

**NATURAL AND SYNTHETIC RUBBER IN CHINA:  
PRODUCTION PERFORMANCE, IMPORT  
ABILITY AND PRODUCTION FORECAST**

**SONG YU**

**UNIVERSITI SAINS MALAYSIA**

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**NATURAL AND SYNTHETIC RUBBER IN CHINA:  
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by

**SONG YU**

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## LIST OF ABBREVIATIONS

|       |                                      |
|-------|--------------------------------------|
| ACFTA | ASEAN-China Free Trade Area          |
| ADF   | Augmented Dickey-Fuller              |
| ARDL  | Autoregressive Distributed Lag model |
| BCC   | Banker - Charnes - Cooper model      |
| CPI   | Consumer Price Index                 |
| CUSUM | Cumulative Sum                       |
| DEA   | Data Envelopment Analysis            |
| DMU   | Decision Making Unit                 |
| FAO   | Food and Agriculture Organization    |
| MAE   | Mean Absolute Error                  |
| MSE   | Mean Squared Error                   |
| NR    | Natural Rubber                       |
| OLS   | Ordinary Least Squares               |
| PTE   | Pure Technical Efficiency            |
| RCA   | Revealed Comparative Advantage       |
| RICI  | Rubber Imports Capacity Index        |
| RMA   | Relative Import Advantage            |
| RMB   | Renminbi                             |
| RO    | Research Objective                   |
| RTA   | Relative Trade Advantage             |
| RXA   | Relative Export Advantage            |
| SE    | Scale Efficiency                     |
| SR    | Synthetic Rubber                     |
| TE    | Technical Efficiency                 |
| TFP   | Total Factor Productivity            |
| TRI   | Total rubber Import value            |
| USD   | United States Dollar                 |
| WTO   | World Trade Organization             |

## **LIST OF APPENDICES**

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# **GETAH ASLI DAN SINTETIK DI CHINA: PRESTASI PENGELUARAN, KEUPAYAAN IMPORT DAN RAMALAN PENGELUARAN**

## **ABSTRAK**

Industri getah China, termasuk getah asli dan sintetik, memainkan peranan penting dalam ekonomi negara tetapi menghadapi cabaran berterusan, dengan purata produktiviti getah asli hanya 1.13 tan sehektar dari 1993 hingga 2022, jauh lebih rendah berbanding Thailand iaitu 1.54 tan, mencerminkan isu produktiviti rendah dan ketidakcekapan. Kecekapan teknikal TE dan produktiviti faktor keseluruhan TFP merosot dalam perusahaan milik negara terutamanya di Hainan dan Yunnan, manakala pengeluaran getah sintetik berkembang stabil dengan sokongan teknologi dan dasar meskipun masih tidak mencukupi. Pertumbuhan pengeluaran getah asli tidak menentu akibat krisis ekonomi global dan turun naik pasaran, dengan kebergantungan tinggi terhadap import meningkatkan kerentanan rantaian bekalan. Kajian ini menilai prestasi pengeluaran dan keupayaan import menggunakan Analisis Penyampulan Data untuk TE, Model Pertumbuhan Solow untuk TFP, regresi linear berganda untuk faktor penentu dan model Prophet untuk ramalan jangka panjang, serta menilai keupayaan import melalui Kelebihan Import Relatif RMA dan kapasiti import. Hasil kajian menunjukkan CPI memberi kesan negatif terhadap TE dan TFP getah asli tetapi harga getah yang lebih tinggi meningkatkan TE, di mana pertumbuhan pendapatan menyokong pengeluaran getah asli sementara import yang meningkat menghalangnya, dengan pertumbuhan import getah sintetik merangsang

pengeluaran domestik dan pengeluaran getah sintetik yang meningkat turut mendorong pertumbuhan getah asli, menonjolkan hubungan saling melengkapi. Proyeksi menunjukkan pengeluaran getah asli akan stagnan manakala pertumbuhan getah sintetik perlahan dari 7.97 peratus pada 2023 kepada 5.51 peratus menjelang 2032, dengan CPI lewat memberi kesan positif kepada RMA getah asli tetapi mengurangkan kapasiti import getah sintetik, sementara harga getah kekal sebagai faktor dominan kapasiti import kedua-duanya. Cadangan dasar termasuk memajukan teknologi melalui mekanisasi, automasi dan amalan mampan, subsidi disasarkan untuk perusahaan getah asli milik negara, kontrak bekalan jangka panjang dan simpanan strategik, pembangunan bersepadu getah asli-sintetik, pengurusan import seimbang dengan mengekalkan tarif rendah untuk sintetik sambil melindungi getah asli, serta kerjasama diperkukuh dengan Thailand, Malaysia dan Indonesia dan perjanjian perdagangan untuk menjamin bekalan dan kestabilan import.

**NATURAL AND SYNTHETIC RUBBER IN CHINA: PRODUCTION  
PERFORMANCE, IMPORT ABILITY AND PRODUCTION FORECAST**

**ABSTRACT**

China's rubber industry, including natural and synthetic rubber, plays a vital role in the national economy but faces persistent challenges. From 1993 to 2022, the average natural rubber productivity reached 1.13 tons per hectare, significantly lower than Thailand's 1.54 tons per hectare, revealing low productivity and inefficiency. Technical efficiency (TE) and total factor productivity (TFP) declined in state-owned enterprises, particularly in Hainan and Yunnan. Synthetic rubber production expanded steadily, supported by technology and policy measures, yet overall production remains insufficient. Natural rubber production growth fluctuated under global economic crises and market volatility, while heavy dependence on imports increased supply chain vulnerability. This study evaluates production performance and import ability, identifies affecting factors, and forecasts future trends. Data Envelopment Analysis measures TE, the Solow Growth Model estimates TFP, and multiple linear regression examines determinants, while the Prophet model predicts long-term production growth. Import ability is assessed using Relative Import Advantage (RMA) and import capacity. Findings indicate that CPI exerted a negative influence on natural rubber TE and TFP, while higher natural rubber prices improved TE. Income growth supported natural rubber production growth, whereas increasing imports constrained natural rubber production. Synthetic rubber import growth

stimulated domestic production growth. Increased synthetic rubber production further promoted the growth of natural rubber production, highlighting the complementary relationship between the two industries. Looking ahead, natural rubber production is projected to stagnate, while synthetic rubber growth slows, with the annual rate declining from 7.97% in 2023 to 5.51% by 2032. Lagged CPI positively affected natural rubber RMA but CPI reduced synthetic rubber import capacity. Rubber price remained a dominant factor for import capacity of both categories. Policy recommendations include promoting technological advancement through mechanization, automation, and sustainable practices to offset labor cost pressure and enhance TE. Targeted subsidies should support natural rubber state-owned enterprises in Hainan and Yunnan. Long-term supply contracts and strategic reserves can stabilize demand during global downturns. Integrated development of natural and synthetic rubber will strengthen industrial resilience. Balanced import management should maintain low tariffs for synthetic rubber while imposing protective measures on natural rubber. Strengthened cooperation with major producers such as Thailand, Malaysia, and Indonesia will secure raw material supply, while supportive trade agreements will reinforce import stability and cost-effectiveness.

## **CHAPTER 1**

### **INTRODUCTION**

#### **1.1 China Rubber Production Performance**

Rubber, categorized as a polymer material, finds extensive applications across various sectors, including manufacturing, agriculture, national defence, transportation, and daily life. As an essential raw material for crafting aircraft, automotive tyres, and diverse sealing materials, thereby holding national strategic significance. Rubber is broadly classified into two categories based on the origin: natural rubber and synthetic rubber (Wang, 2015).

After over 180 years of evolution, the rubber industry has emerged as a pivotal sector in numerous countries worldwide. Currently, the global annual rubber consumption exceeds 17 million tons, with over 100,000 rubber products pervading diverse realms of human society. Over the past five decades, prompted by the repercussions of the twin oil crises during the 1970s, the international rubber industry has manifested a fresh developmental trajectory emphasizing the enhancement of product quality, augmentation of production volume, and cost reduction. This marks a departure from the longstanding reliance on quantitative expansion as the sole avenue for attaining economic gains. Presently, the global rubber industry confronts formidable challenges, including severe overproduction, intense market competition, and a discernible downturn in average industrial income. Given the swift advancements in global high and new technology, a comprehensive restructuring, transformation, and reformation of the traditional rubber industry has become an

inevitable imperative. Only through expediting industrial upgrades, fostering product advancement, and swiftly embracing high-tech innovations can the rubber industry persist in a trajectory of continuous development and growth (Wang, 2015).

As a pivotal sector within China's national economy, the rubber industry holds significant interconnectedness, spanning numerous industries, providing substantial employment opportunities, and generating considerable economic returns. Analogous to oil and coal, rubber stands as a crucial resource underpinning the nation (Deng, 2022). Given China's status as a major producer and consumer of rubber, consistently ranking as the world leader in rubber consumption for many years, examining the industrial and economic dynamics of China's rubber sector becomes imperative. Conducting research on China's rubber industry, conducting thorough analyses of the affecting factors within the sector, and identifying prevalent issues in the development of the rubber industry are critical endeavours. Such endeavours contribute to the optimization of the structure and industrial layout of China's rubber industry, fostering enhanced competitiveness. Subsequently, this research serves as a theoretical underpinning for formulating national rubber industry policies and guiding the effective implementation of these policies.

In 2022, China's rubber production totalled 5.69 million tons, contributing to the global rubber output of 35.23 million tons. China's ranking in rubber production stands at fifth globally. As illustrated in Figure 1.1, China's share in global rubber production constitutes 16%, with the remaining 84% attributed to other countries. This delineation underscores China's significant role in the rubber market, albeit

other nations' production holds sway over the global landscape. The observed phenomenon may stem from factors such as technical efficiency, productivity levels, and domestic demand within China's rubber industry, warranting further academic inquiry.

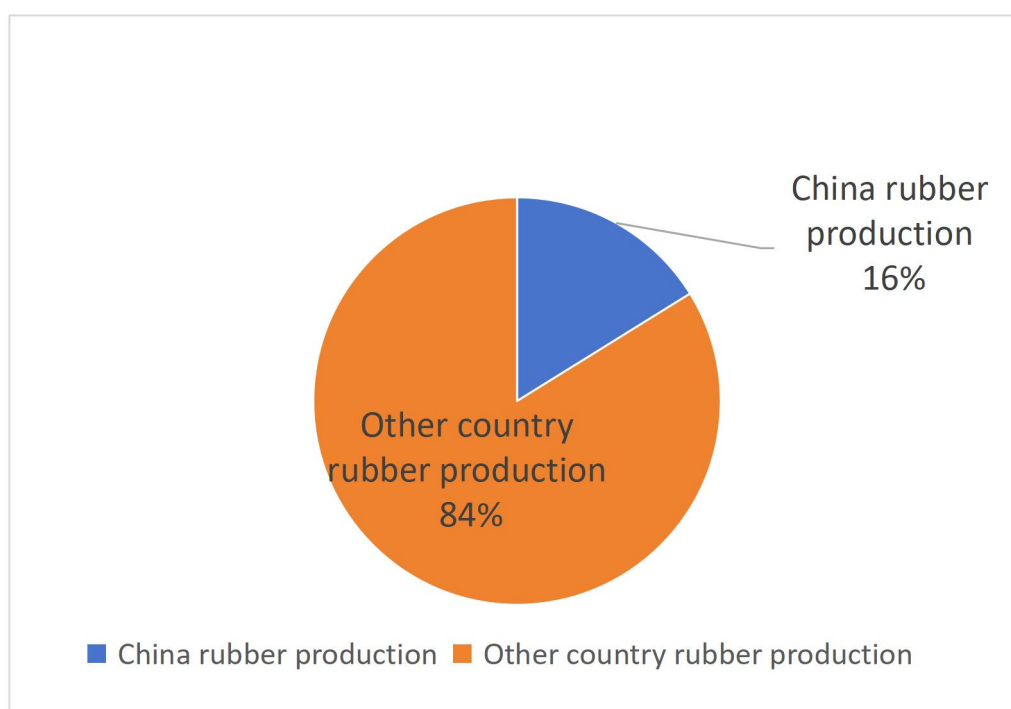


Figure 1. 1 China rubber production and other country rubber production

Source: Yearbook of China Rubber Industry, 2022

As depicted in Table 1.1 and Figure 1.2, spanning from 1993 to 2022, China's rubber market underwent significant transformations. Production surged from 0.72 million tons to 5.69 million tons, showcasing a consistent growth trajectory with a remarkable growth rate of 690%. Concurrently, import volumes soared from 0.66 million tons to 7.27 million tons, surpassing production growth and signalling an escalating reliance on imports, boasting a growth rate of 1002%. Furthermore, export volumes ascended from 0.04 million tons to 0.36 million tons, registering an impressive growth rate of 800%, thereby highlighting an augmentation in China's

rubber industry's competitive prowess on the global stage. Nevertheless, local demand exhibited an overall upward trajectory, escalating from 1.34 million tons in 1993 to 12.60 million tons in 2022, with a growth rate of 840%. Despite intermittent declines in 2008, 2019, and 2021, attributed to the global financial crisis and the COVID-19 pandemic respectively, the overarching trajectory remains favourable. A comprehensive examination unveils stable growth patterns in production, import, export, and local demand for rubber in China. Noteworthy are the discernibly higher growth rates observed in rubber imports and local demand relative to production and exports. This underscores a burgeoning reliance on imports, given China's rubber production consistently falls short of satiating local demand, thereby exacerbating this predicament over time.

Table 1.1 Production, import, export and local demand of rubber in China

| Year \ Metrics | China rubber production, A (million tons) | China rubber import, B (million tons) | China rubber export, C (million tons) | China local rubber demand, A+B-C (million tons) |
|----------------|-------------------------------------------|---------------------------------------|---------------------------------------|-------------------------------------------------|
| 1993           | 0.72                                      | 0.66                                  | 0.04                                  | 1.34                                            |
| 1994           | 0.77                                      | 0.75                                  | 0.04                                  | 1.49                                            |
| 1995           | 0.90                                      | 0.67                                  | 0.05                                  | 1.53                                            |
| 1996           | 0.91                                      | 0.82                                  | 0.03                                  | 1.70                                            |
| 1997           | 1.02                                      | 0.81                                  | 0.05                                  | 1.78                                            |
| 1998           | 1.05                                      | 0.88                                  | 0.05                                  | 1.89                                            |
| 1999           | 1.20                                      | 1.05                                  | 0.06                                  | 2.19                                            |
| 2000           | 1.33                                      | 1.62                                  | 0.08                                  | 2.87                                            |
| 2001           | 1.38                                      | 1.80                                  | 0.08                                  | 3.09                                            |

|      |      |      |      |       |
|------|------|------|------|-------|
| 2002 | 1.52 | 1.97 | 0.09 | 3.39  |
| 2003 | 1.70 | 2.46 | 0.08 | 4.08  |
| 2004 | 1.81 | 2.71 | 0.10 | 4.42  |
| 2005 | 1.84 | 2.79 | 0.10 | 4.53  |
| 2006 | 2.00 | 3.44 | 0.09 | 5.35  |
| 2007 | 2.22 | 3.46 | 0.07 | 5.61  |
| 2008 | 2.17 | 3.33 | 0.10 | 5.40  |
| 2009 | 2.59 | 4.17 | 0.11 | 6.65  |
| 2010 | 3.10 | 4.45 | 0.24 | 7.31  |
| 2011 | 3.42 | 4.40 | 0.29 | 7.52  |
| 2012 | 3.63 | 4.95 | 0.22 | 8.35  |
| 2013 | 3.87 | 5.62 | 0.22 | 9.27  |
| 2014 | 3.77 | 5.76 | 0.20 | 9.33  |
| 2015 | 3.93 | 5.73 | 0.19 | 9.46  |
| 2016 | 4.21 | 5.97 | 0.21 | 9.97  |
| 2017 | 4.45 | 7.28 | 0.26 | 11.47 |
| 2018 | 4.63 | 7.08 | 0.23 | 11.48 |
| 2019 | 4.84 | 6.59 | 0.22 | 11.21 |
| 2020 | 5.14 | 7.39 | 0.31 | 12.22 |
| 2021 | 5.50 | 6.49 | 0.29 | 11.70 |
| 2022 | 5.69 | 7.27 | 0.36 | 12.60 |

Source: Yearbook of China Rubber Industry, 1993-2022

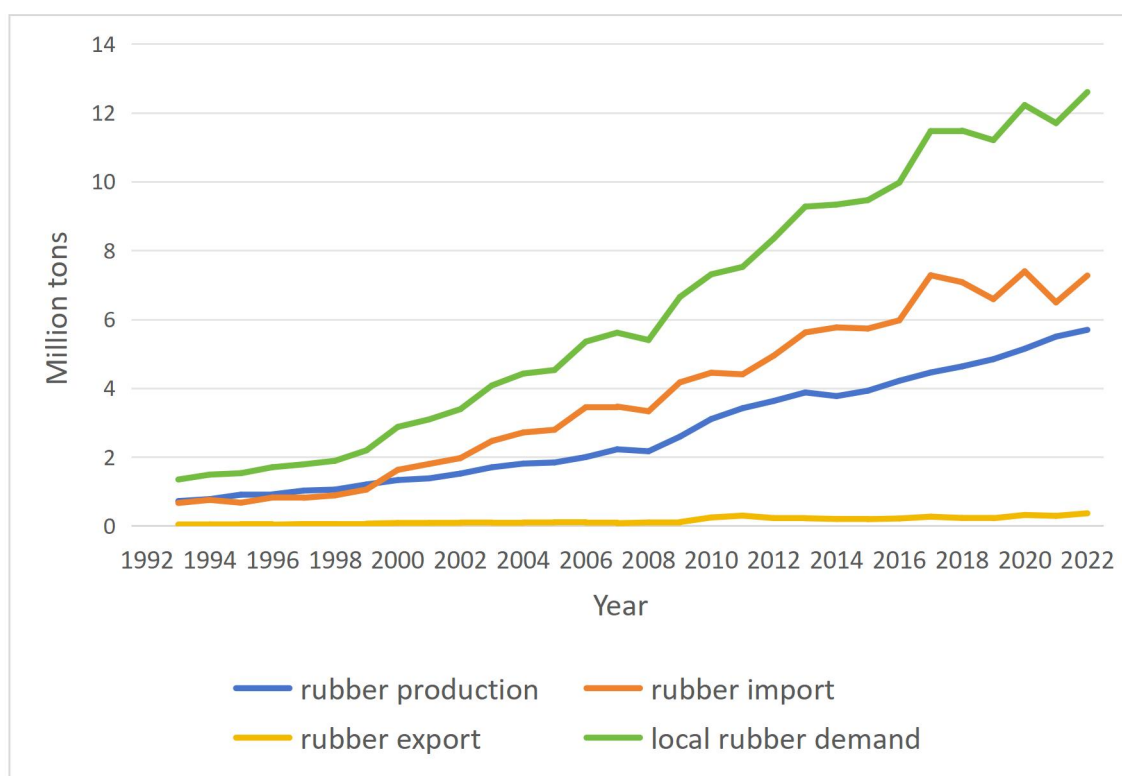


Figure 1.2 Production, import, export and local demand of rubber in China

Source: Yearbook of China Rubber Industry, 1993-2022

In 2022, the aggregate rubber consumption in China, which reflects the local rubber demand, amounts to 12.6 million tons, with natural rubber comprising 6.91 million tons and synthetic rubber 5.69 million tons. As depicted in Figure 1.3, China's rubber consumption is substantial, with natural rubber representing the majority at approximately 55%, while synthetic rubber constitutes a comparatively smaller portion, accounting for about 45% of the total consumption. This underscores the prevalence of natural rubber in China's rubber consumption landscape, reflecting a consumer preference for natural rubber.

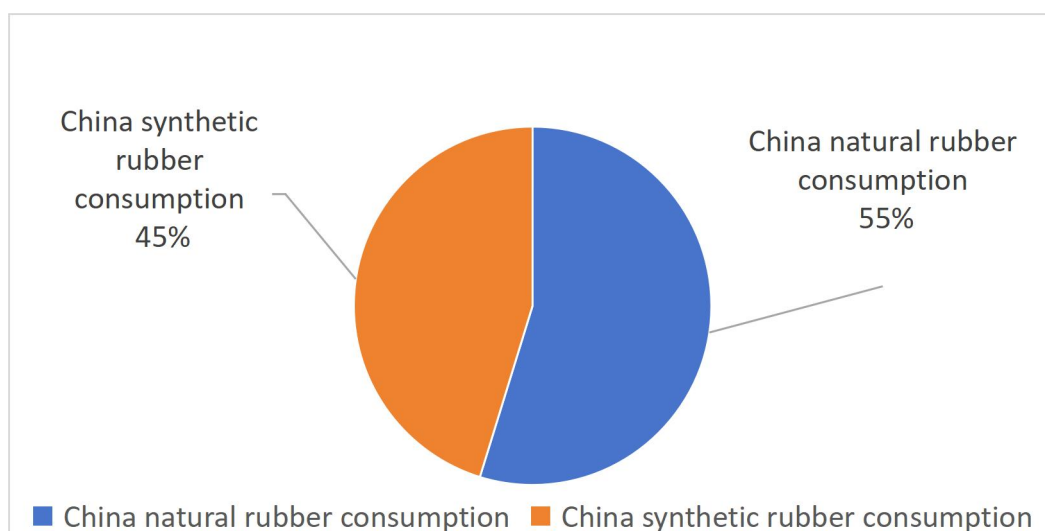


Figure 1.3 China natural rubber consumption and China synthetic rubber consumption in 2022

Source: Yearbook of China Rubber Industry, 2022

In 2022, China's aggregate rubber production stands at 5.66 million tons, comprised of 853,000 tons of natural rubber and 4.84 million tons of synthetic rubber. As depicted in Figure 1.4, China's rubber production is considerable, with synthetic rubber production dominating at approximately 85%, while natural rubber production constitutes a relatively modest share of around 15% of the total output. This underscores the predominance of synthetic rubber manufacturing in China's rubber industry landscape.

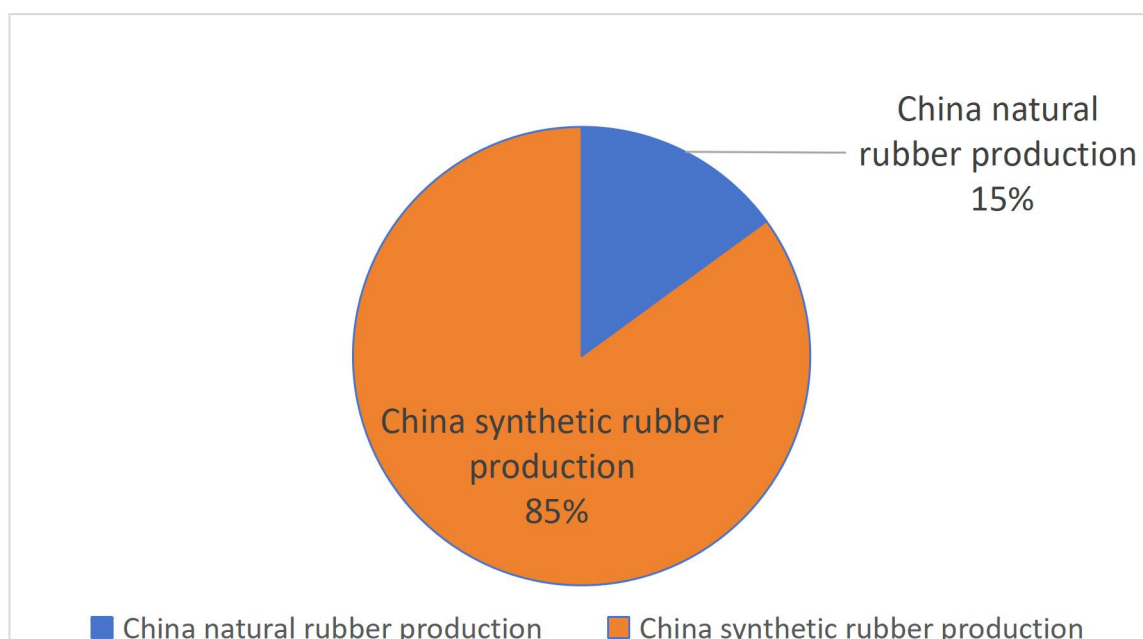


Figure 1.4 China natural rubber production and China synthetic rubber production in 2022

Source: Yearbook of China Rubber Industry, 2022

Figure 1.5 illustrates the fluctuating pattern in the production growth of natural rubber in China, alongside a similar trend observed in synthetic rubber production. From 1993 to 2022, China's natural rubber production showed significant fluctuations, experiencing negative growth in 12 of those years and growth in the remaining 18 years. In contrast, China's synthetic rubber production was relatively more stable, with only 2008 and 2014 experiencing negative growth, and consistent growth observed in the other years. If the production growth of China's natural rubber and China's synthetic rubber is negative and sustained, as depicted in Figure 1.5, this indicates that production will decrease, leading to increased costs and consequently greater dependence on imports.

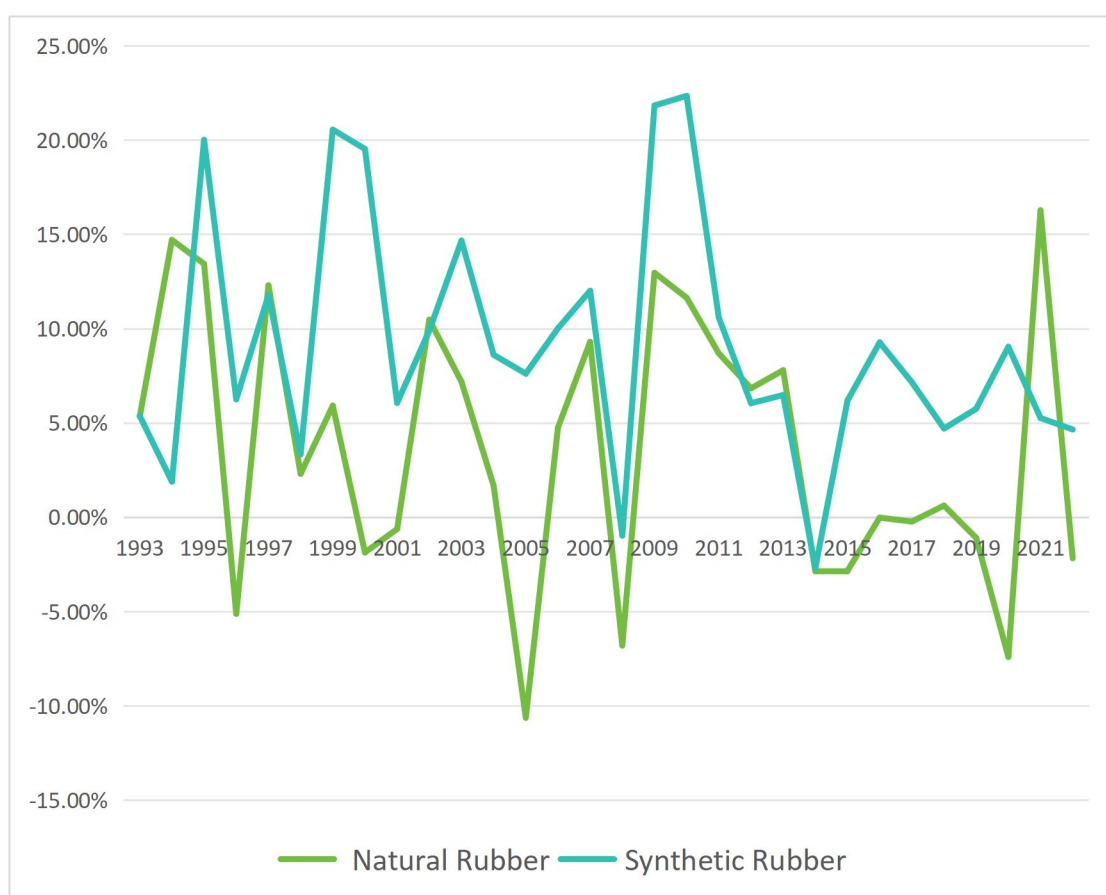


Figure 1.5 The Production Growth of Natural Rubber and Synthetic Rubber in China

Source: Yearbook of China Rubber Industry, 1993-2022

### 1.1.1 Natural Rubber Production

Natural rubber stands out as a quintessential tropical crop in China, boasting an extensive array of applications. Incompletely documented statistics suggest that the global inventory of items containing natural rubber has surpassed 100,000 varieties (Li, 2014). China's foray into natural rubber cultivation commenced with the introduction of Brazilian rubber trees in 1940. Over more than six decades and through the concerted efforts of multiple generations, China successfully debunked the prevailing belief among foreign natural rubber experts. This achievement shattered the myth that natural rubber cultivation could only thrive between 10

degrees south and 15 degrees north of the equator. Instead, China achieved the cultivation of natural rubber on a substantial scale between 18 degrees and 24 degrees north, establishing robust natural rubber production bases in Hainan, Yunnan, and Guangdong provinces (Li, 2014).

China's total production of natural rubber in 2022 amounted to 853,000 tons (China Rubber Industry Association, 2022). An examination of Figure 1.6 reveals notable regional disparities in natural rubber production within China. Yunnan Province emerges as the predominant contributor, with a total production of 521,500 tons, representing 61% of the nation's total output and securing the top position nationally. Following closely, Hainan Province contributed 314,500 tons, constituting 37% of the national output and securing the second rank. Conversely, Guangdong Province exhibited a comparatively modest production figure of 17,000 tons, accounting for a mere 2% of the total. These findings underscore the regional variations in natural rubber production across China, highlighting Yunnan and Hainan provinces as primary producers, while Guangdong Province exhibits comparatively minimal production.

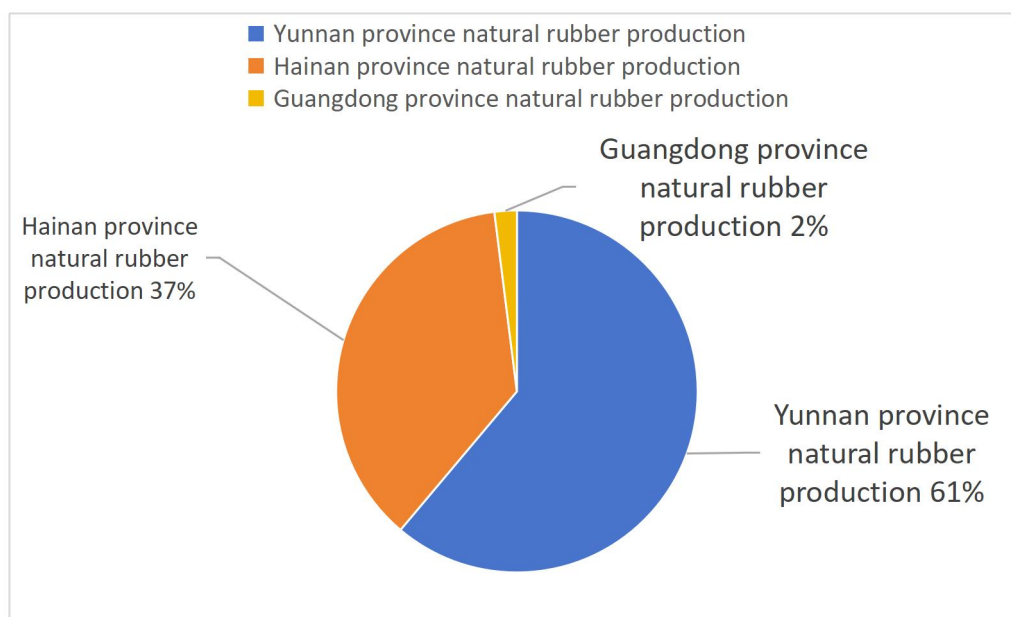


Figure 1.6 Proportion of natural rubber production per province in China in 2022

Source: Yearbook of China Rubber Industry, 2022

In 2022, China's total rubber tapping area for natural rubber amounted to 789,300 ha (China Rubber Industry Association, 2022). Analysis of Figure 1.7 reveals significant regional variations in the distribution of natural rubber tapping areas across the country. Hainan Province emerges as the primary contributor, boasting a tapping area of 391,000 ha, which represents 49% of the nation's total and secures the top rank nationally. Following closely, Yunnan Province contributes a tapping area of 37,800 ha, constituting 38% of the national total and securing the second rank. In contrast, Guangdong Province exhibits a relatively modest tapping area of 20,300 ha, accounting for a mere 3% of the total. These findings underscore the regional disparities in natural rubber tapping areas across China, with Hainan and Yunnan provinces holding dominant positions while Guangdong Province exhibits comparatively limited.

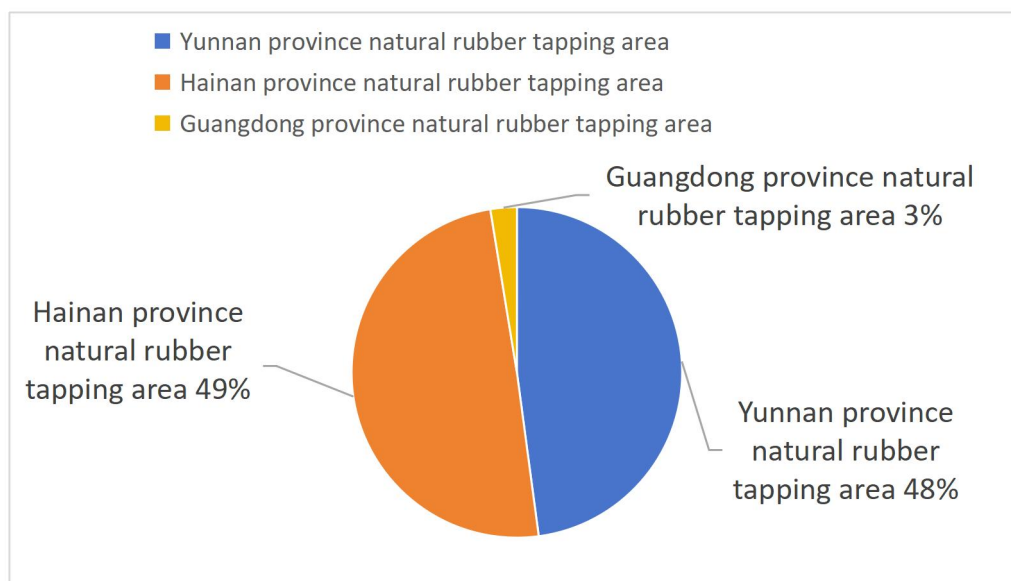


Figure 1.7 Proportion of natural rubber tapping area per province in China in 2022

Source: Yearbook of China Rubber Industry, 2022

China emerges not only as a substantial consumer of natural rubber but also as a major importer, predominantly sourced from Southeast Asian nations such as Thailand, Indonesia, and Malaysia. These countries recognized globally as leading rubber producers, constitute China's primary import sources. Therefore, comparing China's average natural rubber production with that of Malaysia, Indonesia, and Thailand becomes essential. As depicted in Table 1.2, from 1993 to 2022, China's natural rubber production witnessed an upward trajectory from 326 thousand tons in 1993 to 853 thousand tons in 2022, indicating a consistent year-on-year growth trend. In parallel, natural rubber production in Thailand and Indonesia also exhibited upward trends during this period, with Thailand recording an increase from 1506 thousand tons in 1993 to 4826 thousand tons in 2022. Similarly, Indonesia's production escalated from 1475 thousand tons in 1993 to 3135 thousand tons in 2022. Conversely, Malaysia's natural rubber production experienced a downward spiral,

declining from 1074 thousand tons in 1993 to 377 thousand tons in 2022. Although China's natural rubber production demonstrates substantial growth, a significant disparity persists when compared to Thailand, which shows the most substantial increase among the four countries. Notably, Thailand and Indonesia, as primary natural rubber producers, maintained relatively stable production growth throughout this period, solidifying the positions of both countries in the global market, while Malaysia witnessed a pronounced downward trend, indicating a relative decline in Malaysia's production capacity. These trends bear significant implications for understanding the supply dynamics of China's natural rubber market and assessing China's international competitiveness in the natural rubber industry compared to major producers like Thailand and Indonesia, Malaysia.

Table 1.2 Natural rubber production in China, Thailand, Indonesia, Malaysia

| Year<br>Country      | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 |
|----------------------|------|------|------|------|------|------|------|------|------|------|
| Unit (thousand tons) |      |      |      |      |      |      |      |      |      |      |
| China                | 326  | 374  | 424  | 402  | 452  | 462  | 490  | 482  | 477  | 527  |
| Thailand             | 1506 | 1630 | 1693 | 1802 | 1890 | 1943 | 2048 | 2279 | 2523 | 2633 |
| Indonesia            | 1475 | 1464 | 1532 | 1574 | 1548 | 1564 | 1604 | 1501 | 1607 | 1630 |
| Malaysia             | 1074 | 1101 | 1089 | 1082 | 971  | 886  | 769  | 928  | 882  | 890  |
| Year<br>Country      | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
| China                | 565  | 575  | 513  | 538  | 588  | 548  | 619  | 691  | 751  | 802  |
| Thailand             | 2860 | 3007 | 2980 | 3071 | 3024 | 3167 | 3090 | 3052 | 3349 | 4139 |
| Indonesia            | 1792 | 2066 | 2271 | 2637 | 2755 | 2751 | 2440 | 2735 | 2990 | 3012 |

|           |      |      |      |      |      |      |      |      |      |      |
|-----------|------|------|------|------|------|------|------|------|------|------|
| Malaysia  | 986  | 1169 | 1126 | 1284 | 1200 | 1072 | 857  | 939  | 996  | 923  |
| Year      | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 |
| Country   |      |      |      |      |      |      |      |      |      |      |
| China     | 865  | 840  | 816  | 816  | 814  | 819  | 810  | 750  | 872  | 853  |
| Thailand  | 4305 | 4566 | 4466 | 4519 | 4503 | 4814 | 4840 | 4860 | 4892 | 4826 |
| Indonesia | 3108 | 3153 | 3145 | 3307 | 3680 | 3630 | 3449 | 3037 | 3045 | 3135 |
| Malaysia  | 826  | 669  | 722  | 674  | 740  | 603  | 640  | 515  | 470  | 377  |

Source: FAOSTAT, 1993-2022

Table 1.3 provides insights into the natural rubber tapping areas across China, Thailand, Indonesia, and Malaysia. The data reveals that China's natural rubber tapping area expanded from 436 thousand ha in 1993 to 789 thousand ha in 2022, indicating a consistent upward trajectory over the years. Similarly, Thailand and Indonesia exhibited increasing trends in natural rubber tapping areas, with Indonesia notably escalating from 2,675 thousand ha in 1993 to 3,827 thousand ha in 2022. Thailand's natural rubber tapping area also witnessed growth, advancing from 1,601 ha in 1993 to 3,509 ha in 2022. In contrast, Malaysia experienced a marginal decline in the natural rubber tapping area during this period, declining from 1,326 thousand ha in 1993 to 1,136 thousand ha in 2022. Despite China's progressive expansion in the natural rubber tapping area, a substantial gap persists when compared to Thailand and Indonesia. Notably, Thailand and Indonesia, as primary natural rubber producers, sustained relatively stable growth in natural rubber tapping areas throughout this period.

Table 1.3 Natural rubber tapping area in China, Thailand, Indonesia, Malaysia

| Year<br>Country    | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 |
|--------------------|------|------|------|------|------|------|------|------|------|------|
| Unit (thousand ha) |      |      |      |      |      |      |      |      |      |      |
| China              | 425  | 417  | 395  | 395  | 407  | 408  | 418  | 421  | 417  | 429  |
| Thailand           | 1211 | 1249 | 1276 | 1310 | 1345 | 1386 | 1432 | 1462 | 1504 | 1554 |
| Indonesia          | 2065 | 2056 | 2261 | 2246 | 2260 | 2269 | 2300 | 2400 | 2599 | 2635 |
| Malaysia           | 1768 | 1738 | 1689 | 1650 | 1616 | 1556 | 1465 | 1431 | 1389 | 1349 |
| Year<br>Country    | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
| China              | 436  | 454  | 465  | 477  | 476  | 517  | 537  | 577  | 598  | 651  |
| Thailand           | 1601 | 1656 | 1691 | 1743 | 1767 | 1820 | 1856 | 1929 | 2043 | 2520 |
| Indonesia          | 2675 | 2675 | 3279 | 2726 | 2776 | 3424 | 3435 | 3445 | 3456 | 3484 |
| Malaysia           | 1326 | 1279 | 1271 | 1264 | 1248 | 1247 | 1028 | 1020 | 1027 | 1041 |
| Year<br>Country    | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 |
| China              | 686  | 695  | 711  | 720  | 744  | 765  | 770  | 745  | 775  | 789  |
| Thailand           | 2634 | 2916 | 3015 | 3048 | 3057 | 3204 | 3273 | 3518 | 3516 | 3509 |
| Indonesia          | 3556 | 3606 | 3621 | 3637 | 3659 | 3671 | 3683 | 3726 | 3777 | 3827 |
| Malaysia           | 1057 | 1066 | 1074 | 1078 | 1082 | 1083 | 1113 | 1139 | 1137 | 1136 |

Source: FAOSTAT, 1993-2022

As elucidated in Table 1.4, an examination of productivity trends across China and Southeast Asian nations reveals intriguing insights. China's productivity exhibited a notable increase from 0.77 tons per hectare (t/ha) in 1993 to 1.26 t/ha in 2013. However, a subsequent decline ensued, with productivity reaching 1.08 t/ha by 2022. A similar trend can be observed in Indonesia, where productivity increased

from 0.71 t/ha in 1993 to 1.01 t/ha in 2017, before declining to 0.82 t/ha by 2022. This pattern is also evident in Thailand, where productivity rose from 1.24 t/ha in 1993 to 1.79 t/ha in 2003, then decreased to 1.38 t/ha by 2022. Similarly, in Malaysia, productivity improved from 0.61 t/ha in 1993 to 0.97 t/ha in 2011, before falling to 0.33 t/ha by 2022. The notably lower productivity of China's natural rubber compared to Thailand's may stem from underlying issues of inefficiency and lower productivity levels. Consequently, elucidating the factors affecting China's natural rubber productivity assumes paramount importance in comprehending the dynamics shaping the production performance of China's natural rubber industry.

Table 1.4 Natural rubber productivity in China, Thailand, Indonesia, Malaysia

| Year<br>Country | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 |
|-----------------|------|------|------|------|------|------|------|------|------|------|
| Unit (ton/ha)   |      |      |      |      |      |      |      |      |      |      |
| China           | 0.77 | 0.90 | 1.07 | 1.02 | 1.11 | 1.13 | 1.17 | 1.14 | 1.15 | 1.23 |
| Thailand        | 1.24 | 1.30 | 1.33 | 1.38 | 1.41 | 1.40 | 1.43 | 1.56 | 1.68 | 1.69 |
| Indonesia       | 0.71 | 0.71 | 0.68 | 0.70 | 0.69 | 0.69 | 0.70 | 0.63 | 0.62 | 0.62 |
| Malaysia        | 0.61 | 0.63 | 0.64 | 0.66 | 0.60 | 0.57 | 0.52 | 0.65 | 0.63 | 0.66 |
| Year<br>Country | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
| China           | 1.30 | 1.27 | 1.10 | 1.13 | 1.24 | 1.06 | 1.15 | 1.20 | 1.26 | 1.23 |
| Thailand        | 1.79 | 1.82 | 1.76 | 1.76 | 1.71 | 1.74 | 1.66 | 1.58 | 1.64 | 1.64 |
| Indonesia       | 0.67 | 0.77 | 0.69 | 0.97 | 0.99 | 0.80 | 0.71 | 0.79 | 0.87 | 0.86 |
| Malaysia        | 0.74 | 0.91 | 0.89 | 1.02 | 0.96 | 0.86 | 0.83 | 0.92 | 0.97 | 0.89 |
| Year<br>Country | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 |

|           |      |      |      |      |      |      |      |      |      |      |
|-----------|------|------|------|------|------|------|------|------|------|------|
| China     | 1.26 | 1.21 | 1.15 | 1.13 | 1.09 | 1.07 | 1.05 | 1.01 | 1.13 | 1.08 |
| Thailand  | 1.63 | 1.57 | 1.48 | 1.48 | 1.47 | 1.50 | 1.48 | 1.38 | 1.39 | 1.38 |
| Indonesia | 0.87 | 0.87 | 0.87 | 0.91 | 1.01 | 0.99 | 0.94 | 0.82 | 0.81 | 0.82 |
| Malaysia  | 0.78 | 0.63 | 0.67 | 0.62 | 0.68 | 0.56 | 0.57 | 0.45 | 0.41 | 0.33 |

Source: FAOSTAT, 1993-2022

As China's economy surges forward, the rubber industry in China undergoes a continuous expansion, positioning China as the world's foremost consumer of natural rubber. However, the indigenous production of natural rubber in China falls significantly short of meeting domestic demand, resulting in a pronounced reliance on imported natural rubber. As depicted in Figure 1.8, China's natural rubber production has exhibited fluctuations from 1993 to 2022, yet generally demonstrates an upward trajectory, ascending from 326 thousand tons in 1993 to 853 thousand tons in 2022. Concurrently, the volume of natural rubber imports has witnessed a consistent annual increase, escalating from 325 thousand tons in 1993 to 6061.3 thousand tons in 2022, indicative of China's amplified external dependency. Furthermore, China's consumption of natural rubber displays a parallel growth trend, ascending from 650 thousand tons in 1993 to 6,597.4 thousand tons in 2022, underscoring the surge in domestic demand.

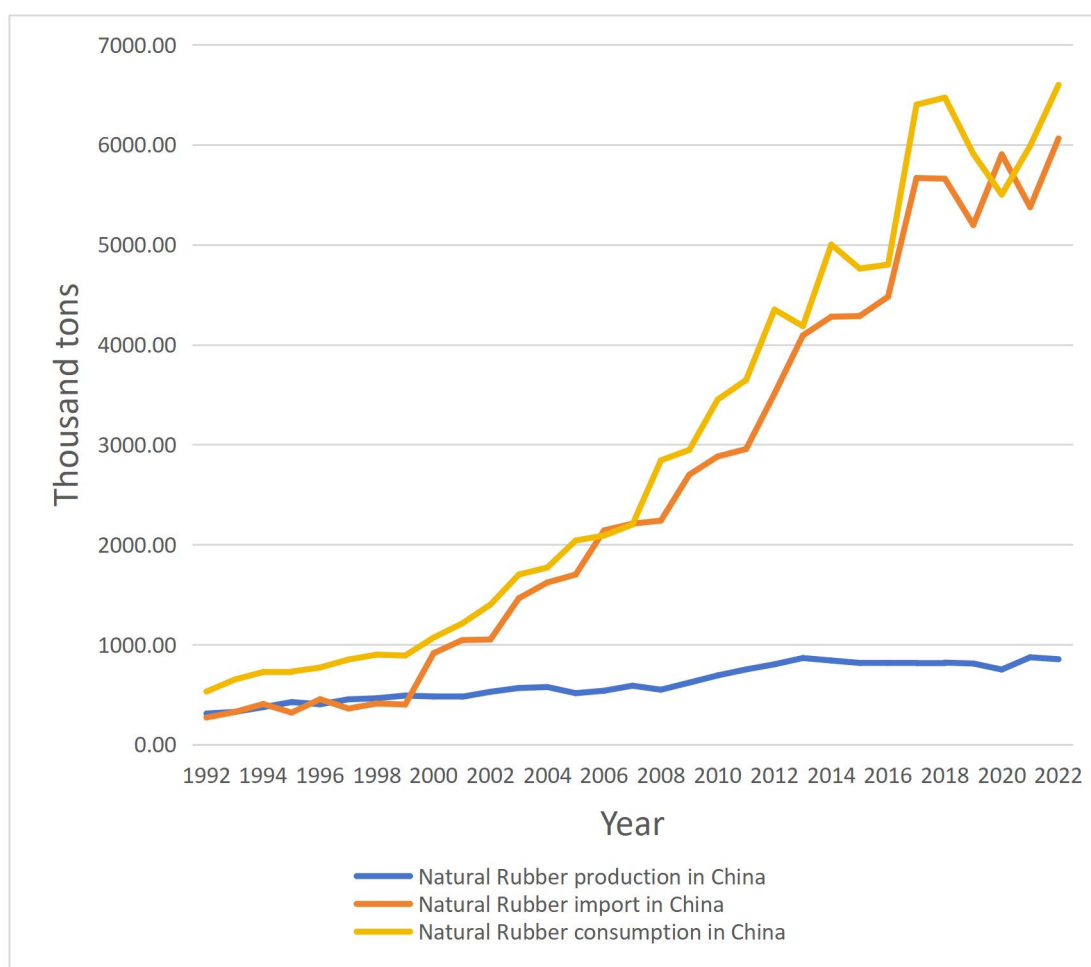


Figure 1.8 Natural Rubber Production, Import and Consumption in China

Source: Yearbook of China Rubber Industry, 1993-2022

### 1.1.2 Synthetic Rubber Production

Synthetic rubber, also known as synthetic elastomer, is a highly flexible polymer produced through chemical methods, which is different from natural rubber made from gum extracted from rubber trees (Yan, 2021). The downstream demand for natural rubber and synthetic rubber is highly overlapping, and both are dominated by the production of tyres. In tyre manufacturing, synthetic rubber can be blended with natural rubber, allowing for a degree of substitution between the two. Encouraging the adoption of synthetic rubber as a substitute for natural rubber

becomes crucial in mitigating China's excessive dependence on the international natural rubber market. This strategic shift can effectively address the imbalance between supply and demand in the country's rubber industry, particularly in light of the pronounced role of tyres as a key driver for both types of rubber (Wang, 2015).

Synthetic rubber stands as one of the three major synthetic materials, representing a petrochemical product intricately linked to both production processes and daily life. This material also holds strategic importance on a national level. This classification of synthetic rubber can be subdivided into general-purpose synthetic rubber and special-purpose synthetic rubber based on performance and applications. General-purpose synthetic rubber encompasses various types of rubber designed to substitute natural rubber. Key varieties include styrene-butadiene rubber, butadiene rubber, isoprene rubber, ethylene-propylene rubber, chloroprene rubber, and styrene-butadiene copolymer rubber. General-purpose synthetic rubber, the primary category of synthetic rubber, commands substantial market demand and finds extensive use in tyre manufacturing and various industrial rubber products. On the other hand, special-purpose synthetic rubber denotes synthetic rubber engineered for specific functions and applications, capable of withstanding challenging conditions. Key varieties include nitrile butadiene rubber and isobutylene isoprene rubber. Typically characterized by high-temperature resistance, oil resistance, ozone resistance, aging resistance, and strong air tightness, special-purpose synthetic rubber is predominantly employed in specialized settings such as the petrochemical industry. Notably, in 2022, over 80% of China's synthetic rubber production capacity structure

was dedicated to general-purpose synthetic rubber varieties (Zheng, 2022).

In 2022, China's synthetic rubber production soared to 4.84 million tons, accompanied by a consumption tally of 5.45 million tons and imports amounting to 1.11 million tons (China Rubber Industry Association, 2022). The principal provinces contributing to synthetic rubber production in China encompass Shandong, Liaoning, Jiangsu, Henan, and Guangdong. These provinces serve as pivotal hubs within China's synthetic rubber manufacturing landscape, boasting well-established industrial bases and formidable production capacities.

With economic expansion, the domestic demand for synthetic rubber is on the rise, as evident in Figure 1.9. This figure illustrates a widening gap between production and consumption, suggesting that sustained investment alone may not suffice for achieving rapid growth in synthetic rubber production. The output curve in Figure 1.9 indicates a consistent year-on-year increase in synthetic rubber production, but the production still falls short of meeting the overall demand. As production reaches a certain threshold, the growth rate tends to decelerate, signalling the conclusion of the phase where output is solely reliant on the input of production factors. Presently, the avenue to achieve increased production lies in adjusting the technical system and product structure.

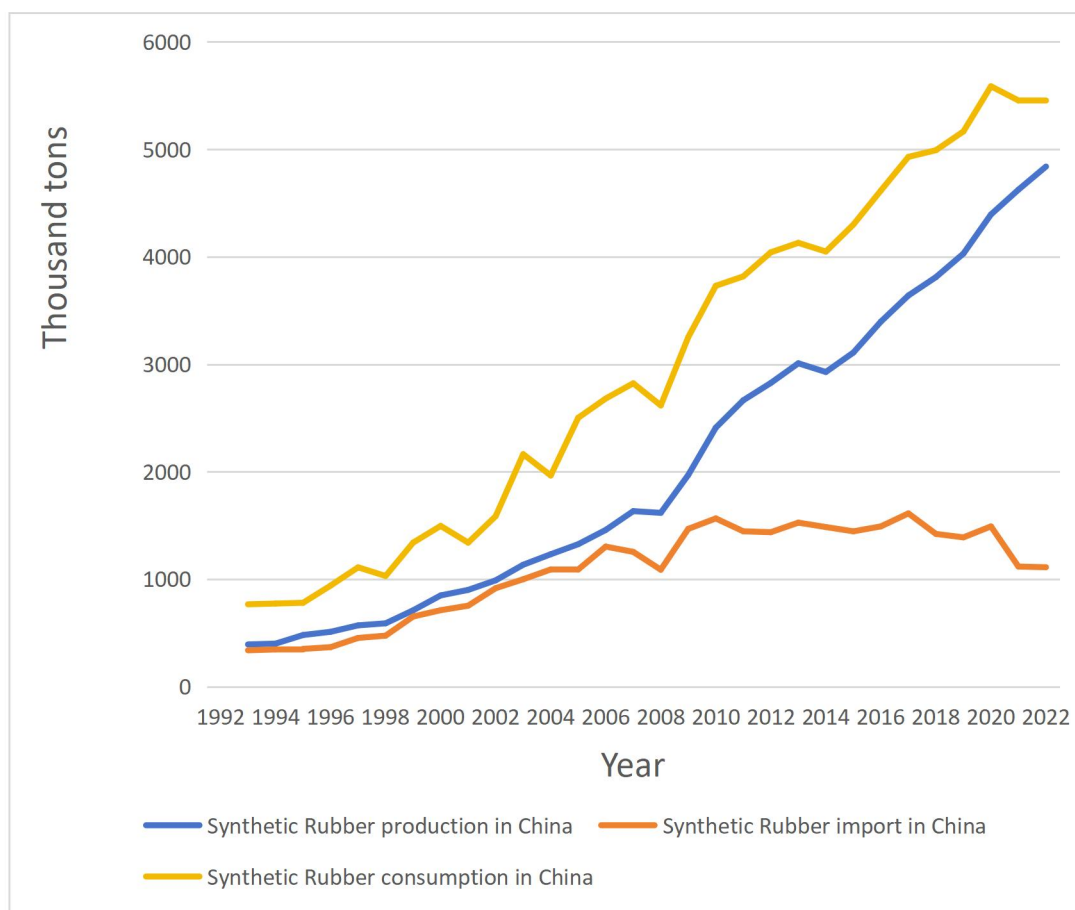


Figure 1.9 Synthetic Rubber Production, Import and Consumption in China

Source: Yearbook of China Rubber Industry, 1993-2022

## 1.2 China Rubber Import

China is the world's foremost importer and consumer of rubber, yet domestic production fails to adequately address the burgeoning demand, both in terms of quantity and quality. In terms of natural rubber, while cultivation boasts a history of over a century in the nation, recent advancements in technology have yielded modest progress. However, the technical efficiency of natural rubber production remains comparatively low, necessitating continued reliance on imports (Dong & Wang, 2018). In terms of synthetic rubber, the industry has experienced rapid growth, spurred by the burgeoning tyre market in China. Nonetheless, current production

levels fall short of meeting actual market demands, prompting the continued reliance on substantial imports (Yan, 2021).

As depicted in Table 1.1 and Figure 1.2, import volumes surged from 0.66 million tons to 7.27 million tons, surpassing production growth and signalling an escalating reliance on imports, with a notable growth rate of 1002%. This highlights a growing dependence on imports, attributable to China's consistent inability to meet domestic rubber demand, exacerbating this dilemma over time. The significant expansion in import volumes underscores a discernible trend of reliance on foreign sources to fulfil the escalating rubber demand within China. This heightened dependency on imports raises pertinent concerns regarding national security implications and the vulnerability of China's rubber industry to fluctuations in global markets, disruptions in supply chains, and geopolitical tensions. Addressing these concerns is imperative to safeguard the stability and resilience of China's rubber sector amidst evolving global dynamics.

National security is a paramount priority for governments worldwide and often involves a complex interplay of diplomatic, military, intelligence, economic, and law enforcement efforts to mitigate risks and preserve the nation's interests. National security refers to the measures and strategies undertaken by a nation to safeguard sovereignty, territorial integrity, political stability, economic prosperity, societal well-being, and the safety of citizens from various internal and external threats. This concept encompasses a wide range of concerns including defence against military aggression, maintenance of economic stability, preservation of social order, and

ensuring resilience to natural disasters (Wikipedia, 2024). The impact of China's rubber industry on national security is multifaceted, rooted in the industry's pivotal role in economic development, industrial production, and strategic interests. Four primary factors contribute to this impact: Firstly, the rubber industry serves as a significant economic contributor in China, fostering employment opportunities, generating income, and supporting diverse sectors like automotive, construction, and manufacturing. Any disruption or instability in the rubber supply chain could detrimentally affect China's economic growth and stability. Secondly, rubber represents a critical strategic resource for various industries, including automotive, tyre manufacturing, and infrastructure development. China's substantial reliance on imported natural rubber makes the country susceptible to supply disruptions, price fluctuations, and market volatility, potentially impacting key economic sectors. Thirdly, rubber is vital for military applications, particularly in tyre production for military vehicles, aircraft, and equipment. Ensuring a stable and secure rubber supply is imperative for maintaining China's military readiness and defence capabilities. Lastly, China's dependence on natural rubber imports necessitates robust diplomatic and trade relations with rubber-producing countries. Any geopolitical tensions, trade disputes, or disruptions in these relations could impede China's access to essential rubber resources, thereby threatening the national security interests (Wang, 2015).

Figure 1.10 illustrates the volumes of China's natural rubber imports, synthetic rubber imports, and total rubber imports from 1993 to 2022. These data underscore the sustained expansion of China's rubber consumer market and the perpetuated

growth in rubber demand. Notably, China's imports of natural rubber greatly exceed China's synthetic rubber, particularly evident in recent years. Over the specified period, natural rubber imports escalated from 325 thousand tons to 6061 thousand tons, while synthetic rubber imports rose from 338 thousand tons to 1205 thousand tons. This disparity underscores the markedly faster pace of natural rubber imports relative to synthetic rubber in the China rubber market. The growth trajectory of China's total rubber imports further accentuates China's stature as the world's foremost rubber importer.

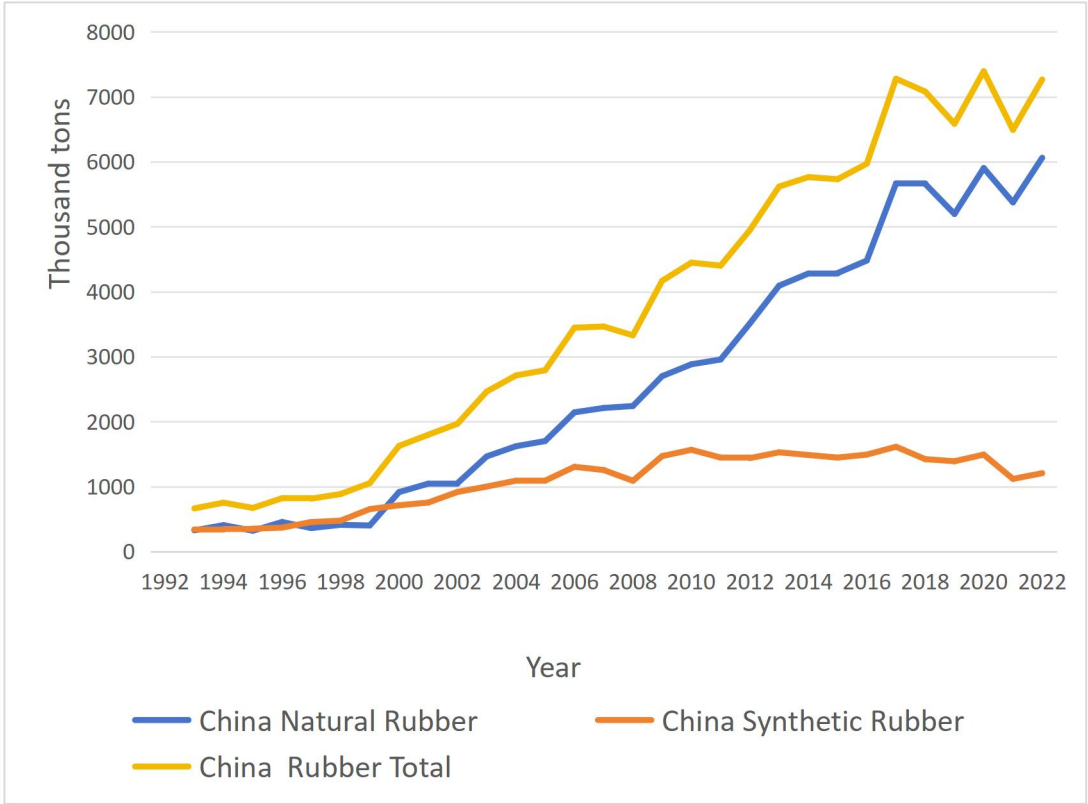


Figure 1.10 The Import Volume of Natural Rubber, Synthetic Rubber and Rubber Total in China

Source: Yearbook of China Rubber Industry, 1993-2022

To understand how China can address these national security concerns, examining the country's import ability is crucial. This is because import ability