while New Zealand, Australia, the European Union, Canada and Thailand have become more important suppliers.

Sources of log imports: hardwood vs. softwood

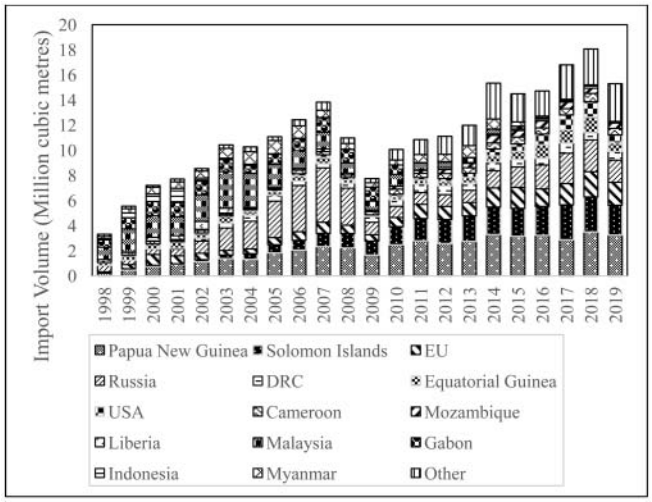
China's main suppliers of hardwood logs in 2019 were Papua New Guinea (21%), Solomon Islands (15%), the European Union (12%), Russia (11%), and the Democratic Republic of Congo (5%) (Figure 6a). From 1998 to 2008, temperate hardwood timber suppliers represented by Russia and the European Union ranked at the top. Since 2009, Papua New Guinea (PNG) and the Solomon Islands have been the main sources of hardwood logs for China, with tropical log imports from these two countries increasing significantly, their combined share increased from less than 6% in 1998 to 36% in 2019. Malaysia and Indonesia were China's main sources of tropical logs in the 1990s, subsequently overtaken by Papua New Guinea, Solomon Islands and African timber producers. China's top ten sources of tropical logs rank low in governance, with illegal logging rampant. Together they supplied 80% of China's tropical timber imports in 2018 (Global Witness 2019). Due to its large and growing timber imports, China have been accused of having promoted deforestation in timber supplying countries (Douglas and Simula 2011).

Imports of softwood logs told a different story. The sources of softwood imports were relatively concentrated (Figure 6b). The main suppliers of China's softwood log imports in 2019 were New Zealand (39%), the European Union (18%), Russia (13%), the United States (9%), and Australia (8%). In 2007, Russia provided about 90% of China's softwood log imports. Since 2015, New Zealand has surpassed Russia to become the largest supplier of softwood logs to China. In 2019, the European Union emerged as the second largest supplier of softwood logs to China, mainly due to the surge in logs from Germany and several Eastern European countries, particulalry Poland, the Czech Republic and Latvia. An oversupply of timber in these countries has altered the log flow into China. However, it is unlikely to be sustained, as Europe's oversupply of logs is beginning to diminish, and domestic demand is increasing (Wood Resources International 2021).

Sources of lumber imports: hardwood vs. softwood

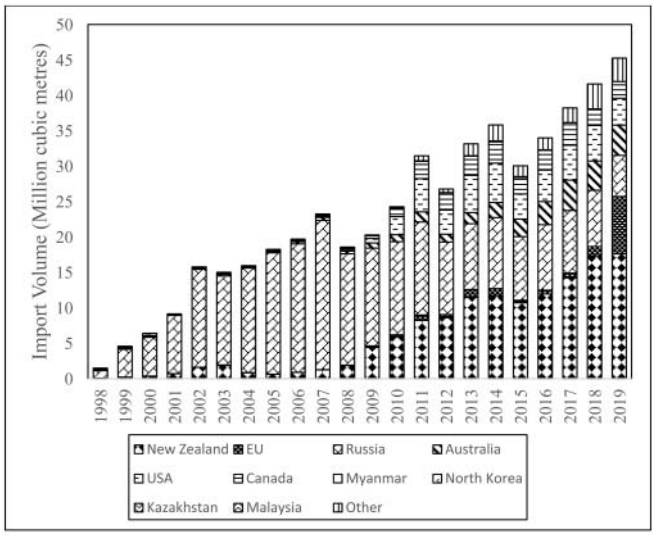
China's imports of hardwood lumber mainly came from Thailand, the United States, and Russia (Figure 7a). Thailand, by supplying rubberwood, has become the largest supplier of lumber imported by China since 2010. In 2019, 38% of China's imported hardwood lumber came from Thailand, a further increase from 26% in 2010. The United States has been one of the main lumber exporters to China, accounting

FIGURE 6a *China's top five suppliers of hardwood log imports*



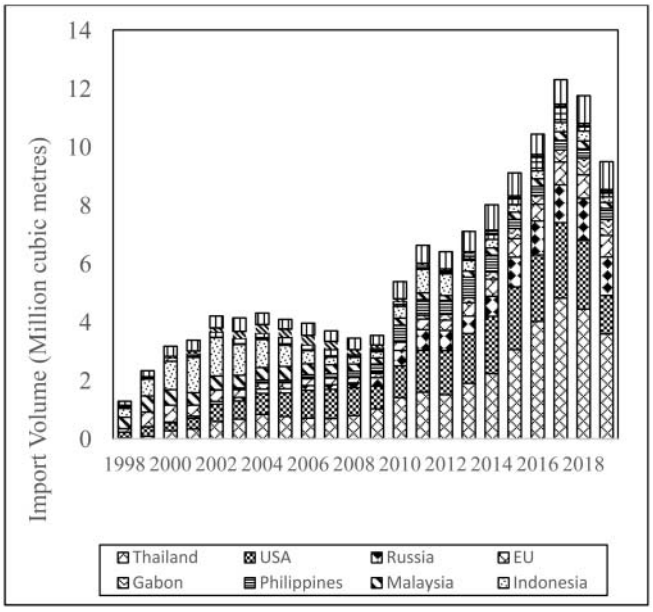
Source of data: China Customs, compiled by authors

FIGURE 6b *China's top five suppliers of softwood log imports*



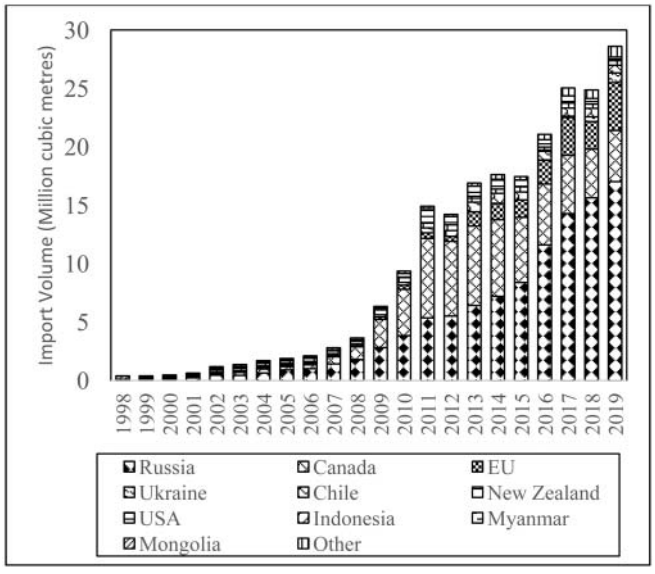
Source of data: China Customs, compiled by authors

FIGURE 7a *China's top five suppliers of hardwood lumber imports*



Source of data: China Customs, compiled by authors

FIGURE 7b *China's top five suppliers of softwood lumber imports*



Source of data: China Customs, compiled by authors

for 20% of China's lumber imports in 2018. The share was dropped to 13% in 2019 as a direct impact of US-China trade war[1] (Pan *et al*. 2021). While Russian log exports to China have declined after the log export tariff was imposed in 2008, the supply of lumber has increased significantly. Gabon was a main supplier of tropical hardwood logs to China. More recently, lumber exports to China have shown an upward trend after 2010, when Gabon enforced a log export ban. By 2019, Gabon became China's most important tropical hardwood lumber supplier after Thailand.

The main import sources of softwood lumber in 2019 to China were Russia (59%), Canada (15%) and the European Union (14%) (Figure 7b). In 1998, China imported less than 10 000 m^3 of softwood lumber from Russia, accounting for 2% of all softwood lumber imports. This figure rose year by year to a peak of 15.65 million m^3 in 2019, accounting for 63%. From 2010 to 2014, Russia and Canada were roughly equal in importance, each supplying around 40% of China's softwood lumber imports. However, imports from Russia

[1] The trade war between the United States and China started in 2018, beginning by the US, which imposed a 25% tariff on approximately $50 billion of goods imported from China. In return, China imposed a 25% ad valorem tariff on $50 billion of goods imported from the US. The primary Chinese forest products subject to the US tariffs are wooden furniture and paper. The main US forest products subject to Chinese tariffs are pulp and waste-paper, sawnwood, paper, and industrial roundwood (Pan *et al*. 2021).

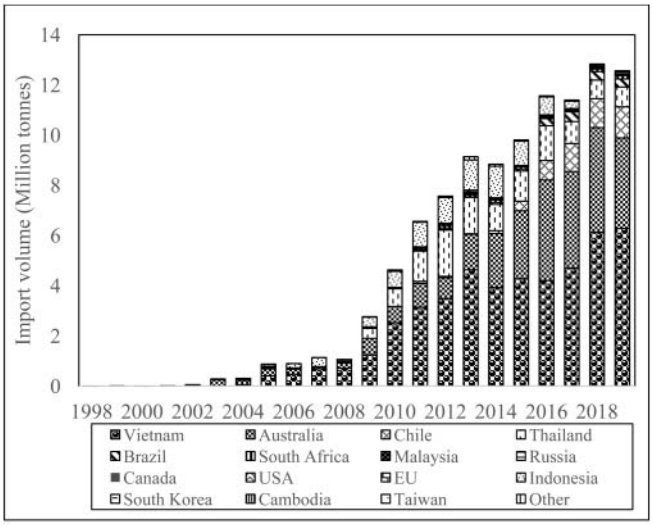
have surged since 2015, while imports from Canada have declined. Within the European Union, Finland and Sweden have been the main supplier of China's softwood lumber imports. As a smaller supplier, Ukraine's softwood lumber exports to China have grown significantly since 2018, with a year-on-year increase of 264% in 2018 and a further increase of 101% in 2019. Ukraine initiated a log export ban, except for pine logs in November 2015 and for pine starting from January 2017 (Kaya and Ok 2023). As a result of the implementation of the pine log export ban, China has shifted from importing Scotch pine logs to lumber since 2017. Imported Scotch pine lumber are mainly low grade used for construction and packaging pallets. Cost advantage of Ukraine Scotch pine lumber may have contributed to the surge of Ukraine softwood lumber imported into China after 2017.

The transition of China's log and lumber imports from mainly hardwood to softwood species has important implications. The main suppliers of softwood imports have been New Zealand, Russia, EU, Canada, and United States. Except for Russia (Russia Far East in particular), these countries are perceived as reliable sources of sustainably harvested timber. As such, China has increased timber imports from sustainable managed sources, which indirectly benefit global forest governance.

Sources of wood chips

China's wood chip imports were dominated by Vietnam (50% share in 2019) and Australia (29%) (Figure 8). Imports from both countries rose fast to become equally important sources in 2016, but imports from Vietnam have increased much faster since then. This partly reflects Vietnam's fast growing plantations of Acacia and eucalyptus and wood chip exports. In 2011, the country surpassed Australia to become the largest exporter of wood chips in the world (Forest Trends 2013). Wood chips imported from Thailand have increased significantly since 2009. At its peak in 2012, Thailand accounted for 24% of China's wood chips imports, but it declined between 2017 and 2019. Imports from Chile have flattened following rapid growth from 2014 to 2017.

FIGURE 8 *China's top five suppliers of wood chips imports*

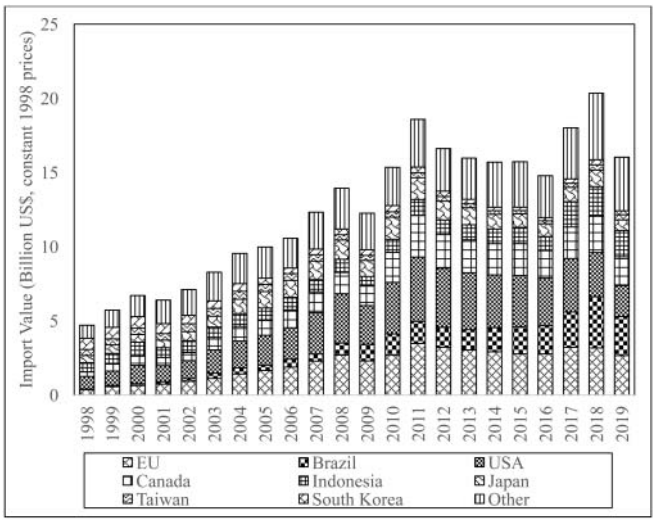


Source of data: China Customs, compiled by authors

Sources of pulp and paper

The import sources of China's pulp and paper were less diversified, compared to the sources of timber product imports. The United States, the European Union, Canada and Indonesia have historically been the main suppliers of China's pulp and paper. The top five suppliers of Chinese pulp and paper imports in 2019 were the European Union with a market share of 17%, Brazil 16%, the United States 13%, Canada 12% and Indonesia 11% (Figure 9). Imports of pulp and paper from Brazil have grown rapidly. In 2018, Brazil surpassed the United States and the European Union to become China's largest supplier of pulp and paper. Data for 2019 showed that imports from the United States fell further. Much of this drop was attributed to the US-China trade war and China's solid waste import ban (Pan *et al*. 2021). The United States used to be China's main wastepaper supplier. The ban on solid waste imports has led to a decline in both the import volume and market share of pulp and paper from the United States.

FIGURE 9 *China's top five suppliers of pulp and paper imports*

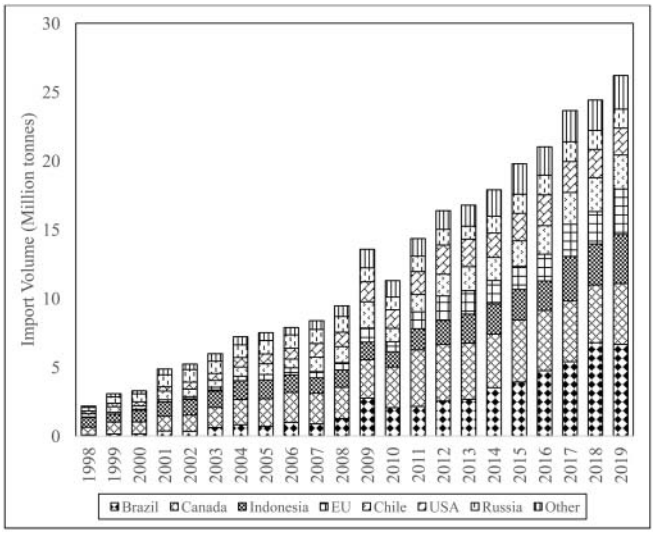


Source of data: China Customs, compiled by authors

Sources of wood pulp

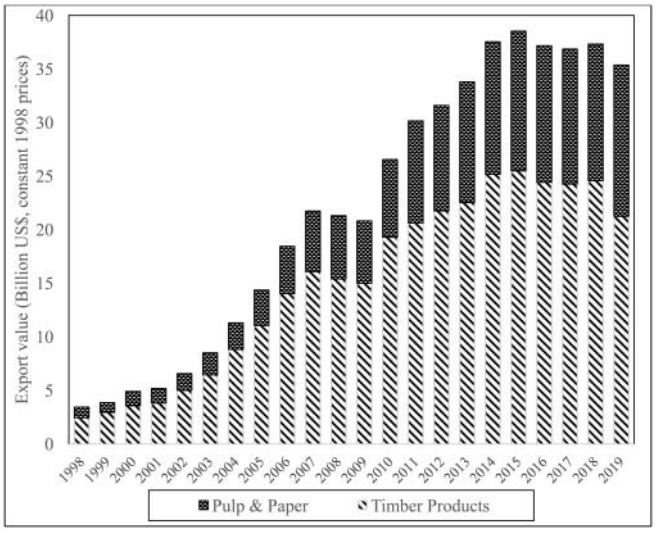
China's wood pulp imports have been mainly sourced from Indonesia, Canada, the United States, Brazil, Chile, Russia and the European Union (Figure 10). Being a dominant supplier in the early 1990s–2000s, Indonesia's export growth slowed in the past decade. This trend occurred because in the early 2000s, two large companies, APP (Asia Pulp and Paper Co. Ltd.) and APRIL (Asia Pacific Resources International Holdings Ltd), have established processing facilities in China to access local raw materials. As a result, imports of wood pulp from Indonesia dropped. Indonesia's share in China's wood pulp imports fell from 33% in 1998 to 14% in 2019. Before 2016, Canada's share in China's imports of wood pulp was stable at 21–28%. Although the import volume continued to grow in 2017–2019, its share decreased. From a relatively

FIGURE 10 *China's top five suppliers of wood pulp imports*



Source of data: China Customs, compiled by authors

FIGURE 11 *China's exports of wood-based forest products*



Source of data: China Customs, compiled by authors

low base, Brazil's wood pulp exports to China have grown rapidly, from 80,000 tonnes (4% of China's wood pulp imports) in 1998 to 6.78 million tonnes (28%) in 2018. In 2019, it fell to 6.66 million tonnes, accounting for 25%. The fast-development of the plantation sector in Brazil has contributed to the surge in wood pulp exports.

Export trends

Overall trends

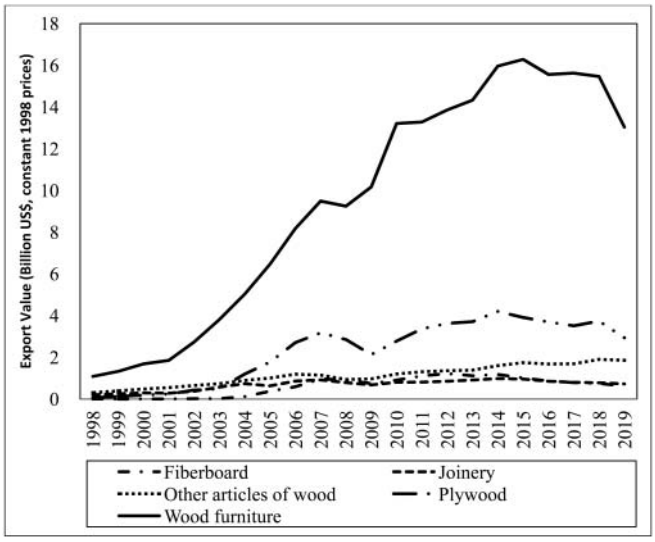
China's exports of forest products rose from US$3.4 billion in 1998 to a peak of US$38.5 billion (at constant 1998 prices) in 2015 (Figure 11), more than tenfold increase after adjusting for inflation. In 2019, due to the impact of the global economic downturn and the trade war between China and the United States, exports declined to US$35.4 billion at constant 1998 prices, down 5% per year. The downward trend since 2015 seems consistent with the emphasis on expanding domestic demand in recent years.

However, overall trends in forest product exports mask differences between timber products and pulp and paper products. Before 2018, more than two thirds of forest products exports were timber products. The share of timber products exports dropped to 60% in 2019. This was largely attributed to the US-China trade war, which has led to a sharp decline in China's timber exports to the United States.

Export mix of timber products

China's wood processing industry has experienced fast growth over the past two decades. Outputs of wood products including wood furniture, and wood-based panels have all been expanded, making China a leading producer and exporter of these products (Ke *et al*. 2021). As shown in Figure 12, China's timber product exports are dominated by wood furniture and plywood. Together, they accounted for 83% of timber product exports in 2019. Wood furniture exports experienced

FIGURE 12 *China's major timber product exported*



Source of data: China Customs, compiled by authors

fast growth from 2000–2008. Growth continued but at a slower pace after some fluctuations due to the global financial crisis in 2008. Nevertheless, China has become the largest exporter of wood furniture since 2004, overtaking the traditional European exporters (Barbu and Tudor 2022).

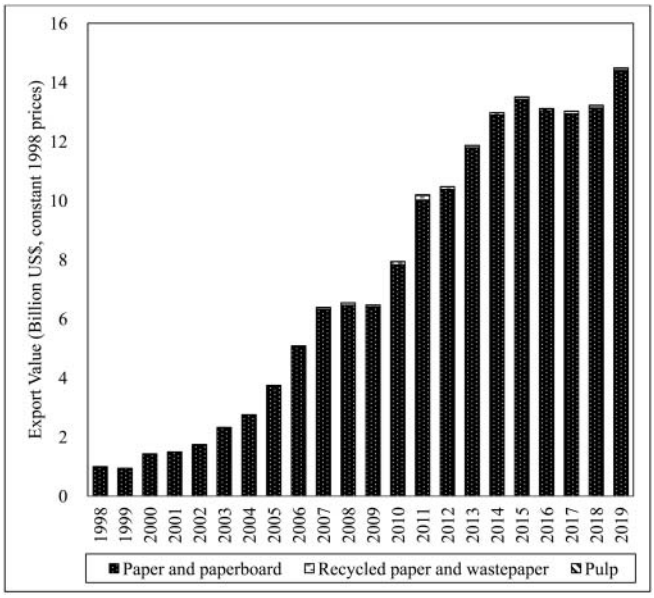
Wood furniture exports increased more than fourteen times between 1998 and 2018. However, wood furniture exports declined in 2019, largely impacted by the US-China trade war.

Plywood exports have fluctuated in recent years after significant growth from 2003–2007 and from 2009–2014. In the 1990s, China was a net importer of plywood, and Indonesia and Malaysia were two large suppliers of China's plywood imports. This situation has changed with the rise of the domestic wood-based panel industry. Today China has become the largest producer and exporter of plywood in the world (Barbu and Tudor 2022).

Export mix of pulp and paper

The majority (99% of the export value) of China's exports of pulp and paper products are paper and paperboard (Figure 13). This confirms the general trend of China's forest products trade, that is, importing raw materials and exporting finished products.

FIGURE 13 *Export mix of pulp and paper*



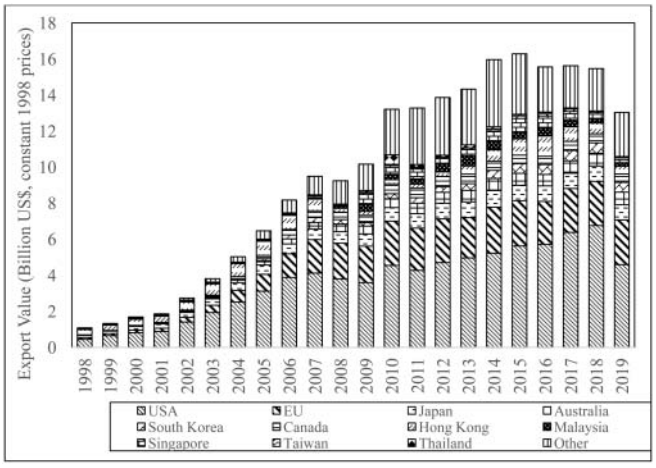
Source of data: China Customs, compiled by authors

Destination of wood furniture exports

The United States has always been the main destination for China's wood furniture, about 44% of the total value of the wood furniture exports in 2018, followed by the European Union (16%), and Japan (5.5%). As shown in Figure 14, from 1998 to 2019, more than half of the wood furniture was exported to these three major markets. The share of these top three markets peaked at 72% in 2004 and has since fallen. China's exports of wood furniture to the United States in 2019 declined significantly in both value and share, from US$10 billion (44%) in 2018 to US $7 billion (35%) in 2019. This is largely due to the trade war between China and the United States. The European Union's market share rose from 9% in 1998 to 21% in 2008, before falling slightly. However, from 2018 to 2019, the European Union's market share rose again, from 16% to 19%. This may be explained by the spillover effect of the US-China trade war. China's wood furniture exports to Japan have been relatively flat, fluctuating between 5% and 9%. The share of wood furniture exports outside the top ten markets has increased from 5% in 1998 to a peak of 24% in 2011, followed by a slow decline to 19% in 2019. With the continuous progress of the Belt and Road Initiative, China's exports to the countries along the route are expected to increase.

It is important to establish linkages between sources of timber and destination of forest product exports, especially for wood furniture. The Chinese wooden furniture industry has witnessed fast growth over the past two decades, making

FIGURE 14 *Destinations of wood furniture exports*



Source of data: China Customs, compiled by authors

China a leading furniture exporter in the world (Han *et al*. 2009). Imports account for more than half of China's timber supply (World Economic Forum 2022). This large share of the timber supply has fed the growing Chinese wood processing industry. However, to our knowledge, there has been no comprehensive research and/or official data on the proportion of imported timber used in processed products for exports. Nonetheless, it is clear that the majority of rosewood imports are for rosewood furniture making, and consumed in the Chinese domestic market (Huang and Sun 2013). Although rosewood imports into China have declined after its peak in 2014, evidence of illegality along the rosewood supply chain has been evident (Richards *et al.* 2022), which calls for China's import control measures.

Beginning in 2008, China's main export markets – the United States, the European Union, Australia, and Japan - have introduced and enforced regulations to control inflow of wood products from illegal sources, namely the Amended Lacey Act in 2008, the European Timber Regulations agreed in 2010 and entered fully operation in 2013, the Australian Illegal Logging Prohibition Act in 2012, and the Japanese Clean Wood Act in 2017 (World Economic Forum 2022). The regulations apply to wood furniture, plywood, wood flooring, among other forest products from China and other parts of the world. Chinese exporters are required to implement due diligence obligations on sourcing timber legally, in order to enter these markets.

As in the case of rosewood, imported primary timber products have been used for making into finished products consumed domestically. Being the world's largest timber importer, the huge domestic market makes China an important player in improving global forest governance and reducing deforestation in its timber supplying countries. Unlike its main export markets, China has not had timber legality regulations in place. Nevertheless, progress has been made towards legal timber imports over the past decades. These include responsible sourcing policies and standards adopted by the wood processing industry, the guidelines issued to promote legal and sustainable forest products trade and overseas investment by the government agencies, and the revised

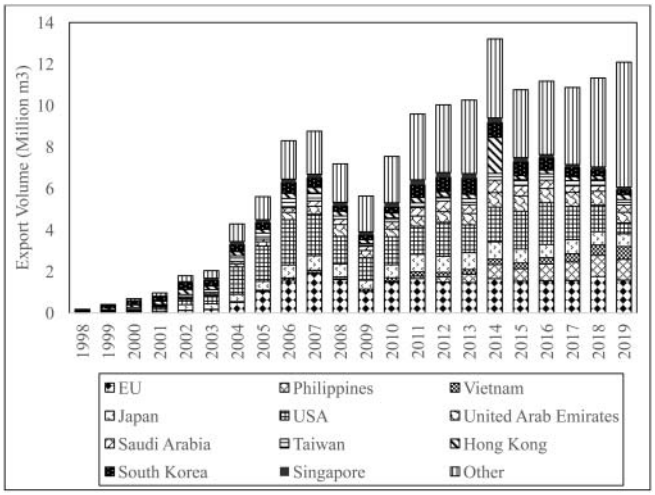
Forestry Law adopted in 2019. The Article 65 of the law not only provided the legal basis for legal and responsible timber sourcing, but also set out how the timber industry could implement its due diligence obligations with regard to legally produced timber.

It states that "timber processing enterprises should establish an account of the entry and exit of raw materials and products. No unit or individual may purchase, process or transport timber that he/she clearly knows was illegally felled or indiscriminately felled in forest regions." (You and Wang 2020, World Economic Forum 2022).

Destinations of plywood exports

In 2019, China's top five plywood export destinations were the European Union (13%), the Philippines (8.3%), Vietnam (5.1%), Japan (5.1%), and the United States (4.4%) (Figure 15). Before 2003, China's annual plywood exports amounted to 2 million m^3, mainly to Japan, South Korea and other Asian markets. Exports to the European Union, the United States and Japan began to grow after China's accession to the WTO in 2001, with some fluctuation. Plywood exports to the United States and the European Union peaked in 2006 and 2007, respectively, and declined thereafter. Exports to the United States reached a new peak in 2016 before falling sharply. A new peak in exports to the European Union occurred in 2018, but they have since decreased. In contrast, China's plywood exports to Vietnam and the Philippines increased sharply between 2010 and 2019. To gain indirect access to the US market, many Chinese mills moved to Vietnam to avoid US import tariffs on China's exports. The United States trade data seems support this claim. Vietnamese plywood exports to the US soared after 2018 while China's plywood exports to the US fell (Alderman 2022).

FIGURE 15 *Destinations of plywood exports*

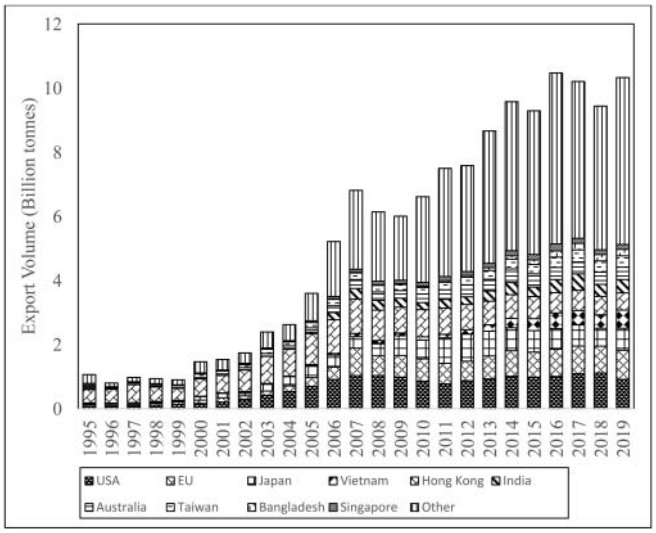


Source of data: China Customs, compiled by authors

Destinations of paper and paperboard exports

Figure 16 shows that China's export market of paper and paperboard is relatively dispersed. The top five markets in 2019 were the United States (8.8%), the European Union (8.8%), Japan (6.6%), Vietnam (5.5%), and Hong Kong SAR (5.2%).

FIGURE 16 *Destinations of paper and paperboard exports*



Source of data: China Customs, compiled by authors

China exports more than half of its paper and paperboard to Asian countries. Among them, Hong Kong SAR plays an important role as a re-export zone. In 1998, 48% of China's paper and paperboard exports were to Hong Kong SAR. This situation has changed, by 2019, Hong Kong's share amounted to just 5.2%.

SUMMARY AND CONCLUSIONS

Restrictions on logging from domestic natural forests and a booming economy have contributed to a surge in China's forest products imports over the past two decades. As a result, China has become the largest wood importer in the world. Exports of forest products have also grown, but at a slower rate after 2015, indicating increases in domestic consumption. China's timber import control measures would play an important role for China to join international efforts in combating illegal logging and deforestation.

China's forest product import mix has been dominated by primary products, namely logs, lumber, wood chips and wood pulp. The proportional import of lumber has grown as timber supplier countries enforce log export bans, tariffs, or quotas to protect their forests and keep value added processing within the countries. Increases in imports of wood chips and wood pulp after 2017 have largely been driven by China's policy on banning imports of wastepaper.

At the species level, China's imports of softwood have grown faster than hardwood products. Suppliers of softwood logs and lumber have been concentrated to global north countries including New Zealand, Russia, European countries, United States and Canada. These countries, except for Russia (Russia Far East in particular), are perceived as reliable sources of sustainably harvested timber. On the other hand, suppliers of hardwood have been more diversified. The top suppliers of tropical hardwood are deemed at "higher-risk" of poor forest governance, leading to the risk of illegal tropical deforestation.

China's exports of timber products have been dominated by wood furniture and plywood. This has been attributed to the fast growing wood processing industry. Wood furniture has been destined to the US and the European Union, while plywood markets started to shift to Southeast Asian countries such as Vietnam and Philippines. US-China trade war contributed partially to the shift.

A common theme of this analysis of China's forest products trade has been change in terms of magnitude, products mix, sources of imports and market destinations of exports, and the species being demanded. These transformations are the results of market demand, policies at home and in trade partner countries, and trade relations between China and its key trade partners.

As a key domestic forest protection policy, NFPP has played an important role in expanding China's timber imports. However, this has raised concerns that China protects its own forests at the expense of increased deforestation embodied in its imports, in countries where tropical forests are most threatened (Hoang and Kanemoto 2021). Domestic forest policy adjustment would ease such concerns. In addition, international collaborations on combating illegal logging and deforestation could have a larger role to play. When exporting to the Unites States, the European Union, Australia, and Japan, proof of timber coming from legally harvested sources is required. For manufactured wood products remaining in China, similar requirements would help to ensure all imported timber into China is being legally sourced.

Going forward, the Chinese industry should continue to be prepared to adjust as markets change, including monitoring trends in deforestation-free initiatives as well as global and regional economies.

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