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An Assessment of China's Productive Power: a Case Study on RCEP and the Electric Vehicle Industry Development
中國結構性生產力評估：RCEP 與電動車產業發展之案例研究

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Abstract

中國加入了世界最大的自由貿易協定：區域全面經濟夥伴協定（RCEP），使其透過電動車產業增強生產力的獲取能力。在蘇珊・斯特蘭奇（Susan Strange）對生產力的定義中，將生產要素與其優勢相結合的國家將獲得經濟結構力量。藉由加入 RCEP，中國的電動車產業直接被關稅降低及優惠原產地規則所影響，並間接受到國內政策自由化和產業合夥關係之影響。中國公司可能會與日本、韓國公司合作生產電動車，並將東南亞國家協會（ASEAN）視為潛在市場。基於 RCEP 會員國間現有的貿易網絡，原物料和鋰電池等中、上游進口產品的關稅降低和原產地規則將施惠中國。這為中國創造了能趕上電動車電池科技領先地位的機會窗口。RCEP 對中國電動車產業之獲益力、研發、市場佔有率的影響，將為國內產業發展做出貢獻。

關鍵詞: 區域全面經濟夥伴協定、自由貿易協定、電動車、生產力

China has joined RCEP, the largest free trade agreement in the world, which enhances their ability to gain productive power through the electric vehicle industry. In Susan Strange's definition of productive power, countries that align the factors of production to their advantage gain economic structural power. By joining RCEP, China's electric vehicle industry is affected directly through lowered tariffs and favorable rules of origin, and indirectly through domestic policy liberalizations and industry partnerships. Chinese firms will likely partner with Japanese and South Korean firms to produce EVs, and look to ASEAN as a possible market. Based on their existing network of trade between RCEP countries, China will benefit from lowered tariffs and rules of origin for upstream and midstream imports on products such as raw materials and lithium battery cells. This creates a window of opportunity for China to catch-up to industry leaders in EV battery technology. RCEP's effect on the profitability, research and development, and market share of China's electric vehicle industry will contribute to domestic industry development.

Keywords: RCEP, free trade agreement, Electric vehicles, productive power

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Abbreviations

ASF	ASF Group Limited, Japanese fabless EV startup
ASSB	All-solid-state battery
BEV	Battery EV
BYD	Biyadi, "Build Your Dream", Chinese EV manufacturer
CPTPP	Comprehensive and Progressive Agreement for Trans-Pacific Partnership
EV	Electric vehicle
FIL	Foreign Investment Law
FTA	Free trade agreement
GDP	Gross domestic product
GVC	Global value chain
HEV	Hybrid EV
ICEV	Internal combustion engine vehicle
IPR	Intellectual property rights
JV	Joint Venture
LFP	lithium-iron-phosphate
LSEV	Low-speed electronic vehicles
NCA	lithium-nickel-cobalt-aluminum oxide
NDRC	National Development and Reform Commission
NEV	New energy vehicle
NMC	lithium-nickel-manganese-cobalt
OEM	Original equipment manufacturer
PEV	Pure EV
PHEV	Plug-in hybrid EV
R&D	Research and development
RCEP	Regional Comprehensive Economic Partnership
ROO	Rules of engagement
RVC	Regional value content
WTO	World Trade Organization

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An Assessment of China's Productive Power:
A Case Study on RCEP and the Electric Vehicle Industry Development

CHAPTER 1. Introduction

In the past few decades, China has embedded itself deeply into the global economy and has emerged as a powerhouse in the Asia-Pacific region. As with most rising powers, China has pursued a multifaceted approach to developing their economy to compete internationally. Two areas of the global economy that China has a growing presence in includes participating in free trade agreements (FTA) and developing advanced technology. Although China has signed many bilateral free trade agreements since its ascension to the World Trade Organization (WTO), their most recent participation in the world's largest FTA, the Regional Comprehensive Economic Partnership (RCEP) signals a shift toward multilateralism. Involvement in RCEP is sure to provoke changes in several industries, and this research will focus on its potential effect on China's productive power through the electric vehicle (EV) industry.

Productive power as defined by Susan Strange is a type of structural power obtained through control over the international factors of production.[1] States that structure the production of goods and services to their own benefit gain productive power due to increased economic access and influence. Because of the multinational nature of supply chains for many goods and services, especially those of the EV industry, factors that influence cross border trade will influence a country's productive power. RCEP is the world's largest FTA and contains many countries within the EV supply chain. Consequentially, changes to linkages between RCEP countries with a stake in the EV supply chain and China's domestic EV related products have the potential to affect China's productive power.

The 'innovation imperative' for rising countries to pursue technological development provides the theoretical basis for China's motivation to invest in advanced technology sectors.[2] For China to truly rise as a global hegemon, they must gain control over advanced technologies that result in economic superiority. As the EV industry has grown exponentially in the past few

[1] Susan Strange, *States and Markets* (London: Pinter Publishers, 1988), 30.

[2] Andrew B. Kennedy and Darren J. Lim, "The Innovation Imperative: Technology and US-China Rivalry in the Twenty-first Century," *International Affairs* 94, no. 3 (2018): 554.

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years and constitutes a major emerging industry, China's growing interest and involvement is understandable.[3] Malkin presents a perspective on China's structural and productive power through assessing intangible assets in global value chains (GVC) and asserts that China possesses latent productive power due to their ascent in intellectual property protection, standard setting, and other areas of international trade policy influence. [4] Their study provides the inspiration for additional analysis on GVCs and production power, which this research intends to conduct from a free trade perspective.

Although China's EV industry has rapidly developed in recent years due to its established internal combustion engine vehicle (ICEV) industry, a technological gap exists between domestic EV batteries and designs used by industry leaders. Although China's policies concerning EVs appear as early as 1995, they only started passing targeted EV policies in 2006. Since then, China's EV industry has skyrocketed, with significant manufacturing operations and technological development. They have significantly increased patent applications and have produced a domestic EV model competitive with industry leaders, signaling success in technology catch-up.

By joining RCEP, China has taken steps toward policy liberalization, which, in combination with tariff and rules of origin (ROO) advantages, positively affect the electric vehicle industry development. China already has significant trade of EV products among RCEP countries that will benefit from joining a large FTA. For industrial linkages, Qiu and Gong's research on the regional effect of RCEP on technologically intensive industries exposes the positive impact on domestic value-added of manufacturing exports.[5] Their study provides a foundation of empirical evidence to further assess RCEP supply chains from a narrower single-industry focus. China's advantage in manufacturing allows domestic firms to build very complete supply chains, especially in parts that overlap with the automobile industry. [6] However,

[3] Mathilde Carlier, "Worldwide number of battery electric vehicles in use from 2016 to 2021 (in millions)," *Statista*, June 2, 2022, https://www.statista.com/statistics/270603/worldwide-number-of-hybrid-and-electric-vehicles-since-2009/.

[4] Anton Malkin, "The Made in China Challenge to US Structural Power: Industrial Policy, Intellectual Property and Multinational Corporations," *Review of International Political Economy* (2020): 1.

[5] Ying Qiu and Yushuang Gong, "Industrial Linkage Effects of RCEP Economies' Imports of Producer Services on Manufacturing Advantages," *PLoS ONE* 16, no. 7 (2021): 1.

[6] W. Wen et al., "Impacts of COVID-19 on the Electric Vehicle Industry: Evidence from China," *Renewable & Sustainable Energy Reviews* 144 (2021): 4-5, https://doi.org/10.1016/j.rser.2021.111024.

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the high dependence on critical raw material imports and need for advanced battery technology development constitute relative weaknesses.[7]

This paper includes five chapters: 1) an introduction with literature review and methodology, 2) a background chapter on China's EV policy history and technological development, 3) an empirical analysis on RCEP's Impact on China's EV industry, 4) an examination of China's EV trade value linkages to RCEP countries, and 5) a conclusion. The literature review addresses the theoretical frameworks of structural and productive power, China's FTA strategy and RCEP, and technology catch-up literature. Chapter two includes a brief historical overview of China's development of EV supply chains and government policies and the development of mature and advanced battery technology. Chapter three's empirical analysis covers China's policy liberalization, RCEP's tariff and ROO impacts, and evidence of industry partnerships with Japan, South Korea, and ASEAN. Chapter five consists of quantitative examination of EV trade flows between China and RCEP countries, and focuses on key raw materials, battery cells, and the EV automobile trade. The conclusion contains a discussion and suggestions for future research.

1.1 Current States of Academic Research

Theoretical framework: Structural and Productive Power

RCEP will restructure trade and economic power in the Asia-Pacific as new policy standards and linkages affect firms' investment and production practices. To analyze the impact of these changes on supply chains and business practices, my research will follow the theoretical framework of "structural power" and "productive power" outlined by Susan Strange in her works establishing a model of the international economy.[8] Her definition of structural power is the power to influence and create the structures of the international political economy that other states operate their political, economic, and knowledge institutions under.[9] This differs from relational power, which is the power for one state to get another state to act in a way they would

[7] Wen et al., "Impacts of COVID-19 on the Electric Vehicle Industry: Evidence from China," 5.
[8] Strange, *States and Markets,* 29.
[9] Ibid.*,* 24.

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not otherwise.[10] Under the umbrella of structural power, her version of productive power encompasses the control over production, which includes the factors of land, labor, capital, and technology. In addition to explicitly including technology as a factor of production, she also places emphasis on new technology as a type of "knowledge power", which is important when understanding the impact of restructured high-technology supply chains on power.[11] Strange's organization of power from an economic lens allows emphasis to be placed on the power of controlling production beyond a state's borders, and alludes to the idea that the state itself gains power by aligning the international factors of production to its advantage. Her framework fuses the liberalist concept of trade interdependence with the realist perspective of using and manipulating trade to gain power.

Recent scholars have used Strange's framework on structural power in international political economy studies. Malkin adds to Strange's framework by breaking down productive power even further into market power, centrality, ownership of assets, and technological standard setting to apply the concept of productive power to GVCs.[12] Their research specifically focuses on China's participation in GVCs and the "global intangible economy", which includes intellectual property assets, technological standards, and other elements of production, to increase its influence and compete with the US in "national security relevant" industries.[13] Their use of productive power as applied to GVCs is particularly fitting for the analysis of China's EV industry, although Malkin's research encompasses a much broader perspective and does not consider specific policy choices such as the impact of RCEP free trade agreement. Another interesting study by Schwartz uses Strange's productive power framework focuses on US efforts to enhance the global environment on intellectual property rights, which allows U.S. firms to compete globally and increase profitability.[14] Although their study focuses on the U.S. policymaking efforts, the methods of analysis could also be applied to China's policy practices, especially those concerning individual property rights. Both of these scholars use Strange's framework on productive power to make contributions to the analysis of the state's engagement with technological industries and its effect on structural power.

[10] Strange, *States and Markets,* 24.
[11] Ibid., 30.
[12] Malkin, "The Made in China Challenge to US Structural Power," 2.
[13] Ibid.
[14] Herman Mark Schwartz, "American Hegemony: Intellectual Property Rights, Dollar Centrality and Infrastructure Power," *Review of International Political Economy* 26, no. 3 (2019): 490.

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Other methods of defining both structural and productive power exist in international relations literature. In an alternate framework, Barnett and Duvall separately define "structural power" and "productive power" instead of nesting one within the other, although they do note the many overlapping elements between the two.[15] Their definition of structural power focuses on the direct structural relationship between subjects while their "productive power" definition includes the more indirect socially influenced "systems of meaning and signification", to include systems of knowledge and discursive practices.[16] This is similar to Strange's framework, as it differentiates direct and indirect influence, but does not offer the degree of clarity on whether "productive power" actually applies to the "power of production". Additionally, their definitions, especially of productive power, leave much to interpretation, and scholars have used their framework liberally. Other authors have used Barnett and Duvall's "productive power" on systems of knowledge and discourse in a symbolic sense, such as Bukh's study on China's national identities or Hagstrom and Jerden's analysis of East Asia power shifts.[17] Although their studies make meaningful observations on the effects of shifting power in Asia, they have little overlap with Strange's definition of "productive power".

However, some scholars have used a fusion of the two frameworks for their research purposes, which allows them to shape the relevant pieces from each framework for their study. Zhang's study on financial power references Barnett and Duvall's systematic power classification as an inspiration to his model, which divides power in political economy based on direct and indirect financial interaction.[18] Notably, Zhang replaces "productive power" with "ideational power" and uses Barnett and Duvall's productive power definition for his ideational power.[19] Zhang also cites Strange's "structural power", to include the productive power element, in his analysis of international political economy institutions.[20] Zhang's method of fusing

[15] Michael Barnett and Raymond Duvall, "Power in International Politics," *International Organization* 59 (2005): 55.

[16] Barnett and Duvall, "Power in International Politics," 43.

[17] Alexander Bukh, "The Productive Power of Rising China and National Identities in South Korea and Thailand," *The Pacific Review* (2021): 1.

Linus Hagstrom and Bjorn Jerden, "East Asia's Power Shift: The Flaws and Hazards of the Debate and How to Avoid Them," *Asian Perspective* 38 (2014): 337.

[18] Falin Zhang, "Power Contention and International Insecurity: A Thucydides Trap in China–US Financial Relations?" *Journal of Contemporary China* 30, no. 131 (2021): 751.

[19] Zhang, "Power Contention and International Insecurity: A Thucydides Trap in China–US Financial Relations?" 751.

[20] Zhang, "Power Contention and International Insecurity: A Thucydides Trap in China–US Financial Relations?" 751.

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frameworks reveals a degree of flexibility required to shape existing ideology to best suit their study.

From an international political economy perspective, the two different frameworks developed by Susan Strange and Barnett and Duvall have influenced many scholars studying structural power and productive power. For this research on free trade agreements and advanced technology supply chains, Strange's framework fits best due to her emphasis on factors of production and alignment of productive power as a contributor to structural power. This would further the argument that productive power changes due to RCEP's impact on the EV GVCs and industry linkages affect China's technology catch up strategy, access to key materials, and ability to capture market share, thus allowing for an increase in structural power in the Asia-Pacific region.

China's Free Trade Agreement Strategy and RCEP

Following China's ascension to the WTO in 2001, China has signed FTAs with a number of Asia- Pacific countries, including Australia, New Zealand, South Korea, Singapore, Pakistan, ASEAN countries, Macao, and Hong Kong. Some scholars focus on China's FTA strategy as a method of gaining political leverage, which would have a positive effect on China's ability to gain productive power. Sampson highlights China's strategy of gradual negotiation, which leads partner countries to make "relation-specific investments" to induce dependency and increases China's leverage to impose increasingly unfavorable agreements on their partner.[21] Salidjanova takes an even more realist stance by asserting that China's FTA strategy in Asia aims to use material dependencies to "pit different countries against one another" and "derail U.S.- led trade initiatives in the Asia Pacific".[22] However, other characteristics of China's FTA strategy could limit their productive power. Scholars tend to classify China's bilateral FTAs as "low quality" in liberalization and coverage, which gives the impression that they are driven by political factors at the expense of economic gains.[23] Song and Yuan take a more pessimistic view by assessing

[21] Michael Sampson, "The Evolution of China's Regional Trade Agreements: Power Dynamics and the Future of the Asia-Pacific," *The Pacific Review* 34, no. 2 (2021): 263.

[22] U.S.-China Economic and Security Review Commission, *China's Trade Ambitions: Strategy and Objectives Behind China's Pursuit of Free Trade Agreements,* by Nargiza Salidjanova, May 28, 2015.

[23] Sampson, "The Evolution of China's Regional Trade Agreements: Power Dynamics and the Future of the Asia-Pacific," 260.

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China's use of FTAs to mitigate concerns caused by China's increasing militarization as an ineffective method of "improving its neighboring environment".[24]

Literature on China's FTA strategy also focuses heavily on the domestic factor, which tend to have negative implications for China's productive power. Jiang explores the internal motivations for China to pursue FTAs, and describes the process as "fragmented" due to opposing interest groups.[25] This opinion aligns with other scholars' commentary on domestic opposition and popular desire for a socialist market economy as hurdles for China's FTA policy process. [26] Zeng also discusses China's strategy for FTAs, especially regional trade negotiations, as politically stabilizing bargaining platforms and a means for controlling the pace of liberalization to placate domestic interest groups.[27] These domestic factors that interfere with economic policymaking harm productive power and have the potential to also surface with RCEP, although the nature of this agreement as a large, multilateral regional FTA may also raise unique concerns or benefits.

RCEP includes 15 countries; China, Cambodia, Indonesia, Laos, Myanmar, Philippines, South Korea, Thailand, Australia, Brunei, Japan, Malaysia, New Zealand, Singapore, and Vietnam.[28] RCEP has been initiated on January 2022, and has been ratified by twelve countries as of July 2022.[29] As the world's largest regional trade agreement, RCEP covers 28% of shares of global goods trade, 31% share of global GDP, and 29% of the global population.[30] RCEP is

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Inkyo Cheong, "Analysis of FTA Negotiation between China and Korea," *Asian Economic Papers* 15, no. 3 (2016): 170.

Yang Jiang, "China's Pursuit of Free Trade Agreements: Is China Exceptional?" *Review of International Political Economy* 17, no. 2 (2010): 249.

Gabriel Gari, "China's Preferential Treatment on Trade in Services: Is the Sleeping Dragon About to Wake Up?" *Journal of World Trade* 54, no. 6 (2020): 890.

[24] Guoyou Song and Wen Jin Yuan, "China's Free Trade Agreement Strategies," *The Washington Quarterly* 35, no. 4 (2012): 114.

[25] Jiang, "China's Pursuit of Free Trade Agreements: Is China Exceptional?" 249.

[26] Ibid.,

Song and Yuan, "China's Free Trade Agreement Strategies," 115.

Gari, "China's Preferential Treatment on Trade in Services: Is the Sleeping Dragon About to Wake Up?" 916.

[27] Ka Zeng, "Multilateral versus Bilateral and Regional Trade Liberalization: Explaining China's Pursuit of Free Trade Agreements (FTAs)," *Journal of Contemporary China* 19, no. 66 (2010): 636.

[28] Peter A. Petri and Michael Plummer, "East Asia Decouples from the United States: Trade War, COVID-19, and East Asia's New Trade Blocs," *Peterson Institute for International Economics* (Working Paper 20-9, June 2020): 3.

[29] Yuka Hayashi, "U.S. on Sidelines as China and Other Asia-Pacific Nations Launch Trade Pact," *The Wall Street Journal,* January 1, 2022, https://www.wsj.com/amp/articles

[30] Congressional Research Service, *Regional Comprehensive Economic Partnership (RCEP)*, by Cathleen D. Cimino-Isaacs et al., August 5, 2021.

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projected to combine the many ASEAN-plus FTAs and straighten out the "noodle-bowl" of bilateral or smaller multilateral FTAs in the Asia-Pacific region.[31] The "noodle-bowl problem" of FTAs refers to the 100 plus overlapping bilateral agreements in the region, which restrict regional productive power by acting as a type of trade barrier due to the tangled agreement architecture.[32] Transaction costs of compliance due to the complex set of rules, especially ROO, plague industries organized as regional production networks with supply chain operations across multiple countries.[33] Politically, the existence of many overlapping trade agreements causes 'trade diversion' problems, where political FTA structures interrupt trade flows that would otherwise operate based on economic efficiencies and market forces.[34] Alleviating RCEP members from problems caused by the "noodle-bowl problem" will increase regional productive power because the factors of production within RCEP will flow more smoothly.

RCEP member countries may also face challenges due to the composition and nature of the agreement, which could have negative impacts on productive power. Scholars have noted the "lower quality" or less ambitious nature of RCEP compared to other FTAs involving advanced economies, although some would suggest this method as more realistic considering the wide range in member countries' stages of development.[35] Others opine that the vast differences in countries' capabilities in RCEP will actually hinder negotiations or even cause fragmentation due to diverging preferences on policy commitments.[36] These studies would suggest that although RCEP is predicted to have positive impacts on free trade in the Asia Pacific, such a large agreement with diverse members is likely to also face difficulties that deter policy implementation and trade restructuring. Multiple studies predict much larger benefits for advanced countries such as South Korea, Japan, New Zealand, and Australia as compared to less developed ASEAN countries, although these benefits vary depending on the measurement

[31] Jeffrey D. Wilson, "Mega-Regional Trade Deals in the Asia-Pacific: Choosing Between the TPP and RCEP?" *Journal of Contemporary Asia* 45, no. 2 (2015): 349.

[32] Mireya Solis and Jeffrey D. Wilson, "From APEC to mega-regionals: the evolution of the Asia-Pacific trade architecture," *The Pacific Review* 30, no. 6 (2017): 929.

[33] Solis and Wilson, "From APEC to mega-regionals: the evolution of the Asia-Pacific trade architecture," 930.

[34] Ibid.

[35] Wilson, "Mega-Regional Trade Deals in the Asia-Pacific: Choosing Between the TPP and RCEP?" 349.

Fan He and Panpan Yang, "China's Role in Asia's Free Trade Agreements," *Asia and the Pacific Policy Studies* 2, no. 2 (2015): 418.

Solis and Wilson, "From APEC to mega-regionals: the evolution of the Asia-Pacific trade architecture," 932.

[36] Ibid., 934.

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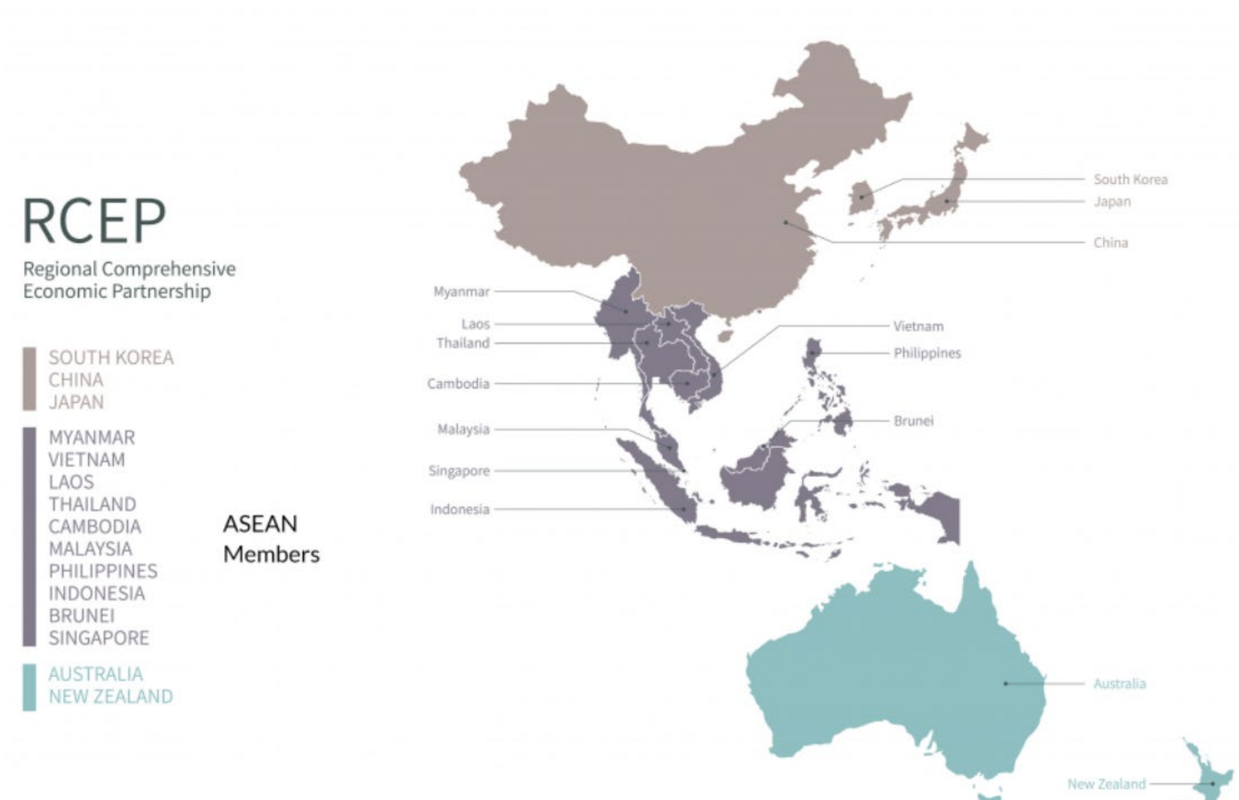
Figure 1-1 Map of RCEP



Source: Xirui Li, "How China Will Implement RCEP: A Subnational Analysis," *AsiaGlobal*, February 10, 2022.

used.[37] These statistics reveal the uneven distribution of benefits for members that join RCEP, which also adds a degree of uncertainty to the calculation of RCEP's impact on trade and its ability to improve member nations' productive power.

A large portion of scholarship dedicated to discussing RCEP do so by comparing it to the Trans-Pacific Partnership (TPP), currently renamed the Comprehensive and Progressive Agreement for Trans-Pacific Partnership (CPTPP). Approaching RCEP from a comparative angle has many advantages; both are Asia-Pacific centric, mega-regional free trade agreements with one regional hegemon involved (although it should be noted that the United States has yet

[37] Petri and Plummer, "East Asia Decouples from the United States: Trade War, COVID-19, and East Asia's New Trade Blocs," 30.

Chunding Li and Donglin Li, "When Regional Comprehensive Economic Partnership Agreement (RCEP) Meets Comprehensive and Progressive Trans-Pacific Partnership Agreement (CPTPP): Considering the "Spaghetti Bowl" Effect," *Emerging Markets Finance and Trade* (2021): 7.

Alex Wolf, "Who will benefit the most from RCEP?" *JP Morgan,* January 16, 2021, https://privatebank.jpmorgan.com.

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to join the CPTPP), and yet differ in scope and composition.[38] The economic and political injury posed by exclusion from the CPTPP threatens to decrease China's productive power, thus joining and promoting RCEP is a major part of China's policy response with the potential to reclaim productive power by beginning to shape new rules of international trade.[39] Drysdale and Armstrong would optimistically agree that RCEP provides China the chance to demonstrate its commitment to economic cooperation and expand international multilateral liberalization, especially in the post-COVID19 world.[40] Indeed, the prospective statistics on the impact of the CPTPP estimate $28 billion in losses for China, while the benefits from RCEP total $100 billion, which definitively underlines the economic motivations for China to promote RCEP, especially as a measure to counteract the losses incurred by their exclusion from the CPTPP.[41] RCEP has the potential to make up China's losses in productive power due to their exclusion from the CPTPP.

A small amount of literature has found that RCEP has mainly positive effects on supply chains or value chains. Qiu and Gong propose a systematic approach of evaluating changes in value chains based on direct effect, downstream effect, and upstream effect.[42] By analyzing industrial linkage functions of RCEP on manufacturing GVCs, they conclude that the nature of RCEP economies' imports of technology-intensive services from developed countries improves the upstream effect, while improved downstream effect reduces manufacturing costs because of improvements in specialization, knowledge spillover effect, and economies of scale.[43] Another author also mentions the more "flexible and cumulative approach to 'rule of origin'", which further enhances the benefits of tariff reduction.[44] Additionally, Chinese analysts have noted that China is in a relatively downstream position in the RCEP regional industrial chain, and recommends China to build linkages between internal and external actors in order to enhance

[38] Wilson, "Mega-Regional Trade Deals in the Asia-Pacific: Choosing Between the TPP and RCEP?" 349.

[39] He and Yang, "China's Role in Asia's Free Trade Agreements," 417.

Song and Yuan, "China's Free Trade Agreement Strategies," 115.

[40] Peter Drysdale and Shiro Armstrong, "RCEP: a Strategic Opportunity for Multilateralism," *China Economic Journal* 14, no. 2 (2021): 137.

[41] Petri and Plummer, "East Asia Decouples from the United States: Trade War, COVID-19, and East Asia's New Trade Blocs," 25.

[42] Qiu and Gong, "Industrial Linkage Effects of RCEP Economies' Imports of Producer Services on Manufacturing Advantages," 14.

[43] Ibid.

[44] Wolf, "Who will benefit the most from RCEP?"

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global governance and upgrade China's place on the GVC.[45] These pieces of literature provide evidence that free trade agreements could result in productive power gains via economic and political means.

Technology Catch-up Literature

In order to gain productive power by increasing their presence in the EV GVC, China must develop technology on par with industry leaders in the supply chain components with high value-added products, namely EV lithium-ion batteries. As a rising power, China's desire to develop their technology sector makes sense. Literature on the 'innovation imperative', or the push for emerging powers to develop and acquire new technologies to overcome the structural challenges that limit their international rise, predicts China's need to gain more control over the GVC.[46] Some authors opine that technological innovation can be used as a factor in evaluating the comprehensive strength of a country. [47] This argument further stresses the challenges states face after industrialization, including diminishing returns on capital investments paired with rising wages that take away low-cost labor advantages.[48] In this situation, states will pursue 'catching-up' strategies to develop their technology industries.

Many models exist to assess the changing nature of supply chains. Some focus on evaluating China's generally low value contribution, even as the final assembly location, through buyer driven supply chains.[49] Alternately, Sun and Grimes' framework labels firms based on their place on the GVC, and they comment on the effect on productive power developed by leading firms in high-tech industries by reaching dominance in the market through leadership in

[45] Feng-lan Chen and Ai-zhen Chen, "Research on the Development Mechanism of RCEP Regional Industrial Chain- On the Upgrading Path of China's Industrial Chain (RCEP 区域产业链发展机制研究 ——兼论中国产业链升级路径)," *Economist* (經濟學家) (June 2021): 70.

[46] Kennedy and Lim, "The Innovation Imperative: Technology and US-China Rivalry in the Twenty-first Century," 554.

[47] Duanwu Yan, Xiaocong Deng, and Xirui Mei, "Evolution of Global EV Battery Technology Based on the Main Path of Patent Citation," Journal of Physics: Conference Series 1955, no. 1 (2021): 2, https://doi.org/10.1088/1742-6596/1955/1/012096.

[48] Kennedy and Lim, "The Innovation Imperative: Technology and US-China Rivalry in the Twenty-first Century," 555.

[49] Gary Gereffi and Joonkoo Lee, "Why the World Suddenly Cares About Global Supply Chains," *Journal of Supply Chain Management* 48, no. 3 (2012): 27.

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technological innovations and control of core intellectual property.[50] Other literature compares supply chains across industries to comment on patterns, such as Jaovorcik's analysis of GVC restructuring by distinguishing between producer-driven and buyer-driven chains and Curran and Zignago's similar study of Asia's technology supply chains that compares high, medium, and low technology sectors.[51] These models all reveal evidence of China's solidified place in advanced technology supply chains and provide methods of analysis for any possible shift in the GVC.

Industry catch-up can be defined as "the process of closing the gap in market competence between domestic latecomers and foreign incumbents."[52] One framework used to analyze technology catch-up divides the strategies used into leapfrogging, stage-skipping, and path-following.[53] Leapfrogging, which includes path creating and stage-skipping, refers to the practice of bypassing older technology and entering straight into advanced or next generation technology to compete with advanced countries, and is particularly appealing to sectors with short-cycle technologies.[54] Stage-skipping refers to the process of following the previously established development path to an extent, but skipping some stages, while path-creating occurs when firms explore a unique path of technological development.[55] In contrast, path-following entails the gradual catch-up of market shares, where latecomers move along existing technical trajectories of established companies.[56] Although each of these strategies have distinct characteristics, firms often use various combinations throughout their catch-up process, such as starting off with path-following but switching to stage-skipping or path-creating once reaching a certain level of development. Alternately, other scholars divide catch-up methods into duplication, creative

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[50] Yutao Sun and Seamus Grimes, "China's Increasing Participation in ICT's Global Value Chain: A Firm Level Analysis," *Telecommunications Policy* 40 (2016): 212.

[51] Beata Javorcik, "Reshaping of Global Supply Chains Will Take Place, but It Will Not Happen Fast," *Journal of Chinese Economic and Business Studies* 18, no. 4 (2020): 322.

Louise Curran and Soledad Zignago, "Trade in East Asia in ASEAN13: Structure and Dynamics of Intermediates and Final-goods Trading Activity by technology," *Asia Pacific Business Review* 18, no. 3 (2012): 385.

[52] Shuyan Zhao et al., "Closing the Gap: The Chinese Electric Vehicle Industry Owns the Road," The Journal of Business Strategy 41, no. 5 (2020): 3, https://doi.org/10.1108/JBS-03-2019-0059.

[53] Keun Lee, Xudong Gao, and Xibao Li, "Industrial Catch-up in China: a Sectoral Systems of Innovation Perspective," *Cambridge Journal of Regions, Economy and Society* 10, no. 1 (2017): 2.

Keun Lee and Chaisung Lim, "Technological regimes, Catching-up and Leapfrogging: Findings from the Korean Industries," *Research Policy* 30 (2001): 460.

[54] Lee, Gao, and Li, "Industrial Catch-up in China: a Sectoral Systems of Innovation Perspective," 14.

Lee and Lim, "Technological regimes, Catching-up and Leapfrogging: Findings from the Korean Industries," 460.

[55] Ibid., 465.

[56] Lee, Gao, and Li, "Industrial Catch-up in China: a Sectoral Systems of Innovation Perspective," 15.

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imitation, and R&D based innovation.[57] Duplication, like path-following, refers to latecomers using "copycat actions" to acquire basic knowledge, while creative imitation, similar to stage-skipping, requires latecomers to add their own elements to competitors' designs. [58] These two frameworks differ in focus; the former emphasizes path-dependency and views each firms' technology development as separate paths that influence each other, while the latter draws attention more acutely to the methods used by firms to obtain target technologies and frame existing technology as an entity of knowledge that firms have different quantities and portions of.

A parallel body of literature focuses on evaluating "windows of opportunity" while assessing methods of technology catch-up. Xiong et al. defines windows of opportunity as "industrial dynamic discontinuity" and categorizes them into technology, market, and institutional domains. [59] Zhao et al. agrees, suggesting these windows arise due to discontinuous technologies, drastic changes in market demand, and shifts in policies.[60] Also important in identifying windows of opportunity includes the process of technology evolution. Technology evolution analysis goes hand in hand with technology catch-up, and can be considered the beginning of the catch-up process. Technology evolution path, also known as technology main path, assesses main technologies in a chronological order, which then leads to discovery of main technologies and their development directions.[61] This in turns allows researchers to understand the development path, explore origins, analyze current status and development trends, and identify emerging technologies in the domain.[62] Within the EV industry, identifying the technological evolution, from lead-acid to lithium-ion batteries, reveals the projectile development of EV batteries that are safer, have longer mileage in one charge, and decrease the

[57] Zhao et al., "Closing the Gap: The Chinese Electric Vehicle Industry Owns the Road," 4.
[58] Ibid.
[59] Jie Xiong et al., "How Latecomers Catch up to Build an Energy-Saving Industry: The Case of the Chinese Electric Vehicle Industry 1995–2018," Energy Policy 161 (2022): 1, https://doi.org/10.1016/j.enpol.2021.112725.
[60] Zhao et al., "Closing the Gap: The Chinese Electric Vehicle Industry Owns the Road,"5.
[61] Yan, Deng, and Mei, "Evolution of Global EV Battery Technology Based on the Main Path of Patent Citation," 1.
[62] Ibid., 1-2.

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environmental footprint. [63] Furthermore, this logic supports the prediction of solid-state EV batteries as the next step in battery technology evolution. [64]

Technological windows of opportunity occur when disruptive innovations alter market positions because incumbents fail to adopt new technologies, usually due to risk avoidance and technology lock-in with existing technologies.[65] When Tesla, a new market entrant, adopted higher-Ni Nickel-Cobalt-Aluminum material in their battery cathodes, they surpassed competitors in EV mileage, thus opening the window for auto industry innovation. [66] In these "incumbent trap" situations, latecomers have the opportunity to break into the market and catch up.[67] Market demand windows of opportunity arise when industrial leaders fail to address new demand or preferences for innovative products and services, such as when multinational enterprises' global strategies leave openings in local markets for latecomers to take advantage of.[68] Institutional windows of opportunity appear following governmental support, such as policies and incentive plans benefitting local latecomers.[69]

RCEP will inevitably create windows of opportunity due to major changes in trade institutions and differential price fluctuations. Countries that take advantage of or create technological windows of opportunity increase their productive power, particularly firms that use innovative technology to increase profits and market share, thus gaining economic access and influence. The projected shift from ICEVs to EVs offers opportunities in powertrain innovation for both incumbent suppliers and new market suppliers, with some analysts predicting the latter as the main drivers of innovations.[70] EVs in particular have significant overlap with both the ICEV industry and the battery industry. Table 1-1 shows components shared between ICEVs,

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[63] Calin Iclodean et al., "Comparison of different battery types for electric vehicles," *IOP Conference Series Materials Science and Engineering* 252 (2017): 2.

[64] Gang Zhao, Xiaolin Wang, and Michael Negnevitsky, "Connecting Battery Technologies for Electric Vehicles from Battery Materials to Management," *IScience* 25, no. 2 (2022): 1, https://doi.org/10.1016/j.isci.2022.103744.

[65] Xiong et al., "How Latecomers Catch up to Build an Energy-Saving Industry: The Case of the Chinese Electric Vehicle Industry 1995–2018," 2.

[66] Sarah Ball, Joanna Clark, and James Cookson, "Battery Materials Technology Trends and Market Drivers for Automotive Applications: Challenges for Science and Industry in Electric Vehicles Growth," *Johnson Matthey Technology Review* 64, no. 3 (2020): 288, https://doi.org/10.1595/205651320X15783059820413.

[67] Xiong et al., "How Latecomers Catch up to Build an Energy-Saving Industry: The Case of the Chinese Electric Vehicle Industry 1995–2018," 2.

[68] Ibid.

[69] Ibid.,

[70] Philipp Borgstedt, Bastian Neyer, and Gerhard Schewe, "Paving the Road to Electric Vehicles – A Patent Analysis of the Automotive Supply Industry," *Journal of Cleaner Production* 167 (2017): 75–87, https://doi.org/10.1016/j.jclepro.2017.08.161. 76.

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hybrid EVs (HEV), and battery EVs (BEVs). Firms with either established vehicle or Li-ion battery industries have a potential advantage in the EV industry due to the principle of manufacturing flexibility. Swamidass defines manufacturing flexibility as "the capacity of a manufacturing system to adapt successfully to changing environmental conditions as well as changing product and process requirements."[71] Production plant level manufacturing flexibility occurs due to advantages in 1) "hard technologies" such as hardware, software, and equipment, 2) "soft technologies", to include know-how, procedures, organization, and techniques, 3) design, and 4) manufacturing infrastructure.[72] Countries with developed tangential industries to EVs have the potential to strengthen their productive power by capitalizing on manufacturing flexibility and the pre-establish supply chains through those industries. With an immerging industry such as electric vehicles, firms compete on the international stage. As consumer demands shift and prices fall, major changes in the trading environment cannot be ignored as a contributor to firms' competitiveness, and by default, a country's productive power.

Table 1-1 Comparison of ICEV, HEV, and BEV Components

Category	Component	ICEV	HEV	BEV
Glider	Cab	●	●	●
	Frame	●	●	●
	Chassis	●	●	●
	Tires and Wheels	●	●	●
	Others (e.g., underride guard)	●	●	●
Conventional Components	Engine	●	●	○
	Exhaust	●	●	○
	Diesel Tank	●	●	○
	Transmission	●	●	○
	Lead-Acid Battery	●	●	○
	Retarder	●	●	○
	Others (e.g. engine oil)	●	●	○
Electrical Components	Electric Motor	○	●	●
	Li-Battery	○	●	●
	Others (e.g. exterior electrical)	●	●	●

Source: Sebastian Wolff, Moritz Seidenfus, Karim Gordon, Sergio Álvarez, Svenja Kalt, and Markus Lienkamp. "Scalable Life-Cycle Inventory for Heavy-Duty Vehicle Production." *Sustainability*, May 27, 2020.

[71] Paul M. Swamidass, "Manufacturing Flexibility," In *Innovations in Competitive Manufacturing*, ed. Paul M. Swamidass (Boston: Springer US, 2000), 117, https://link.springer.com/chapter/10.1007/978-1-4615-1705-4_11.

[72] Ibid.

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1.2 Research Objectives and Methodology

This research constitutes an assessment of RCEP's influence on China's productive power through an analysis of the electric vehicle industry. This leads to the central research question: *How will RCEP influence China's productive power through their electric vehicle industry development?* To address this question, this study addresses China's relevant policy history, China's current place in the EV industry, and RCEP's possible influence on China's EV trade in the Asia-Pacific region. Important subordinate questions to address include: *How will RCEP benefit China's domestic EV technology catch-up and development environment? How will RCEP affect domestic EV firms' profitability and competitiveness?* Since RCEP has been ratified so recently, this study constitutes an assessment on future possibilities based on current trends and empirical evidence. The objective of this research is to present a structural power perspective from which to view China's rise to power, and hypothesizes that RCEP will positively influence the development of China's EV industry. The independent variable of this study is the effects of RCEP initiation, which is measured by policy liberalization, tariff and ROO adjustments, and industry partnerships. The dependent variable, China's EV industry development, is assessed based on probability of change in profitability, technology development, and market share capture. These variables contribute to China's power to influence and create the structures of IPE which other states operate their political, economic, and knowledge institutions under.

This study uses a mixed methods approach, to include a qualitative case study and a quantitative data analysis. Chapter three's focuses on the independent variables of policy liberalization, RCEP tariff and ROO impacts, and industry partnerships. This case study focuses on the time frame leading up to and immediately after the initiation of RCEP in 2022, and uses legal documents, research and journal article, and newspaper as sources to assess China's domestic laws, the RCEP doctrine, and action of individual companies. RCEP will have sweeping political and economic effects, and this study emphasizes these three because of their strong connection to the development of advanced technology industries. The section on policy liberalization reviews changes in laws affecting ownership requirements, intellectual property rights (IPR) protections, FTA requirements, and overall foreign investment environment based on articles published by legal advisors and institutions. The section on tariffs and ROO also uses

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publications from FTA experts and government entities along with industry projections. Although RCEP contains many chapters that affect trade, tariffs and ROO are chosen due to their direct influence on supply chains. The section on industry partnerships focus on Japan, South Korea, and ASEAN; the former two because of their potential as technological partners and ASEAN because of its market potential.

Chapter four uses quantitative methods to analyze trade value data between China and RCEP countries. It assesses current electric vehicle industry linkages between China and other RCEP countries in critical raw materials, lithium battery cells, and pure electric vehicles. These three categories represent upstream, midstream, and downstream products along the EV supply chain. Based on productive power theory, the trade value between countries constitutes an economic link, thus the addition of a free trade agreement increases the potential for new links to form as well as established links to strengthen. From an international perspective, existing literature has suggested RCEP will straighten out the "noodle bowl" of FTAs and add new countries to China's FTA web, thus implying the trade linkages among RCEP states stand to benefit from a more straightforward free trade policy environment. For this assessment, higher import or export values will indicate stronger existing linkages between Chinese-based firms and target country firms. This study uses data from Wen et al.'s study on EV battery trade for raw material import analysis due data availability and complexity. The data used for analysis in lithium battery cells and pure EVs is from UN Comtrade data, and is mapped with QGIS visualization software. The UN Comtrade data from the ITC database breaks down trade data to a six-digit HS code, thus allowing for analysis to be divided into upstream and downstream products. The strength of the existing linkages indicates the degree of foundation that future trade can develop from.

The basis of this study relies on the realist perspective, particularly the perception of 'security externalities' from international trade, which alleges states could use gains from trade to build hard power.[73] This research will also add to the discussion on productive power as a component of structural power, which emphasizes the alignment of land, labor, capital, and technology to a states' benefit.[74] Generally, it will comment on rising regional hegemons and

[73] William J. Norris, *Chinese Economic Statecraft: Commercial Actors, Grand Strategy, and State Control* (Ithaca, New York: Cornell University Press, 2016), 12-13.

[74] Strange, *States and Markets,* 30.

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their strategies to gain productive power, specifically through advanced technology industries. Developments in electric vehicles allow for advancements in a wide range of fields of technology, including energy storage, transportation, and environmental conservation. From a regional perspective, this research has the potential to further the general conversation on how RCEP fits into China's Asia Pacific Strategy. Addressing China's role in EV industry development provides a possible insight into trade-based methods China may employ to improve their position in high-tech global value chains.

This study intends to fill the gaps in literature by providing an analysis connecting free trade agreements and China's supply chain productive power. Although previous studies have analyzed the effect of RCEP on technology intensive GVCs, these lack structural power analysis.[75] Other pieces of literature that connect advanced technology, GVCs, and productive power lack analysis of the free trade agreement or RCEP variable.[76] These two sides of literature contain significant overlap, and conducting a study focusing on China's EV GVC assists in pushing forward the conversation concerning influences of free trade agreements on advanced technology catch-up. RCEP gives China the ability to gain rule-making influence and strengthen existing industry supply chains in combination with policy adjustments that could affect domestic technology development. By using productive power as a theoretical basis, the framework developed in this study has the potential to offer an alternate perspective on free trade agreement literature and technology supply chain literature for the benefit of structural power assessment.

[75] Qiu and Gong, "Industrial Linkage Effects of RCEP Economies' Imports of Producer Services on Manufacturing Advantages," 1.

[76] Malkin, "The Made in China Challenge to US Structural Power," 1.
Sun and Grimes, "China's Increasing Participation in ICT's Global Value Chain," 222.

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CHAPTER 2. Background

A review of China's historical EV policy initiatives and EV technological development assists in understanding RCEP's role in influencing China's domestic industry. This chapter is organized into two main sections; the first discusses the policy-lead growth of China's EV industry, and the second contains China's EV technological development within the global industry. The first section is divided into three timeframes, inspired by Xiong et al.'s historical review of China's EV development concerning windows of opportunity. China's EV industry starts from a policy initiation phase from 1995-2005, where most EV policies existed under broad auto industry development policies, then moves to the 2006-2015 creative imitation phase, which introduce policies specifically targeting the EV industry, and finally shifts to the phase of independent innovation, which marks the shift from subsidy-heavy policies to a more market-based model. [1] This section also includes an assessment of China's EV policy motivations. This historical review focuses on shifting government policies to gain a basic understanding of the relationship between China's policy making and EV industry growth. The second section focuses on China's technological development in context of the global EV industry. This overview starts with an assessment of China's patent trends as compared to RCEP countries and global industry leaders. The next portion discusses China's mature EV battery experimentation and is followed by a short synopsis of advanced EV battery technology and China's technology catch-up within the industry.

2.1 Brief History of China's Electric Vehicle Industry and Policies

1995-2005 Policy Initiation

Government policies during this period were implemented mainly for the development of the auto industry as a whole, although they had tangential effects on initiating China's domestic EV industry. Global movements in environmental conservation and new energy sources influenced China's domestic development decisions. The Chinese government collaborated with

[1] Xiong et al., "How Latecomers Catch up to Build an Energy-Saving Industry: The Case of the Chinese Electric Vehicle Industry 1995–2018," 4.

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the United Nations on "The Clean Energy City Plans" in the early 1990s, which significantly affected EV market trends.[2] Policies in the mid-1990s targeted R&D and technology-intensive industries, and aimed to capture technology transfers through FDI inflows.[3] China's National Development and Reform Commission (NDRC) passed the "Policy on Development of Automotive Industry" in 1994 and "The National 863 R&D Program" in 2001 in support of the auto industry, which was initially hindered by lack of capital until China joined the WTO.[4] Joining the WTO in 2001 integrated China with the global automobile industry, both as a potential manufacturer and market.[5] "The National Policy on the Development of the Automobile Industry" in 2004 encouraged intellectual property rights and expansion of domestic automobile enterprise firms.[6] Like earlier legislation, this policy suggested the development of EVs as an aside to the auto industry and did little to boost consumer recognition and market demand for EVs.[7]

EV battery technology mainly consisted of lead-acid models, with lithium-ion appearing as a new technology.[8] In the 1990's, China was actually able to develop domestic EVs in line with international competitors, although the technology threshold was relatively low.[9] The 863 R&D policy provided some financial support to Chinese firms developing EVs, especially in promoting electric, hybrid electric, and battery vehicle technology.[10] This policy also launched research in powertrain control systems, drive motors, and power batteries.[11] Research program in the early 2000s also contributed to clean vehicle technology development and produced 19 types

[2] Xiong et al., "How Latecomers Catch up to Build an Energy-Saving Industry: The Case of the Chinese Electric Vehicle Industry 1995–2018," 4.

[3] Qiuyi Wang and Jai S. Mah, "The Role of the Government in Development of the Electric Vehicle Industry of China," *China Report (New Delhi)*, (August 12, 2021): 2, https://doi.org/10.1177/00094455211031685.

[4] Xiong et al., "How Latecomers Catch up to Build an Energy-Saving Industry: The Case of the Chinese Electric Vehicle Industry 1995–2018," 6.

[5] Wang and Mah, "The Role of the Government in Development of the Electric Vehicle Industry of China," 4.

[6] Ibid., 5.

[7] Xiong et al., "How Latecomers Catch up to Build an Energy-Saving Industry: The Case of the Chinese Electric Vehicle Industry 1995–2018," 6.

[8] Wang and Mah, "The Role of the Government in Development of the Electric Vehicle Industry of China," 10.

[9] Ibid., 11.

[10] Xiong et al., "How Latecomers Catch up to Build an Energy-Saving Industry: The Case of the Chinese Electric Vehicle Industry 1995–2018," 6.

[11] Wang and Mah, "The Role of the Government in Development of the Electric Vehicle Industry of China," 5.

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of engines and vehicles to national emission standard.[12] Some firms even reached mass production capabilities with products on the market.[13] The policy initiation phase of China's EV development lacked significant motivation, whether from the international community or the government. Although identified as an emerging industry, China had not yet begun to consider the EV industry as an important economic and political venture.

2006-2015 Creative Imitation

Following a proposition by the NDRC to regard EVs as a key area to build engineering capacity, the Chinese government started to initiate a string of policies targeted specifically at developing the domestic electric vehicle industry.[14] Key policies such as "The New Energy Vehicle Production Access Management Rules" in 2007 and "The New Energy Vehicle Demonstration and Application Project" in 2009 funneled much larger quantities of government funding into the EV industry.[15] They included major requirements such as the domestic manufacturing of EV auto parts and core technology mastery.[16] These initial steps would prove crucial to the domestic industry down the road in light of minimal technology transfers from international firms. The global financial crisis in 2008 can also be considered a contributing factor to China's window of opportunity to break into the EV industry, which they responded to by promoting supply-side reforms and updating the industrial structure to support the production of high-quality products.[17] As international companies suffered from financial repercussions that would inevitably stall progress, China took advantage of the situation to engage in technology and production catch-up activities.

Notably, by 2009 China had already become the world's largest producer of automobiles, which positively affected the EV industry through the linkage effect.[18] In the same year, the Ministry of Finance developed EV pilot works in 13 cities, and implemented policies to bolster

[12] Xingping Zhang et al., "The Current Dilemma and Future Path of China's Electric Vehicles," Sustainability (Basel, Switzerland) 6, no. 3 (2014): 1576, https://doi.org/10.3390/su6031567.
[13] Ibid.
[14] Wang and Mah, "The Role of the Government in Development of the Electric Vehicle Industry of China," 6.
[15] Xiong et al., "How Latecomers Catch up to Build an Energy-Saving Industry: The Case of the Chinese Electric Vehicle Industry 1995–2018," 6.
[16] Ibid.
[17] Wang and Mah, "The Role of the Government in Development of the Electric Vehicle Industry of China," 5.
[18] Ibid., 2.

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EV use.[19] By 2010, the State Council listed EVs as a key strategic emerging industry and announced the pursuit of developing internationally competitive vehicles.[20] Following this political endorsement, the government strengthened efforts to support technological innovation in combination with transformation strategies in a pivot to "pure electric drive" vehicles.[21] Unfortunately, China struggled to hit the goals set by these policies. The three-year output of EV production from 2010-2012 is estimated at 100,000 vehicles, considerably lower than the goal of 500,000, and most of the vehicles produced were purchased by government entities.[22] Variables such as high cost, lack of infrastructure, low range, and safety problems hindered EV promotion.[23] However, China was eventually able to master basic core technologies and churned out more than 5,000 types of EVs by 2010.[24]

During this period, domestic EV firms struggled to develop adequate technology to meet consumer demands. Between 2011 and 2015, technology focused policy directed investments into energy supply systems, battery technology, and business operation mode development.[25] Although China was not alone in their struggles, the inability to design batteries even remotely comparably to ICEVs made EVs undesirable and unprofitable. Battery technology restrictions limited range to 50-150 km for the vast majority of EVs, which is significantly less than ICEVs.[26] Further constraints include limits to the total number of charges and short battery life, which raised EV costs.[27] The main types of batteries used were 1) lead-acid, which had low cost but also short lifespan and travel distances, 2) nickel-cadmium, which offers longer life expectancy but has higher costs, and 3) sodium-sulfur, which had longer driving range and energy density but faced corrosivity and safety problems.[28] An emerging option, lithium-ion batteries presented charging and safety issues at the time, thus limiting its popularity.[29]

[19] Wang and Mah, "The Role of the Government in Development of the Electric Vehicle Industry of China," 6.
[20] Ibid.
[21] Ibid.
[22] Zhang et al., "The Current Dilemma and Future Path of China's Electric Vehicles," 1570.
[23] Ibid., 1572.
[24] Ibid., 1576.
[25] Zhang et al., "The Current Dilemma and Future Path of China's Electric Vehicles," 1577.
[26] Ibid., 1578.
[27] Ibid.
[28] Ibid.
[29] Ibid.

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One factor hindering technological development during this period was the unwillingness of international firms to bring advanced EV technology to joint venture (JV) agreements. The Chinese government tried to force foreign JV firms to bring in EV technology, in some cases even suspending permits for auto ventures that lacked an EV component.[30] Some JV firm complied by producing low volumes of conventional vehicles fitted with electric drive trains, which had high production costs and often sold at a loss, usually as taxi fleets.[31] These and other "check the box" responses indicate foreign firms' unease with the risk associated with technology transfer agreements embedded in JV intellectual property rules.[32] Because of China's many comparative advantages, to include cheap labor and abundant land for manufacturing, international firms needed to rely on maintaining a technological edge on Chinese firms to remain profitable. As with other advanced technology industries, EVs showed promise as as a viable substitute to ICEVs and as a vast untapped market. In this case, protecting IPR, especially in battery technology, was the key to compete and profit off of the international EV market.

Subsidies aimed at stimulating the demand side of the domestic EV market affected private purchases, energy taxis, and logistics vehicles. The scope and quantity of subsidies steadily climbed from 2009 and grew to encompass plug-in hybrid passenger cars and buses as well as fuel cell passenger cars.[33] China used monetary incentives as a method to increase customer demand and offer EVs as an alternate personal vehicle option. Subsidy policies spread from the initial 13 cities in the 2009 pilot program to 88 cities in 2014 and finally expanded nationwide in 2016.[34] However, the subsidies caused market overheating due to the number of EV enterprises springing up.[35] In an effort to combat unpromising EV initiatives, the Chinese government began to decrease subsidies and raise qualifying standards. Table 2-1 shows the decrease of subsidies for various types of EVs based on their range from 2013 through 2015, which continue to drop in the following years.

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[30] John P. Helveston et al., "Institutional Complementarities: The Origins of Experimentation in China's Plug-in Electric Vehicle Industry," *Research Policy* 48, no. 1 (2019): 206–22, https://doi.org/10.1016/j.respol.2018.08.006. 211.

[31] Ibid.

[32] Ibid.

[33] Wang and Mah, "The Role of the Government in Development of the Electric Vehicle Industry of China,"9.

[34] Shanjun Li et al., "The Role of Government in the Market for Electric Vehicles: Evidence from China," Journal of Policy Analysis and Management 41, no. 2 (2022): 458, https://doi.org/10.1002/pam.22362.

[35] Xiong et al., "How Latecomers Catch up to Build an Energy-Saving Industry: The Case of the Chinese Electric Vehicle Industry 1995–2018," 7.

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Table 2-1 Central Subsidies from 2013 to 2019

Type	Range	2013	2014	2015	2016	2017	2018	2019
BEV	≥ 80km	¥35,000	¥33,250	¥31,500	-	-	-	-
	≥ 100km				¥25,000	¥20,000	-	-
	≥ 150km	¥50,000	¥47,500	¥45,000	¥45,000	¥36,000	¥15,000	-
	≥ 200km						¥24,000	-
	≥ 250km	¥60,000	¥57,000	¥54,000	¥55,000	¥44,000	¥34,000	¥18,000
	≥ 300km						¥45,000	
	≥ 400km						¥50,000	¥25,000
PHEV	≥ 50km	¥35,000	¥33,250	¥31,500	¥30,000	¥24,000	¥22,000	¥10,000

Notes: This table shows the subsidies from the central government. The amount of the subsidy is based on driving range. Starting from 2018, the subsidies are adjusted based on two additional requirements for EVs to be eligible: minimum energy efficiency (kWh/100km) as a function of vehicle weight, and battery energy density ≥105Wh/kg. For comparison, the amount of EV subsidies in the U.S. is only based on battery capacity.

Source: Li et al., "The Role of Government in the Market for Electric Vehicles: Evidence from China," 258.

Supporting policies on charging infrastructure, new energy policies, and subsidies for EV purchase also contributed to the rapid development of China's EV industry environment.[36] An interesting policy in Shanghai allowed purchasers of EVs to gain licenses more quickly and bypass license fees, with similar policies enacted in Beijing and Shenzhen.[37] Considering the difficulty for individuals to acquire licenses through the lottery system in these cities, this smart policy contributed to driving up demand. The government also directly contributed by incrementally increasing the proportion of EVs among public buses, which were concentrated around cities and megacities. [38] Additionally, mandates for EVs to constitute 30% of new vehicle purchases for government agencies appeared, with the required percentage increasing each year.[39] By stipulating the purchase of EVs in sectors directly controlled by the government, China increased EV visibility and penetration into the public sphere. Since the quality of passenger EVs had not surpassed ICEVs, low demand would greatly affect profitability and firm

[36] Xiong et al., "How Latecomers Catch up to Build an Energy-Saving Industry: The Case of the Chinese Electric Vehicle Industry 1995–2018," 6.

[37] Wang and Mah, "The Role of the Government in Development of the Electric Vehicle Industry of China," 9.

[38] Ibid., 7.

[39] Ibid.

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survivability. Government induced EV demand would help to keep firms afloat, thus furthering firms' ability to continue with the process of innovation necessary to develop advanced-generation EVs.

2016-2022 Independent Innovation

China continued to master mature EV technology models and mass production but struggled to develop the advanced-generation technology necessary for the industry to strive without subsidies. By 2017, China accounted for 49 percent of plug-in EV sales in the world.[40] Pivotal policies during this time include the "Three-year Action Plan for Winning the Blue Sky Defense War" in 2018, which reconfirmed EV promotion and set targets for production and sales to 2 million EVs by 2020, and the "Development Plan for the EV Industry 2021-2035", which solidified the turn to a "market-led, innovation-driven, coordinated advancement and open development" strategy to achieve advanced, internationally competitive core EV technology.[41] As an update to previous policies mandating increasing percentages of EVs in the public sector, these policies dictate public vehicles to be fully electrified.[42] This indicates a certain level of confidence had been reached with introducing EVs to the public sector in previous policies. The government also increased national quality threshold demand, and set vehicle performance requirements standards for battery density, energy efficiency, and driving range.[43] These new standards force companies to manufacture higher quality products to stay on the market, and they raise the reputation of EVs as an enticing alternative to traditional cars for personal use.

China started to lower subsidy standards starting in 2017 to weed out uncompetitive manufacturers taking advantage of generous subsidies, thus shifting to a competitive market

[40] Helveston et al., "Institutional Complementarities: The Origins of Experimentation in China's Plug-in Electric Vehicle Industry," 209.

[41] Wang and Mah, "The Role of the Government in Development of the Electric Vehicle Industry of China," 8.

Xiaoxue Zheng et al., "Manufacturing Decisions and Government Subsidies for Electric Vehicles in China: A Maximal Social Welfare Perspective," Sustainability (Basel, Switzerland) 10, no. 3 (2018): 3, https://doi.org/10.3390/su10030672.

[42] Wang and Mah, "The Role of the Government in Development of the Electric Vehicle Industry of China," 8.

[43] Li et al., "The Role of Government in the Market for Electric Vehicles: Evidence from China," 459.

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order by forcing companies to compete against each other.[44] Table 2-1 reveals a steep drop off in subsidies from 2016 to 2019, with the notable elimination of underperforming models able to qualify in later years. Although the central government strove to cancel subsidies in 2019, negative sale growth prompted ministries to reinstate them in 2020.[45] Compared to 2020, subsidy standards declined by 10 percent in 2021 and 20 percent in 2022.[46] Some studies indicate that these subsidy reductions have successfully eliminating incompetent firms and retaining qualified ones.[47] However, the inability for the Chinese EV industry to perform well without subsidies indicates a reliance on government support policies and an unwillingness for the central government to adopt a hands-off approach. Sun et al. explains that consumer subsides and manufacturer subsidies are both important because "consumer preferences are usually stuck in established products due to the path dependence", thus, traditional technologies will challenge advanced-generation technology when entering the market."[48]

Although subsidies decreased substantially during this timeframe, alternate policies continued to motivate the domestic EV industry. Figure 2-1 displays the growing popularity of green plate policies, which increased from five cities in 2016 to 20 cities in 2017, and finally to 147 across all of China in 2018.[49] Other strategies such as the dual credit-point system for corporate average fuel consumption increased EV penetration as supply-side motivators.[50] These policies indicate the increasing commitment of the central government to evolve the transportation sector to EVs, as they are willing to provide compensation, whether financially or in the form of some other convenience, to individuals willing to transition to EVs. This greatly contributed to China's current position as the world's largest EV market.[51] Additionally, China

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[44] Xiong et al., "How Latecomers Catch up to Build an Energy-Saving Industry: The Case of the Chinese Electric Vehicle Industry 1995–2018," 6-7.

[45] Li et al., "The Role of Government in the Market for Electric Vehicles: Evidence from China," 460.

[46] Wang and Mah, "The Role of the Government in Development of the Electric Vehicle Industry of China," 10.

[47] Xiong et al., "How Latecomers Catch up to Build an Energy-Saving Industry: The Case of the Chinese Electric Vehicle Industry 1995–2018," 7.

[48] Xiaohua Sun et al., "The Effects of Public Subsidies on Emerging Industry: An Agent-Based Model of the Electric Vehicle Industry," *Technological Forecasting & Social Change* 140 (2019): 281, https://doi.org/10.1016/j.techfore.2018.12.013.

[49] Li et al., "The Role of Government in the Market for Electric Vehicles: Evidence from China," 461.

[50] Ibid.

[51] Clemens Dabelstein et al., "Winning the Chinese Electric Car Market," *McKinsey and Company*, May 4, 2021, https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/winning-the-chinese-bev-market-how-leading-international-oems-compete.

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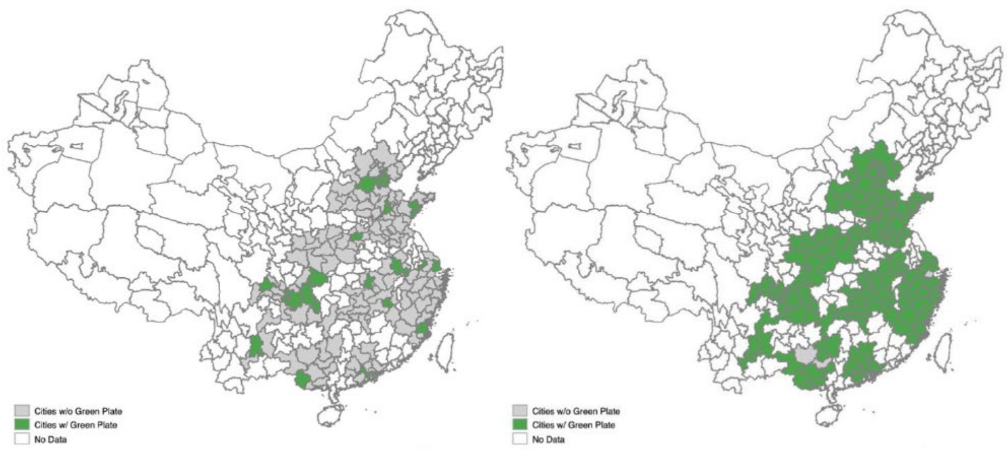
loosened JV technology transfer regulations in 2018, allowing foreign firms such as Tesla, BMW, and Volkswagen greater access to the Chinese market.[52]

Figure 2-1 Green Plate Policy by City



(c) Green plate policy in 2017 (d) Green plate policy in 2018

Notes: Panels (a) and (b) depict average consumer subsidies from central and local governments in ¥10,000 per EV in 2015 and 2018. Panels (c) and (d) show the rollout of the green plate policy for EVs in 2017 and 2018. The policy started in 2016 with five cities: Shanghai, Nanjing, Wuxi, Jinan, and Shenzhen.

Source: Li et al., "The Role of Government in the Market for Electric Vehicles: Evidence from China," 459.

Policy Motivation: Air and Oil

Nearly every research article on electric vehicles mentions air quality or the global climate crisis as the most important motivating factor for investment in the EV industry. International and domestic political actors have shown great interest in EVs as a clean air solution. The Kyoto Protocol has influenced governments worldwide to adopt cost-effective carbon reduction measures to mitigate climate change.[53] Domestically, one of the driving motivations for EVs in China's 863 program was achieving environmental protection and a low-

[52] Victoria Waldersee, "BMW Pays $4.2 Bln to Take Control of Chinese JV," *Reuters*, February 11, 2022, https://www.reuters.com/business/autos-transportation/bmw-receives-license-take-75-stake-china-joint-venture-bmw-brilliance-automotive-2022-02-11/.

[53] Dunnan Liu and Bowen Xiao, "Exploring the Development of Electric Vehicles under Policy Incentives: A Scenario-Based System Dynamics Model," Energy Policy 120 (2018): 13, https://doi.org/10.1016/j.enpol.2018.04.073.

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carbon economy.[54] Air related environmental problem directly affecting China includes global warming and PM 2.5, both of which directly impact the livelihood of citizens.[55] In an effort to control national greenhouse gas emissions and air pollutants, China has passed EV-friendly pollution control measures.[56] However, the environmental benefits of EVs as compared to conventional vehicles depends highly on the type of fuel consumption, costs and CO2 emissions associated with electricity generation.[57] In China, EVs basically shift gasoline consumption to coal-based electricity generation, and Li et al.'s study actually predicts a 2.74-3.74% increase in CO2 emissions with the deployment of EVs.[58] The Chinese government would need to increase energy generation with lower or zero CO2 emission rates, such as renewable energy or gas power, in order to increase positive environmental impact of EVs.[59]

China suffers from oil import dependence exacerbated by their growing vehicle market. China is responsible for almost 50 percent of the global increase in oil consumption in the past twenty years.[60] Some scholars list oil security as another driving factor for adopting electric vehicles.[61] This makes sense, as the quantity of oil China imports each year is much higher than the international security threshold of 65 percent.[62] Figure 2-2 compares China's fossil fuel import dependence, revealing an increase from 50 percent in 2008 to over 70 percent in 2018. This graph also reveals the huge gap between oil and coal dependency. In 2018, China's import dependence on coal was below 10%, significantly less than that of oil. China's comparative advantage in coal as opposed to oil further motivates the adoption of EVs from a resource safety perspective.

[54] Wang and Mah, "The Role of the Government in Development of the Electric Vehicle Industry of China," 6.

[55] Liu and Xiao, "Exploring the Development of Electric Vehicles under Policy Incentives: A Scenario-Based System Dynamics Model," 11.

[56] Ibid.

[57] Ying Li et al., "Electric Vehicle Charging in China's Power System: Energy, Economic and Environmental Trade-Offs and Policy Implications," Applied Energy 173 (2016): 536, https://doi.org/10.1016/j.apenergy.2016.04.040.

[58] Ibid., 546.

[59] Ibid., 549.

[60] Li et al., "The Role of Government in the Market for Electric Vehicles: Evidence from China," 451.

[61] Zhang et al., "The Current Dilemma and Future Path of China's Electric Vehicles," 1568.

[62] Xiong et al., "How Latecomers Catch up to Build an Energy-Saving Industry: The Case of the Chinese Electric Vehicle Industry 1995–2018," 1.

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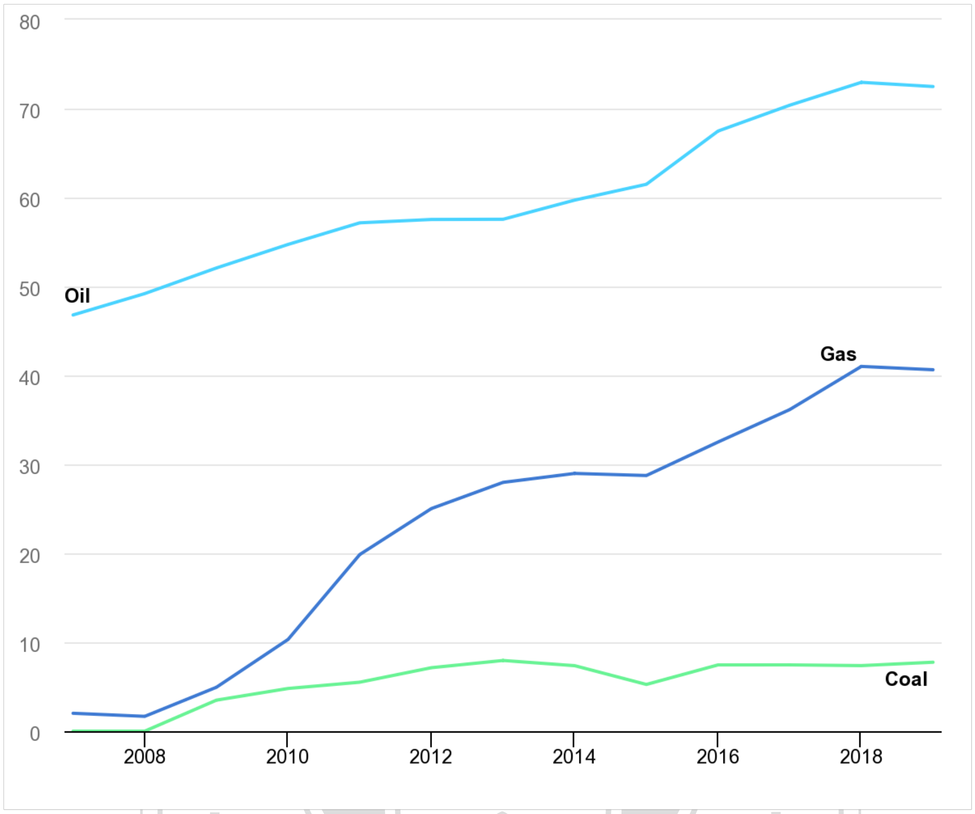
Figure 2-2 Oil, Gas, and Coal Import Dependency in China



Source: "Oil, Gas and Coal Import Dependency in China, 2007-2019 – Charts – Data & Statistics," IEA, accessed July 1, 2022.

From a strategic standpoint, EVs can insulate China from international shocks to the oil industry that would greatly affect China's transportation sector. Vehicles in any category other than pure electric vehicles (PEV) contribute to China's reliance on foreign oil. As the distribution of oil favors countries unequally, dependencies exacerbate security relations. EVs offer the opportunity to reduce such dependencies, as electricity can be derived from both renewable energy and other fossil fuels. Additionally, China gains political favor with countries such as those within the EU that consider environmental conservation an important issue. The energy source flexibility gained by the increasing adoption of EVs allows China to play by its strengths, and decreases its vulnerability to international oil market fluctuations.

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2.2 Technology Development

Patent Trends

Global technology patents reflect the technological innovation process and also reveal the direction of trending technologies in each country.[63] The upward patent trend of EV battery technology as shown in Figure 2-3 has been established as the most important area of technological innovation for EVs, and indicates the increased focus and R&D investment from countries around the world.[64] Patent grants and applications have risen sharply worldwide since 2004, with China's patent applications have experienced a huge jump from 2016-2017. Interestingly, the authors of Figure 2-3 point out that although patent applications drop off completely in 2020, this does not represent the true number of applications and grants.[65] Thus, the trend of patent applications beyond 2020 in the post pandemic era could move in either direction, although Yuan and Wu predict the continued upward momentum in following years.[66]

Even though China is a latecomer to the EV industry, they have developed quickly, and have even surpassed other incumbent nations. Figure 2-3 shows China's EV battery patent applications as mostly following global trends, with two notable divergences. First, the global patent application trends show a steeper increase from 2009 to 2012 compared to China's, during which time China may have fell behind in EV technology, especially for EV batteries. Starting in 2016, China started to close the gap, with the number of patents granted to China nearly equaling the number granted worldwide in 2019. This aligns with China's historical transition in government EV policy from the "creative imitation" phase to the "independent innovation" phase in 2016. Analyzing patent trends in China reveals the impact of government policies on industry practices.

[63] Yan, Deng, and Mei, "Evolution of Global EV Battery Technology Based on the Main Path of Patent Citation," 2.

[64] Xinyue Yuan and Jie Wu, "Research on the Development of Pure Electric Vehicle Power Battery Technology Based on Patent Analysis," *IOP Conf. Series: Earth and Environmental Science* 615 (2020): 3.

[65] Yuan and Wu, "Research on the Development of Pure Electric Vehicle Power Battery Technology Based on Patent Analysis," 2.

[66] Ibid.

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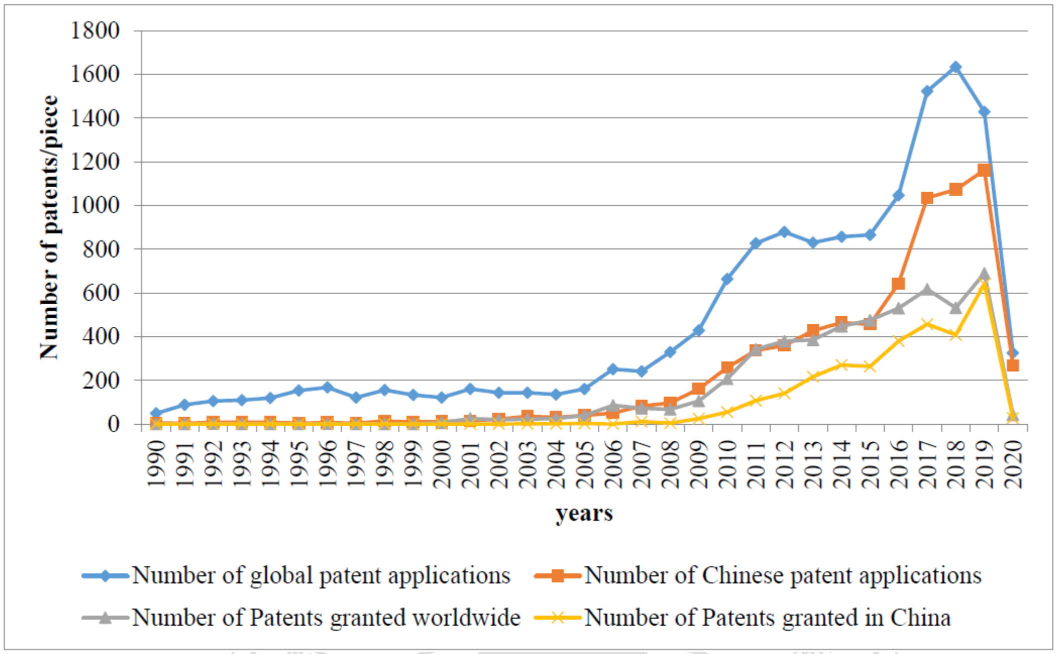
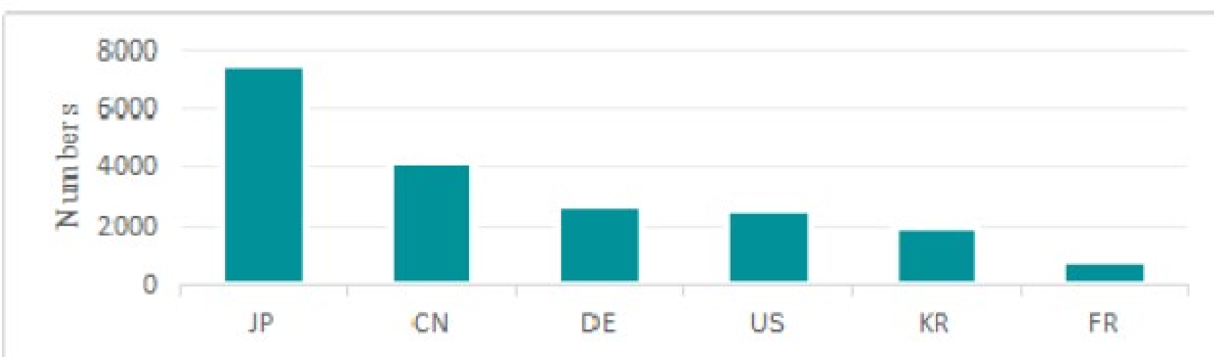
Figure 2-3 Global Patent Trends in the Field of Battery Technology for PEVs



Source: Yuan and Wu, "Research on the Development of Pure Electric Vehicle Power Battery Technology Based on Patent Analysis," 3.

Figure 2-4 Patent Distribution among Industry Leading Countries



Source: Yan, Deng, and Mei, "Evolution of Global EV Battery Technology Based on the Main Path of Patent Citation," 3.

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For emerging technology industries such as EVs, patents can indicate the countries that hold proportions of knowledge within the industry, thus strengthening their productive power. As shown in Figure 2-4's depiction of the distribution of patents among industry leaders up to 2019, Japan leads the world in EV related patent applications.[67] Among the top six countries with the most patent applications, RCEP countries (Japan, China, and South Korea), make up half. As an incumbent holding nearly double the number of patents as the next highest country, Japan emerges as the clear leader for quantity of EV technology knowledge. However, analysis of patent trends from a broad perspective has drawbacks. Different levels of patents indicate the value, or "quality" of the innovation. For example, a closer examination of EV chassis technology patent filing reveals that although Toyota and Hyundai have filed many more patents than other EV firms, the vast majority are "D" value, which is the lowest quality category.[68] Although Chinese company BYD has a similar quantity of filings as compared to Tesla, BYD's patents all fall in the "B" and below categories, whereas Tesla's extend into the "AA" category.[69] Evidently, the quantity of patents does not necessarily indicate great leaps in innovation.

Susan Strange's inclusion of technology in the factors of production assists in assessing free trade comparative advantages. China has a clear advantage in labor over Japan and Korea. However, analysis of patent filings shows Japan's absolute and comparative advantage in EV technology over China and likely Korea's comparative advantage as well. A closer relationship with Japan and Korea through RCEP would benefit China's productive power with the increased probability of information transfer or business linkages. At the very least, the upwards trend of patent filing in China reveals enthusiasm for EV technology development, likely spurred by favorable government policies.[70] However, existing data also shows that patent applications within RCEP are largely confined to China, Japan, and South Korea. Further analysis of the EV technology within China and RCEP will augment the industry development indicated by patent trends.

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[67] Yuan and Wu, "Research on the Development of Pure Electric Vehicle Power Battery Technology Based on Patent Analysis," 2.

[68] Andrea Orivati, "Electric Vehicle Patent Trends & Technology Trajectory — Part 1: The Chassis Control System," *InQuartik*, accessed July 1, 2022, https://www.inquartik.com/blog/trends-electric-vehicle-patent-trends-chassis/.

[69] Ibid.

[70] Yuan and Wu, "Research on the Development of Pure Electric Vehicle Power Battery Technology Based on Patent Analysis," 5.

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Mature Technology Experimentation

EVs have existed for over two decades already, and within that time, a wide range of products have entered the market. The technical maturity of the ICEV industry has already developed to a point where incumbents control all key patents and only incremental innovations occur, whereas the relatively new and undeveloped EV industry presents the chance for upstart companies to break into the vehicle industry by leap-frogging past ICEVs and directly focusing on developing EVs.[71] In a sense, mature technology EVs occupy a gray area in automobile technology. EVs that use older battery technology do not have the high price points of advanced technology EVs, but have a lower quality than fuel-powered alternatives. In China, a combination of policy incentives and local interest has opened a window of opportunity allowing some EV companies to develop local mature technology options.

China's industry policies have contributed to the opportunity for new EV firms to enter the market without necessarily developing advanced technology. China's previous requirements for JV technology transfer in mature industries would necessitate foreign firms bring in advanced EV technology, a risky and potentially costly move.[72] However, this has led to multinational automakers having barely any presence in China's EV market.[73] Domestic EV firms have taken advantage of this absence established a presence within a protected market. China's industrial policies leave spaces of ambiguity to motivate market latecomers to establish competitive capabilities. [74] Local policy support for firms has transformed local markets into "laboratories" facilitating technology experimentation across various levels of the EV industry.[75]

Some areas of China have seen the development of alternatives such as low-speed electronic vehicles (LSEV). As shown in Table 2-2 China's LSEV models have lower speeds

[71] Yu Zou et al., "Agile Business Development, Chinese Style: An Exploration of the Low-Speed Electric Vehicle Industry in Shandong Province, China," *China Review (Hong Kong, China: 1991)* 22, no. 1 (2022): 110.
Borgstedt, Neyer, and Schewe, "Paving the Road to Electric Vehicles – A Patent Analysis of the Automotive Supply Industry," 76.
[72] Helveston et al., "Institutional Complementarities: The Origins of Experimentation in China's Plug-in Electric Vehicle Industry," 207.
[73] Helveston et al., "Institutional Complementarities: The Origins of Experimentation in China's Plug-in Electric Vehicle Industry," 206.
[74] Zou et al., "Agile Business Development, Chinese Style: An Exploration of the Low-Speed Electric Vehicle Industry in Shandong Province, China," 118.
[75] Helveston et al., "Institutional Complementarities: The Origins of Experimentation in China's Plug-in Electric Vehicle Industry," 207.

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and mileage than their OEM counterparts. In comparison to conventional EVs, LSEVs use mature lead-acid battery technology, which allows for a lower price tag and broader public appeal.[76] Table 2-2 shows LSEV firms' rural or niche market position, where advanced electric vehicles are simply too expensive for locals to purchase, creating a demand for LSEVs. For example, the Shandong LSEV industry has risen in recognition within China's national market.[77] Local entrepreneurs successfully commercialized an EV model, however, the product was banned from sale in other provinces for not meeting the speed and mileage requirements.[78] In other cases, LSEV firms have established a local presence through exploiting creative market niches to avoid central government licensing standards, such as the 'sightseeing cars' with the company Shifeng and the local government police cars with the company Baoya.[79] The ability for firms to operate in these untapped markets relies on flexible local policies and evasion of direct competition with globalized incumbents.[80] Unfortunately, the lead-acid batteries used by these LSEVs present sustainability and environmental concerns, such as low cycling performance and risk of soil contamination, which limits the practicality of current models.[81]

The members of RCEP have extremely different market environments. As the EV industry challenges the ICEV industry, user preferences range depending on regional factors. While advanced EV firms strive to meet demands in increased mileage and decreased charging time, these options will inevitably replace medium to higher quality ICEV products. However, this excludes regions with demands for a cheaper product that have different mileage and charging expectations. As the popularity of EVs spreads internationally, especially as a global push for de-carbonization, the affordability of EVs becomes an important factor. Thus, RCEP's effect on China's production power potential with the domestic LSEV industry lies in the possibility of niche market expansion. Although China's LSEVs would not likely contribute to

[76] Zou et al., "Agile Business Development, Chinese Style: An Exploration of the Low-Speed Electric Vehicle Industry in Shandong Province, China," 111.

[77] Ibid., 112.

[78] Ke Rong et al., "Organizing Business Ecosystems in Emerging Electric Vehicle Industry: Structure, Mechanism, and Integrated Configuration," *Energy Policy* 107 (2017): 235, https://doi.org/10.1016/j.enpol.2017.04.042.

[79] Ibid., 239.

[80] Zou et al., "Agile Business Development, Chinese Style: An Exploration of the Low-Speed Electric Vehicle Industry in Shandong Province, China," 109.

[81] Zhao, Wang, and Negnevitsky, "Connecting Battery Technologies for Electric Vehicles from Battery Materials to Management," 3.

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trade with high income RCEP members or even to the domestic market, the increased linkages to lower income regions present export opportunities to LSEV firms.

Table 2-2 Comparison of LSEV Models to other EVs

Case firm's business ecosystem	Company description	Project	Market position	Specification (approximately)
Case 1: Renault-Nissan	The joint venture	Fluence	City market	135 km/h 185 km/charge
Case 2: ECOmove	Denmark EV OEM	QBEAK	City market	120 km/h 300 km/charge
Case 3: Daimler AG	German car OEM	Smart ED	City market/ specific area	120 km/h 140 km/charge
Case 4: Volkswagon	German car OEM	E-Golf	City market/ additional car	140 km/h 150 km/charge
Case 5: BYD	Chinese car OEM	E6	City market	140 km/h 300 km/charge
Case 6: WanXiang	Chinese car OEM	Passenger Car	City market	110 km/h 150 km/charge
Case 7: Shifeng	Chinese Low Speed EV	Rural car	Rural/small area	80 km/h 120 km/charge
Case 8: Baoya	Chinese Low Speed EV	Eco-car	Specific area	80 km/h 120 km/charge

Source: Rong et al., "Organizing Business Ecosystems in Emerging Electric Vehicle Industry: Structure, Mechanism, and Integrated Configuration," 237.

Advanced Battery Technology Development

As an emerging advanced industry, EV technology has the potential to advance quickly and develop early path dependencies. Some industry experts have described the EV industry as requiring "competence destroying change", which forces established firms to compete in EV technology or lose the upper hand in the auto market.[82] Although incumbent automobile firms have the pressure to develop advanced EV technology as a replacement for the shrinking ICEV industry, firms outside of the automotive industry, or new market entrants, also contribute significantly to innovation, especially in battery technology. Incumbent firms have productive power advantages through established supply chains for ICEVs, which have significant overlaps with EV supply chains, but they still need a meaningful share of advanced technology to remain competitive.

For EV specific components, battery unit innovation is the most important for electric vehicles, and advancements in fuel cell technology directly contributes to the success of EV firms. On the average EV, the battery pack comprises of 35-45 percent of the total manufacturing

[82] Borgstedt, Neyer, and Schewe, "Paving the Road to Electric Vehicles – A Patent Analysis of the Automotive Supply Industry," 76.

DOI:10.6814/NCCU202201039

cost, usually making it the most expensive single unit.[83] EV battery innovation occurs in one of three components: the cathode, anode, or electrolyte.[84] Cathode innovation matters because it determines the capacity and power of a battery, and also comprises 51 percent of battery cost.[85] The innovation of higher energy cathodes require developments in energy storage per area and volume of anode electrodes.[86] Cell manufacturers incorporate silicon or silicon oxide into graphite materials to enhance cell level energy gravimetric and volumetric density.[87] The overall performance of a battery depends not only on the individual innovations of each component, but also the synergy between them.[88] Firms must develop cathode and anode technology simultaneously to achieve a marketable product. On top of energy storage and output power, EV battery innovation must also consider minimizing weight in order to reduce friction and extend driving mileage.[89] The biggest disadvantage to Li-ion batteries is performance variation in high and low temperatures, which affect factors such as energetic performance, lifetime, and safety.[90] According to battery cell research, "high temperatures degrade the life of Li-ion batteries, whereas cold temperatures reduce power and energy capabilities, thus limiting the driving range and performance capabilities of EVs".[91] For EVs to expand into regions with very high or very low temperatures, further developments are needed.

The future of EVs likely relies on developments in solid-state batteries. All-solid-state batteries (ASSB) require major innovations in anode and electrolyte technology. Proposed ASSB models would replace the graphite porous electrode with lithium metal and the porous polymer separator with a solid separator.[92] Metal anodes previously posed technical challenges, but recent

[83] Zhao, Wang, and Negnevitsky, "Connecting Battery Technologies for Electric Vehicles from Battery Materials to Management," 2.
[84] Ball, Clark, and Cookson, "Battery Materials Technology Trends and Market Drivers for Automotive Applications: Challenges for Science and Industry in Electric Vehicles Growth," 287.
[85] James Morris, "Rising Lithium Prices Could Stop The EV Revolution – Or Could They?" *Forbes*, accessed June 1, 2022, https://www.forbes.com/sites/jamesmorris/2022/04/16/rising-lithium-prices-could-stop-the-ev-revolution--or-could-they/.
[86] Ball, Clark, and Cookson, "Battery Materials Technology Trends and Market Drivers for Automotive Applications: Challenges for Science and Industry in Electric Vehicles Growth," 290.
[87] Ibid.
[88] Zhao, Wang, and Negnevitsky, "Connecting Battery Technologies for Electric Vehicles from Battery Materials to Management," 8.
[89] Ibid.
[90] Iclodean et al., "Comparison of different battery types for electric vehicles," 2.
[91] Chakib Alaoui, "Solid-state thermal management for lithium-ion EV batteries," *IEEE Transactions on Vehicular Technology* 62, no. 1 (January 2013): 98.
[92] Ball, Clark, and Cookson, "Battery Materials Technology Trends and Market Drivers for Automotive Applications: Challenges for Science and Industry in Electric Vehicles Growth," 292.

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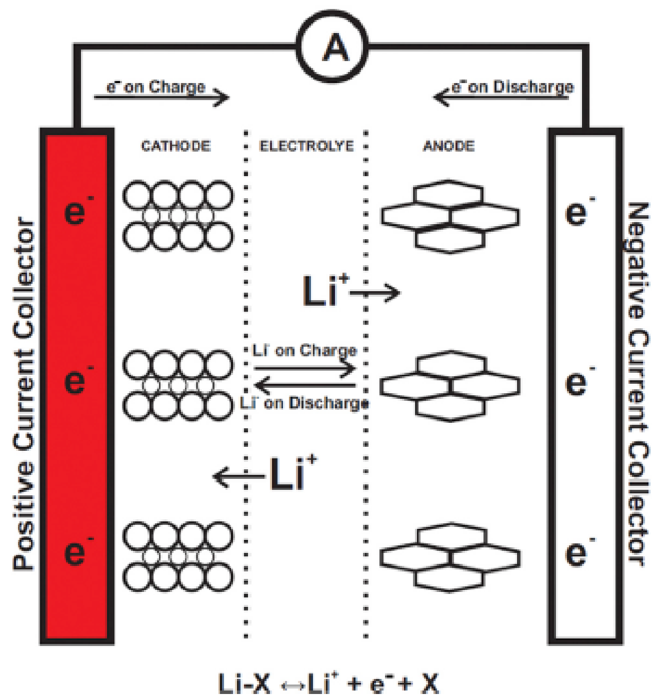
research has attempted to use solid electrolytes to mitigate anode instability.[93] Solid-state electrolytes would replace the highly flammable organic electrolytes currently used in Li-ion batteries while maintaining the advantages of using metal anodes.[94] Another positive outcome of ASSBs would be an increased bandwidth for using higher voltage cathode materials, thus increasing the power and mileage of EVs.[95] However, ASSBs currently faces major technical bottlenecks such as low interface compatibility and poor ionic conductivity, which makes them not commercially viable in their current state.[96] These problems have prevented successful mass-production models, and no breakthroughs have occurred thus far.

Figure 2-5 Schematic Diagram of a Li-ion Battery Cell



Source: Zhao, Wang, and Negnevitsky, "Connecting Battery Technologies for Electric Vehicles from Battery Materials to Management," 4.

[93] Ball, Clark, and Cookson, "Battery Materials Technology Trends and Market Drivers for Automotive Applications: Challenges for Science and Industry in Electric Vehicles Growth," 292.

[94] Ibid.

[95] Ibid.

[96] Zhao, Wang, and Negnevitsky, "Connecting Battery Technologies for Electric Vehicles from Battery Materials to Management," 28.

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Table 2-3 Specifications of Some Power Batteries on Hot-Sale EVs

Batterytype	Battery manufacturers	EV Model	Capacity (kWh)	Nominal driving range (km)
NA	Panasonic	Tesla Model S 75D	75	405
		Tesla Model S 90D	90	445
		Tesla Model S 100D	102	510
		Tesla Model S P100D	102	505
LCO	Panasonic, CATL	Tesla Roadster (2020)	200	1,000
		Daimler Benz Smart Fortwo Electric Drive	18	120
LFP	BYD, GS Yuasa, Lishem, Valence	BYD E6	82	390
		Mitsubishi iMiEV	16	95
NMC	CATL, Hitachi, LG Chem, Samsung SDI, Panasonic, SK Innovation	Chevrolet Bolt EV	60	350
		Chevrolet Volt	18.4	85
		Ford Focus Electric	33.5	180
		BYD E6	82	390
		Roewe Ei5	52.5	301
		Renault Zoe ZE50 R135	41	230
		Nissan LEAF	30	170
		NIO ES6	70	415
		BMW i3	33	180
		Hyundai Kona Electric	64	415
		Audi e-tron 55 Sportback	95	446
		Volkswagen e-Golf	35.8	195

Source: Zhao, Wang, and Negnevitsky, "Connecting Battery Technologies for Electric Vehicles from Battery Materials to Management," 7.

Battery manufacturers have continuously developed different mixtures of lithium-ion battery cathode elements to increase power and mileage outputs. Table 2-3 shows the four main battery types used by industry leaders, revealing the wide range of performance output even for batteries within the same category. As the obvious industry leader, Tesla's earlier models used lithium-ion batteries with lithium-nickel-cobalt-aluminum oxide (NCA) cathodes. The EVs manufactured with NCA batteries have relatively high capacity and range as compared to lithium-iron-phosphate (LFP) and (NMC) batteries. Because of consumer demand for greater

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range, more companies are using high-Ni. [97] A key point of innovation for the EV battery industry has been working out technical problems with lithium nickel oxide stability.[98] The other metals, mainly cobalt, aluminum, and manganese are introduced to impart stability and improve capacity retention.[99]

China's leading EV company BYD has produced models with impressive results. BYD started as a battery company before also entering the auto industry.[100] They have exported electric busses to European countries such as Finland, Slovakia, Hungary, and Sweden, and to other countries worldwide such as Pakistan, Colombia, and New Zealand.[101] Their BYD E6 passenger vehicle model uses an LFP battery that has a capacity of 82kWh and a nominal driving range of 390 km. In comparison to other leading models, the BYD E6 ranks high in both capacity and mileage categories, indicating China's success in technology catch-up within the EV industry. China can be considered a trend setter in the EV industry with their battery development, as rising costs of critical materials in 2021 have motivated other EV automakers to switch to LFP batteries.[102] In 2021, Tesla announced its transition for standard range vehicles to LFP batteries, and their Q1 2022 financial results confirm that about half of their new vehicles use LFPs.[103] The estimated capacity and range of Tesla's Model 3 vehicle fitted with the new LFP battery is 58kWh and 380km respectively, which would make China's BYD E6 a superior option based on power and range metrics.[104]

Moving forward in electric vehicle technology, China has a distinct productive power advantage. With the BYD model, China is poised to lead the transition to LFP batteries. China has managed to secure a relative advantage with all four factors of production, considering their significant role in battery manufacturing while also possessing advanced technological knowledge. Also, producing a competitive EV option will assist China in establishing a presence in advanced economy markets worldwide, just as EV are growing in popularity. However, China

[97] Ball, Clark, and Cookson, "Battery Materials Technology Trends and Market Drivers for Automotive Applications: Challenges for Science and Industry in Electric Vehicles Growth," 288.

[98] Ibid.

[99] Ibid.

[100] "BYD Co., Ltd.," *Nikkei Asia*, July 4, 2022, https://asia.nikkei.com/Companies/BYD-Co.-Ltd.

[101] "Newsroom – BYD SINGAPORE," *BYD*, accessed July 1, 2022, http://sg.byd.com/newsroom/.

[102] Fred Lambert, "Tesla Is Already Using Cobalt-Free LFP Batteries in Half of Its New Cars Produced," *Electrek*, April 22, 2022, https://electrek.co/2022/04/22/tesla-using-cobalt-free-lfp-batteries-in-half-new-cars-produced/.

[103] Ibid.

[104] EV Database, "Tesla Model 3," accessed June 2, 2022, https://ev-database.org/car/1555/Tesla-Model-3.

DOI:10.6814/NCCU202201039

still faces technological challenges ahead to maintain their advantage. China still relies heavily on imports for many of the critical battery minerals, and future advancements in battery technology will likely still require access to these raw materials.[105] Additionally, the electric vehicle industry is poised for a shift to ASSB technology. Although the effect of ASSBs on the quality and cost of EVs is unknown, the recent return of EVs to the older LFP technology, even with evidence of better performance with other Li-ion battery types, signals a hesitancy to continue developing other battery options due to profitability and accesses to raw material concerns.

[105] Wen et al., "Impacts of COVID-19 on the Electric Vehicle Industry: Evidence from China," 6.

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CHAPTER 3. RCEP's Impact on China's Electric Vehicle Industry

This chapter assesses three elements of RCEP that affect China's EV industry development: domestic policy liberalization, tariff and rule of origin impacts, and foreign partnerships. These variables impact productive power by contributing to the alignment of international factors of production in China's favor, especially for generation of capital and possession of technology. China passed liberalization policies such as the Foreign Investment Law (FIL) prior to the initiation of RCEP, which include provisions for future FTAs. Additionally, they affect the domestic operating environment for the purpose of attracting foreign investment. RCEP's tariff liberalization schedule immediately lowers tariffs on many imports for EV components but allows China to keep EV tariffs for a period of time, which creates a window of opportunity for China's domestic industry to develop. Additionally, RCEP's ROO lower transactional costs and expands firms' flexibility in the sourcing of EV parts. In the wake of RCEP, China has developed partnerships with foreign firms to boost their own EV productivity. The study of China's EV partnerships will focus on domestic firms' collaborations with partners from Japan, South Korea, and ASEAN.

3.1 China's Policy Liberalization

China's economic policy liberalization include the necessary changes for RCEP and also maximizes the benefits of joining the FTA. Even though RCEP is generally considered a 'low quality' FTA, China still had to make domestic policy adjustments in order to comply as a member. The consequential new FIL contains many of the policy changes necessary for legally incorporating RCEP while also elevating many of China's investment policies on par with western standards. The new FIL and other liberalization initiatives aim to attract foreign investors and partners to China, to include within the EV industry. China's commitment to joining RCEP has contributed to long-awaited changes in the domestic investment policy environment. These domestic market liberalizations increase China's productive power by enticing investors and firms to work in China, thus generating investment capital and increasing the potential for advanced technology development.

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China's recently passed liberalization legislation replaces previous protectionist policies typically found in government-controlled economies. On January 1, 2020, China implemented the new FIL and the Regulations on Implementation of the Foreign Investment Law.[1] These new policies effectively ended three laws that have government China for 40 years: the Sino-Foreign Equity Joint Venture Law, the Sino-Foreign Cooperative Joint Venture Law, and the Wholly Foreign-owned Enterprises Law.[2] Dubbed "the Three Laws", these older policies subjected foreign invested enterprises to different laws than domestic firms for establishment and operation, which contrasted with legal frameworks in western countries.[3] Although these policies had the benefit of "flexibility to adjust to changing economic situations", conflicts arose between the Three Laws and other laws, which ultimately hindered China's efforts to reform and open up in the modern era.[4]

The FIL and Implementation Regulations actively promote foreign investment by significantly expanding protections, lifting certain foreign ownership limitations, and relaxing regulatory requirements for outside investors in China.[5] The Chinese government initiated a preliminary draft of the FIL in 2015 and published the final text in 2019.[6] Within this policy development period, China took several liberalization measures. They adopted the Special Administrative Measures for the Access to Foreign Investment (Negative List), which limited the previously employed strict government vetting process and afforded the same market access to foreign investors as domestic entities in non-prohibited industries.[7] This negative list was previously tested in pilot free trade zones, which experimented with new styles of foreign investment management before nationwide implementation.[8] In 2016, the mandatory requirement for firms to gain prior approval from the Commerce Department was lifted in lieu of

[1] Patrick Corcoran, "Securing Liberalization: China's New Foreign Investment Law," *New York University Journal of International Law and Politics* (December 6, 2020), https://www.nyujilp.org/securing-liberalization-chinas-new-foreign-investment-law/.

[2] Sheng Zhang, "Protection of Foreign Investment in China: The Foreign Investment Law and the Changing Landscape," *European Business Organization Law Review* (April 27, 2022): 2, https://doi.org/10.1007/s40804-022-00247-1.

[3] Ibid.

[4] Ibid.

[5] Corcoran, "Securing Liberalization: China's New Foreign Investment Law."

[6] Ibid.

[7] Ibid.

[8] Zhang, "Protection of Foreign Investment in China: The Foreign Investment Law and the Changing Landscape," 5.

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a simpler filing process and other reductions in institutional transaction costs.[9] China has taken a large step forward toward Western standards of international trade and investment practices, which has already led to major investments from the international EV industry. Tesla established a production line in China due to policy relaxation allowing 100% foreign ownership, even though China still required cooperation with local authorities on R&D and technology.[10] By eliminating cumbersome government bureaucracy processes and employing equal treatment policies, the FIL prepared China's domestic market for many of the changes caused by RCEP.

China's liberalization efforts attempt to strengthen IPR protections, however, investors remain cautious on technology transfer stipulations and indirect knowledge spillovers. Foreign firms have an incentive to transfer proprietary know-how in order to out-perform other domestic firms, and FIL requires transfers based on "freewill and business rules".[11] Article 22 further prohibits government departments from forcing technology transfers, which is reinforced by Article 24 of the Implementation Regulation barring administrative authorities from directly or indirectly forcing technology transfers.[12] Even with these protections, domestic firms benefit from knowledge spillovers, to include agreed upon internal technology transfers and indirect methods of observation and appropriation, which China has long considered the most efficient method to obtain foreign technology.[13] Leaked knowledge to domestic firms increases their performance, which could negatively affect foreign firms bringing in advanced technology. While liberalization policies contribute to enticing foreign firms to enter China's market, they still have limitations.

The FIL also has language specifically aimed toward trade agreements and provides the legal framework for sub-national market planning related to RCEP. The FIL states that where China is a member of an international treaty, "provisions for more favorable treatment of foreign investors and their investment at the stage of entry" may prevail.[14] RCEP includes provisions on pre-establishment national treatment and market access, which differs from most of China's

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[9] Zhang, "Protection of Foreign Investment in China: The Foreign Investment Law and the Changing Landscape," 5.

[10] Kun Jiang et al., "China's Joint Venture Policy and the International Transfer of Technology," *VoxChina*, February 6, 2019, http://www.voxchina.org/show-3-115.html.

[11] Ibid.

[12] Zhang, "Protection of Foreign Investment in China: The Foreign Investment Law and the Changing Landscape," 11.

[13] Jiang et al., "China's Joint Venture Policy and the International Transfer of Technology."

[14] Zhang, "Protection of Foreign Investment in China: The Foreign Investment Law and the Changing Landscape," 10.

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previous FTAs.[15] The flexibility in the FIL legal text aims to incentivize foreign investors with favorable treatment developed through bilateral and multilateral investment treaties.[16] As a national policy, FIL acts as a guideline for sub-national governments as they prepare for the arrival of RCEP. Provincial governments have begun to prioritize local industries and lay out market expansion plans. For example, Yunnan, Shaanxi, and Fujian are among the provinces with published RCEP implementation plans that include focusing on the local auto industry.[17] With national government policies pushing EVs, these provincial-level policies likely include developing EVs within their auto industry development plans. Many provincial plans include expanding access to the Japanese market, with provinces such as Guangxi encouraging enterprises to import components and parts for automobiles from Japan.[18] Guangxi expresses the same enthusiasm for attracting investment in the automobile industry from Japan, South Korea, and Singapore.[19] Many provinces have also proposed plans for IPR protection.[20] As these provinces prepare their local industries for the introduction of RCEP, the FIL provides the supporting legal basis.

By joining RCEP, China made binding promises to accommodate agreed upon market liberalizations. Although RCEP may have directly influenced China's legislation on some of the domestic liberalization policies, the broader relationship between RCEP and market liberalization is circular in nature. From one perspective, the numerous advantages to joining RCEP likely contributed to government motivation to push forward liberalization policies. On the other hand, the collective liberalization policies will allow China to take full advantage of RCEP. Many areas covered in the FIL are also in RCEP, which has allowed ambitious provincial governments to begin crafting RCEP policies tailored to their local industry and market strengths. China's liberalization policies act as an amplifier for RCEP to increase China's productive power by drawing in foreign capital for local industries and influencing technology development. They create an environment for foreign firms to bring in advanced technology,

[15] Zhang, "Protection of Foreign Investment in China: The Foreign Investment Law and the Changing Landscape," 10.
[16] Ibid.
[17] Li, "How China Will Implement RCEP: A Subnational Analysis."
[18] Ibid.
[19] Ibid.
[20] Ibid.

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thus addressing the two factors of productive power, capital and technology, that China is relatively weak in.

3.1 Tariff and Rules of Origin

As the world's largest FTA, tariff liberalization is RCEP's central feature and the most direct impact to China's productive power. From an overall market access perspective, duty free tariff lines will increase from 22.9% before RCEP to 63.4% upon enactment for all members, and increased further to 89.7% after 20 years.[21] Considering RCEP economies have a total of 140,205 tariff lines, this will significantly impact trade over time.[22] The tariff liberalization strategy for RCEP is quite complicated and contains 39 different liberalization schedules spanning over 20 years, with each member adopting their own timelines for different products. The uneven removal schedules for China's EV related products create a pocket of time featuring the removal of tariffs for imports in conjunction with continued tariff protections for exports. Depending on the previous status of China's bilateral FTAs, RCEP will either deepen existing tariff commitments or start preferential tariff reductions.[23] According to Table 3-1, the only country within RCEP that China does not currently have an FTA with is Japan.[24] The eventual reduction of tariffs with Japan in key products along the EV supply chain will affect China's domestic industry.

China's negotiated tariffs on EV related products reveal a double-sided strategy to boost their EV industry. Trade liberalization has two opposing effects on a firm's profits; 1) lowered output tariffs decrease profits due to increased competition, and 2) reduced input tariffs on imported intermediate goods increase profits by lowering firms' marginal costs.[25] In the case of China's EV industry, tariff cuts to input goods such as parts and machinery will increase profits,

[21] Carlos Kuriyama, Sylwyn C. Calizo, and Jason Carlo O. Carranceja, "Study on Tariffs: Analysis of the RCEP Tariff Liberalization Schedules," *Asia-Pacific Economic Cooperation* (May 2022): v.

[22] Ibid., 10.

[23] Ibid., vi.

[24] Jose Duran Lima, Angel Aguiar, and Ira Nadine Ronzheimer, "Economic and Social Effects of a Possible Trade Agreement between Latin America and the Asia-Pacific Region," *International Trade Series*, Santiago: Economic Commission for Latin America and the Caribbean, 2021.

[25] Haichao Fan et al., "Trade Liberalization and Decentralization of State-owned Enterprises: Evidence from China," *Economic Inquiry* 60, no. 1 (February 25, 2022): 225, https://doi.org/10.1111/ecin.13014.

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Table 3-1 Status of Intra-Regional Relations Between RCEP Member Countries

Regions/Countries	ASEAN	Australia	China	Japan	Republic of Korea	New Zealand
ASEAN	-	FTA	FTA	FTA	FTA	FTA
Australia	FTA	-	FTA	FTA	FTA	FTA
China	FTA	FTA	-		FTA	FTA
Japan	FTA	FTA		-		
Republic of Korea	FTA	FTA	FTA	detained	-	FTA
New Zealand	FTA	FTA	FTA		FTA	-

Source: Lima, Aguiar, and Ronzheimer. "Economic and Social Effects of a Possible Trade Agreement between Latin America and the Asia-Pacific Region."

while output tariffs on EVs expose China to outside competition. China has already taken steps to manipulate tariff effects in favor of their EV industry. Under China's RCEP phasing out plan, EV technologies will enjoy long-term tariff protection, thus indicating the Chinese government's strategy for nurturing emerging industries.[26] In contrast, raw material categories such as 'ores, slag and ash', 'nickel and articles thereof' and 'other base metals; cermets; articles thereof' are all listed within the top ten most fully liberalized chapters upon RCEP's entry into force, which are all upstream in the EV supply chain.[27] Additionally, nearly every member country has 'machinery and mechanical appliances' at the top of their 'most liberalized tariff' for the first year of RCEP tariff eliminations, and many have 'electrical machinery' in the top five, which affect the EV supply chain's midstream.[28] A broad overview of RCEP tariff lines related to China's EV industry reveals immediate tariff removals for inputs combined with slower removals for outputs. The RCEP tariff liberalization schedule opens a short window for China to simultaneously reap the benefits of trade liberalization and mitigate the costs of inputs. Tariff liberalization directly impacts firms' profitability, which, if reinvested into R&D, then raises the chance for development of advanced technology and subsequent boost in competitiveness.

[26] Takako Gakuto, "China's RCEP Tariff Concessions Still Guard Growth Sectors," Nikkei Asia, November 17, 2020, https://asia.nikkei.com/Economy/Trade/China-s-RCEP-tariff-concessions-still-guard-growth-sectors.

[27] Kuriyama, Calizo, and Carranceja, "Study on Tariffs: Analysis of the RCEP Tariff Liberalization Schedules," 17.

[28] Ibid., 20.

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The cumulative ROO under RCEP particularly affect raw material and intermediate goods trade among member states. Prior to RCEP, intermediate goods crossing multiple FTA blocks were subject to different ROO requirements, which raised compliance and transaction costs. This occurred because cumulative ROO laws only apply to countries within a preferential trade agreement. [29] For countries within RCEP, goods originating in country A and used for manufacturing in country B but then sold to country C are considered as originating in country B.[30] For example, lithium mined in Australia, exported and processed in Japan, and finally sold to China is considered to originate from Japan. Without RCEP, the "noodle-bowl" of FTAs within the Asia-Pacific region would restrict companies' sourcing options in order to meet separate regional value content (RVC) origin requirements. For example, if a company were to manufacture a product within ASEAN to sell to South Korea, the percentage of parts and components from outside of these two countries must remain below a certain threshold in order enjoy lowered tariffs from the ASEAN-South Korea FTA. However, operating under RCEP would allow companies to source materials and components from anywhere within RCEP to meet the RVC. EV manufacturers in China have more flexibility in sourcing raw materials and parts from across RCEP countries for production to meet the required 40% RVC required to take advantage of tariff benefits.[31]

RCEP ROO and RVC rules contribute to consolidating the EV supply chain within member countries. RCEP essentially creates a bubble where member countries have a wide selection among the 15 members to source parts to meet the 40% RVC. As a result of tariff liberalization and ROO, free trade mechanisms will motivate firms to build supply chains and sell final products within RCEP. Countries outside of RCEP will not receive the same benefits. For China's EV industry, domestic firms planning on selling EVs within RCEP have a wider range of options to choose components and have more freedom to make decisions based on product quality and price. RCEP ROO positively influences China's ability to gain productive power by lowering transaction costs and supporting the graduate introduction of free market mechanisms. Conversely, ROO also puts Chinese products on more equal footing with RCEP

[29] Singapore International Chamber of Commerce, *RCEP Benefits for the Advanced Manufacturing Sector*, 2021, https://sicc.com.sg/wp-content/uploads/2021/12/SICC-RCEP-Benefits-for-the-Advanced-Manufacturing-Sector.pdf.

[30] Sean Jia and Jing Ning, "What Are the Highlights of RCEP Cumulative Rules of Origin," Albright Law Offices, January 8, 2021, https://www.allbrightlaw.com/en/10475/621866ffa1744ca3.aspx.

[31] Singapore International Chamber of Commerce, *RCEP Benefits for the Advanced Manufacturing Sector*.

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competitors, which could negatively affect uncompetitive domestic companies. However, firms that develop efficient processes and higher quality products at good price points benefit China's industry in the long run.

Tariff concessions from RCEP will lower intra-regional trade costs and promote the increase of output, export, and trade in most manufacturing sectors.[32] However, some studies predict that China's medium and high-tech manufacturing industries "lack international competitiveness", and may experience negative impacts.[33] EVs contain products along the technology development spectrum, with many of the manufactured parts shared by EVs and ICEVs considered low-tech, and parts such as battery, power train, or raw material processing considered hi-tech. Within RCEP, China does not have an advantage in high-tech industries over Japan and South Korea, which would result in low predicted outputs. However, these analyses do not consider the speed of technology development within each country, which, in the rapidly evolving EV industry, could lead to different trade outcomes. Other strategies for China to mitigate tariff related damages include capitalizing on manufacturing advantages of low-tech EV parts, encouraging domestic firms to move up the global value chain through R&D, and partnering with foreign firms.

3.3 Industry Partnerships: Japan, South Korea, and ASEAN

Japan, South Korea, and ASEAN each bring unique opportunities to China's EV industry to increase productive power through firm-level linkages and open markets. The new China-Japan and Japan-South Korea FTA relationships are projected by some sources to generate the most gains brought by RCEP liberalization.[34] Reports indicate tariffs will be eliminated on 86% of industrial goods exported from Japan to China, an increase from 8%, and tariffs will be eliminate on 92% of industrial goods from Japan to Korea compared to the previous 19%.[35] According to a JP Morgan report, the electronics manufacturing sector stands to benefit the most

[32] Dan Ling and Caiyun Lv, "Research on the Impact of RCEP on China's Manufacturing Output and Trade: Based on GTAP Simulation," *IBusiness* 14, no. 02 (2022): 41, https://doi.org/10.4236/ib.2022.142004;

[33] Ling and Lv, "Research on the Impact of RCEP on China's Manufacturing Output and Trade: Based on GTAP Simulation," *IBusiness* 14, no. 02 (2022): 48, https://doi.org/10.4236/ib.2022.142004;

[34] John Ravenhill, "The Political Economy of an 'Asian' Mega-FTA: The Regional Comprehensive Economic Partnership," *Asian Survey* 56, no. 6 (2016): 1095.

[35] Hayashi, "U.S. on Sidelines as China and Other Asia-Pacific Nations Launch Trade Pact."

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from RCEP due to the inclusion of lower tariffs for related products and because of the new northeast Asia trade linkages.[36] One Chinese analyst claims that RCEP will actively promote the negotiation of China-Japan-Korea free trade area and strengthens economic relationships for the benefit of the East Asian industrial chain.[37] China already has an FTA with ASEAN, which has allowed China to gain an early foothold in some ASEAN industries. However, with the initiation of RCEP, multiple ASEAN+1 agreements will merge to operate under one FTA, with manufacturers benefiting from ROO and lower tariffs.

Scholars have already noted the benefits of a China-Japan-South Korea trilateral free trade agreement on strengthening EV Li-ion trade and accelerating Northeast Asia's regional integration.[38] Global battery production is currently dominated by these three countries, with total manufacturing capacity reaching 85% of global Lithium-ion battery production in 2020.[39] Figure 3-1 shows battery firms CATL, LG Energy Solution, and Panasonic, from China, South Korea, and Japan respectively, as the top three producers of EV battery capacity around the world. RCEP provides a platform for Chinese and Japanese or Chinese and Korean firms to connect and form agreements and alliances, which would assist both sides in breaking into the EV industry.

Following the initiation of RCEP on January 1, 2022, collaborations between Chinese and Japanese EV firms started making headlines. During the first RCEP Business Leaders Forum, Japanese fabless electric vehicle startup company ASF and Chinese firm Guangxi Auto signed an agreement to jointly produce small battery powered commercial vehicles.[40] Evidently, Guangxi Auto was able to take advantage of the RCEP meeting held in Nanning, Guangxi Zhuang autonomous region.[41] Through this partnership, ASF will provide EV technology, while

[36] Wolf, "Who will benefit the most from RCEP?"

[37] Sa Ma and Erzhen Zhang, "Reconstruction of East-Asian Regional Industrial Chain within the Framework of RCEP and China's Countermeasures (RCEP 框架下东亚区域产业链重构与中国对策)," *Journal of South China Normal University (Social Science Edition)* (*華南師範大學學報 (社會科學版)*) 4 (July 2021):19.

[38] Xiaoqian Hu et al., "Trade Structure and Risk Transmission in the International Automotive Li-Ion Batteries Trade," *Resources, Conservation and Recycling* 170 (2021): 13.

[39] Zhao, Wang, and Negnevitsky, "Connecting Battery Technologies for Electric Vehicles from Battery Materials to Management," 1.

[40] Graeme Roberts, "Guangxi to Make EVs with Japan's ASF," Just Auto (blog), January 10, 2022, https://www.just-auto.com/news/guangxi-to-make-evs-with-japans-asf/.

[41] Usman Ansari, "Guangxi Auto of China Join Hands with ASF to Develop Electric Vehicles for Japan," *Car Spirit PK*, January 2022, https://carspiritpk.com/guangxi-auto-of-china-join-hands-with-asf-of-japan-to-develop-electric-vehicles/amp/.

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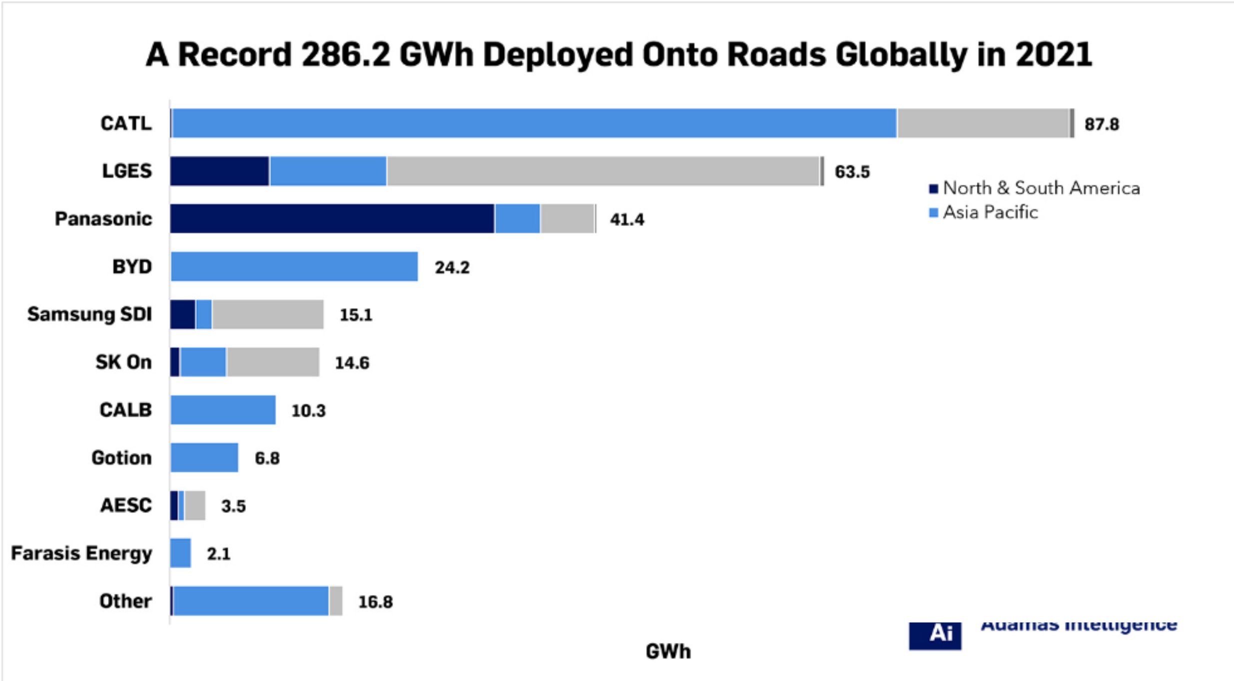
Figure 3-1 Global EV Battery Producers



Source: Matt Cousineau, "2021 Global Trends in EV Battery Production: 3 Asian Firms Dominated," *Charged EVs*, February 14, 2022.

Guangxi will manufacture the vehicles in Liuzhou, with the first batch of vehicles valued at 33 million USD.[42] The collaborative model focuses on flexibility, small size, and convenient access, and is projected to have a cruising range of 200km, which is ideal for "short-distance transportation of goods by local, small, and micro enterprises" and logistics distribution in small areas.[43] This deal also stipulates the target sale of 100,000 units in Japan by 2030, with production scheduled to start by the end of 2022.[44] The general manager of Guangxi Auto Yuan Zhijun made a statement at the signing ceremony, saying:

> In the next 10 to 15 years, some gasoline and diesel vehicles will start to phase out and rapid development has been seen in the new energy vehicle industry. China is taking the lead globally in NEV (new energy vehicle) development. This cooperation is expected to help Guangxi Auto accelerate tapping the Japanese market for microtype NEVs for

[42] Roberts, "Guangxi to Make EVs with Japan's ASF."
Ansari, "Guangxi Auto of China Join Hands with ASF to Develop Electric Vehicles for Japan."
[43] Ibid.
[44] Roberts, "Guangxi to Make EVs with Japan's ASF."

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> logistics distribution. The cooperation also marks the first time for Guangxi's vehicles to enter the market of Japan – a global automobile power – marking a milestone for the region's automobile industry.[45]

In response, the Chief Operating Officer of ASF Atsushi Tamura remarked upon the ability for Guangxi auto to assist in forming business opportunities in Southeast Asian markets, due to the "geographic advantages" of the autonomous region.[46]

In this arrangement, both firms gain productive power; ASF gains land and labor advantages with Guangxi's manufacturing capacity and Guangxi Auto gains technological expertise from ASF. The product from this joint venture fits into the mature technology demand that would have wide appeal to lower income customers. Although the driving range is rather short, the low production costs by manufacturing in China will likely lower the price tag. Similar to China's local LSEV firms, this collaboration has the potential to offer a product that fits into niche markets more developed EV firms disregard. Additionally, the ASF representative's remarks about tapping into business opportunities in Southeast Asia reveal an even larger target market. Depending on the price point, a cheap, reliable EV with reasonable mileage has a greater potential to break into the lower income markets of Southeast Asia than some EV industry leaders.

The signing of joint collaboration agreements by EV firms at the first RCEP business forum sets an important precedence for other companies to follow. Business meetings, whether affiliated by RCEP or prompted by RCEP-induced policy liberalization, allow for diplomacy and the exchange of people and ideas. In short, more engagements lead to more collaboration opportunities. In the case of ASF and Guangxi, the partnership will likely lead to the development of a new product outside of the mainstream EV development. Moving forward, RCEP will exist as a platform for other companies across the Asia-Pacific region to come together, whether for product development, market access, or even infrastructure development. For instance, Japanese auto giant Toyota announced a partnership with Chinese firm BYD to develop an affordably EV using BYD's lithium-iron-phosphate Blade battery that is expected to

[45] Ansari, "Guangxi Auto of China Join Hands with ASF to Develop Electric Vehicles for Japan."
[46] Ibid.

DOI:10.6814/NCCU202201039

launch by the end of the 2022.[47] As a central player in the possible linkages that arise from the initiation of RCEP, China stands to gain significant productive power through both increased access to technology and the opening up of previously untapped markets.

Chinese EV firms will benefit from South Korea's domestic automotive industry shift toward electric vehicles. As the sixth largest producer of automobiles and exporting about three-fifths of manufactured vehicles, their existing automotive industry is already large and well developed.[48] South Korea is a global leader in rechargeable batteries, which boosts its competence in the EV industry.[49] South Korea's EV industry is dominated by three major players: LG Energy with 20 percent market share, Samsung SDI with 5 percent market share, and newcomer SK On with 6 percent market share.[50] In response to problems with air pollution, the South Korean government has issued policies established to promote green growth, to include the development of EVs.[51] These government policies promoting EVs could assist China's entry into the South Korean market. Former President Moon Jae-in announced goals for South Korea to become the world's leading EV battery manufacturer by 2030 and implemented tax incentives, which lead to investments totaling $35 billion dollars from the big three EV battery firms.[52] In consideration of raw material limitations, these companies have also invested in developing alternatives to Li-ion batteries and could become major players in future EV technology.[53] Trade officials have noted the need for China and South Korea to deepen supply-chain cooperation under RCEP, especially for high-tech manufacturing industries, and they consider China as a potential market for South Korean products.[54] With China's new trade liberalization policies, South Korean firms have an incentive to enter China's market, which

[47] Usman Ansari, "BYD Aims to Become Second Car Company to Reach 1 Million EV Sales in a Year," *CarSpiritPK*, December 17, 2021, https://carspiritpk.com/byd-aims-to-become-second-car-company-to-reach-1-million-ev-sales-in-a-year/?.

[48] Euna Lee and Jai S. Mah, "Industrial Policy and the Development of the Electric Vehicles Industry: The Case of Korea," *Journal of Technology Management & Innovation* 15, no. 4 (2020): 71, https://doi.org/10.4067/S0718-27242020000400071.

[49] Ibid.

[50] Catherine Wang, "Charged Up: Korea's Chaebols Race For EV Battery Supremacy," Forbes, April 20, 2022, https://www.forbes.com/sites/catherinewang/2022/04/20/charged-up-koreas-chaebols-race-for-ev-battery-supremacy/.

[51] Lee and Mah, "Industrial Policy and the Development of the Electric Vehicles Industry: The Case of Korea," 71.

[52] Wang, "Charged Up: Korea's Chaebols Race For EV Battery Supremacy."

[53] Ibid.

[54] Yin Yeping, "China, South Korea Aim for Greater Openness under RCEP: Ministry - Global Times," Global Times, January 20, 2022. https://www.globaltimes.cn/page/202201/1246518.shtml.

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would put pressure on local Chinese firms to develop competitive models. Additionally, South Korean firms already operate within a highly competitive battery and automotive industry, and Chinese companies with manufacturing capacities that lack technological capabilities would benefit from partnerships.

On February 21, 2022, leading Chinese EV company Geely signed a collaboration contract with South Korean auto parts company Myoung Shin Co. to jointly develop and manufacture small-size EV trucks to sell in South Korea.[55] This 1.5 ton truck will be produced in Gunsan Korea and target Korean consumers with the intention to eventually expand overseas.[56] The firms will begin work in June 2023 with a target production volume of 4,000 units a year, and have plans to include a larger 8-ton model along with an expansion of their yearly target sales to 30,000 units by 2025.[57] Geely has also signed a JV with South Korean company Renault Samsung firm, a move that assists Geely's efforts to gain access to advanced markets.[58] By entering into a JV with Renault, Geely could gain access to the US market due to the KORUS FTA, a benefit that experts say allow Geely to circumvent the limits imposed by Beijing's Made in China strategy.[59] Partnerships with South Korean firms have the potential to expand China's EV industry productive power through multiple avenues. Considering the automobile manufacturing prowess and possession of EV technology by both companies, auto makers and battery manufacturers on both sides could engage in productive partnerships. With the initiation of RCEP and ensuing policy liberalizations, Chinese and South Korean firms have increased opportunities for interactions leading to new EV products.

ASEAN countries could contribute to China's EV industry development as a potential market, or challenge domestic firms as a rival production destination. Due to their relatively low labor costs, Southeast Asian countries are expected to experience an increase of new assembly plants via foreign investment. [60] Core EV technologies such as energy power batteries can enter the ASEAN market quickly, and Chinese firms may choose to transfer their industrial chain to

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[55] Il-Gue Kim, Hyung-Kyu Kim, and Byung-Uk Do, "China's Geely Challenges Hyundai with Entry to Korea's e-Truck Market," The Korea Economic Daily, February 23, 2022, https://www.kedglobal.com/electric-vehicles/newsView/ked202202230015.

[56] Ibid.

[57] Ibid.

[58] "Korea Move: Geely's Overseas Acquisition Drive Continues," Week In China, May 20, 2022, https://www.weekinchina.com/2022/05/korea-move/.

[59] Ibid.

[60] "Korean auto, steel sectors to benefit most from RCEP with ASEAN - Pulse by Maeil Business News Korea," accessed June 2, 2022, //m.pulsenews.co.kr/view.php?year=2020&no=1174852.

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ASEAN and build factories at a lower cost.[61] Others believe that China's EV industry will seize a larger share of the ASEAN market with its technology and cost advantages. [62] China and ASEAN share similarities in their factors of production strengths and weakness. Both have abundant land and labor, and have a relative weakness with capital and technology. However, China has an advantage over ASEAN with their development of EV battery technology, thus placing China higher on the EV GVC.

China has already begun breaking into ASEAN markets such as Thailand and Malaysia. Chinese automakers have expressed interest in Thailand's electric vehicle market because of government subsidies and forecasts of rapid growth in the sector. [63] Due to the China-ASEAN FTA, Chinese companies benefit from zero percent import tax and are a major presence in Thailand's EV market. [64] Great Wall Motor, a Chinese firm, announced plans to begin electric vehicle production in Thailand in 2024 following a previous plan to build an EV battery production plant in 2023. As part of a broader push into global emerging markets, Great Wall Motor plans to establish a regional production hub for EVs in Thailand. It had already announced plans to build an EV battery production plant in the country in 2023. [65] The Malaysian government has also welcomed "strategic engagement" with the Chongqing Municipality on EVs, and have expressed a desire for "market expansion, technology transfer, and cross-border investment" in key EV parts and components.[66] With the tariff cuts from the initiation of RCEP, EV firms from other countries will begin to break into the ASEAN market and catch up to China.[67] However, China already has a foothold and stands to benefit from RCEP's ROO in partnering with ASEAN countries for EV production.

China has the opportunity to exploit the individual strengths and weaknesses of the EV industries in Japan, South Korea, and ASEAN to promote its own productive power. The accelerated integration of the Asia-Pacific market will align supply chains in favor of member

[61] "Korean auto, steel sectors to benefit most from RCEP with ASEAN - Pulse by Maeil Business News Korea."

[62] Ibid.

[63] Apornrath Phoonphongphiphat, "China, Japan Automakers Charge into Thai Electric Car Market," Nikkei Asia, March 23, 2022, https://asia.nikkei.com/Business/Automobiles/China-Japan-automakers-charge-into-Thai-electric-car-market.

[64] Ibid.

[65] Ibid.

[66] "RCEP to Further Strengthen Malaysia-China Engagements Especially for EV Manufacturing," Money Compass (blog), April 11, 2022, https://moneycompass.com.my/2022/04/11/malaysia-china-rcep-ev/.

[67] Phoonphongphiphat, "China, Japan Automakers Charge into Thai Electric Car Market."

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countries, especially with the elimination of tariff and ROO trade barriers. Businesses within Japan, Korea, and ASEAN have already begun to collaborate with Chinese companies, thus increasing the bilateral flow of goods and knowledge. Domestic firms with EV technology or auto supply chain weaknesses can find Japanese or South Korean counterparts to fill in the gaps, and ASEAN's competitiveness in land and labor offers opportunities for Chinese investors to expand internationally. All three regions are potential markets, which would increase Chinese EV firms' profitability with more sales opportunities. RCEP plays a central role in promoting regional integration of the EV industry by encouraging trade and domestic policy liberalizations, resulting in an environment more conducive to collective product development.

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CHAPTER 4. China's Electric Vehicle Trade Value Linkages to RCEP Countries

As a recently enacted free trade agreement, RCEP's potential to deepen trade linkages will benefit industries with pre-existing interdependencies among members. The new RCEP trade infrastructure provides direct benefits such as the eventual lowering of tariffs and indirect structural benefits from increased industry interactions and favorable domestic policy adjustments. International firms have advanced EV technology as an increasingly viable substitute to ICEVs, and countries that develop policies to assist in capturing advantageous supply chains influence market competitiveness. Under the RCEP agreement, Chinese companies benefit from immediate tariff removals and increased opportunities for cooperation with firms among member countries. Although some tariffs will take many years before elimination, firms with long-term planning can anticipate eventual gains under the assumption of the RCEP terms. Especially as an emerging industry, the initial development of international EV supply chains is crucial for gaining an edge in the global industry and building structural power from an early stage.

Before the initiation of RCEP, China had already established trade linkages throughout the EV supply chain with member countries. These pre-established linkages reveal the starting point for RCEP's impact on China's EV industry and the foundation for China do build their productive power. As this new multi-national agreement launches and unravels the 'noodle bowl' of FTAs among member states, existing linkages have the potential to further develop and weak linkages have the opportunity to emerge. Within RCEP, the economic, resource, and technical diversity of members allow partners to contribute differently to China's EV industry. This assessment will observe two main variables: trade volume and market potential. Countries with relatively higher volumes of trade have stronger pre-existing linkages and higher potential for trade policy impact. However, more trade also generally translates to higher dependency. Conversely, lower levels of trade have lower immediate trade policy impact but could indicate alternative market potential.

The following chapter is divided into three levels of EV supply chain segments: upstream, midstream, and downstream. As depicted in Figure 4-1, many EV products overlap with conventional vehicle supply chains. China has demonstrated an intent to increasingly participate in the advanced EV industry by continuing to enact domestic policies to promote EVs

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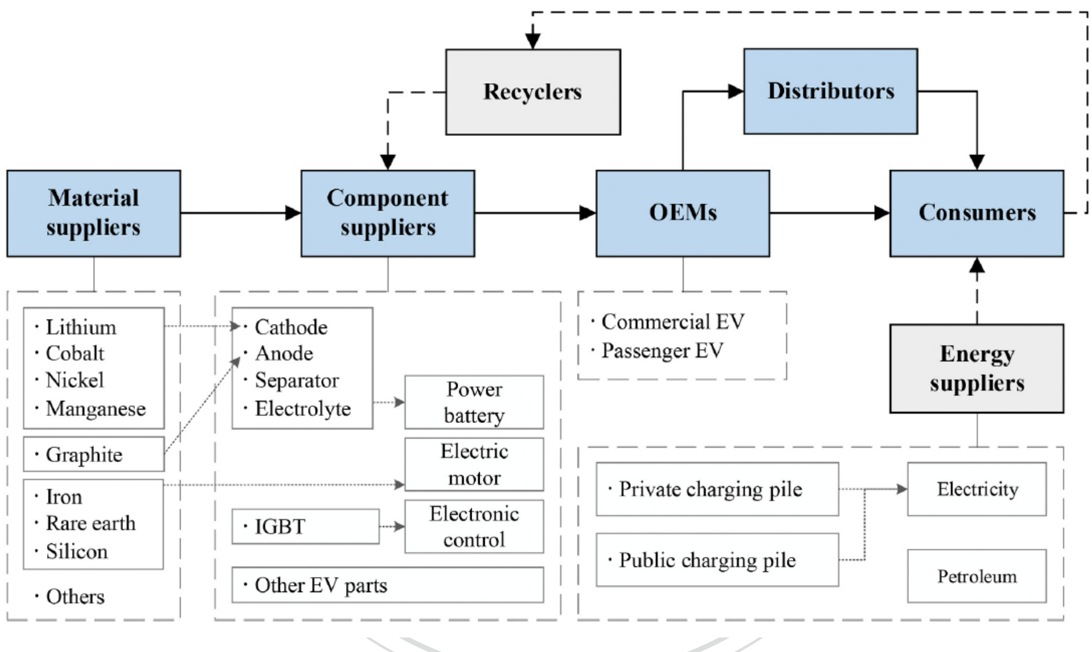
with a greater range and use RCEP as a platform to facilitate technology collaborations. Trade products are selected along the supply chain to reflect the linkages strongly associated with the development of the advanced EV industry. For upstream, this study analyzes China's import of critical raw materials used for EV lithium-ion batteries within RCEP, which includes spodumene, lithium carbonates, manganese ore, and nickel ore. The midstream and downstream sections include import and export between China and RCEP countries of lithium battery cells and pure electric vehicles respectively.

Figure 4-1 EV Supply Chain Structure with Key Players



Source: Wen et al., "Impacts of COVID-19 on the Electric Vehicle Industry: Evidence from China," 5.

4.1 Key Raw Materials

Electric vehicles, particularly EV batteries, contain raw materials with deposits in a wide variety of locations worldwide. Since EVs are still considered an immerging industry, the critical elements needed for batteries are constantly evolving in tune with advances in battery technology. For the most cutting-edge batteries on the market, the four elements considered most important for future EV battery development are lithium, cobalt, nickel, and manganese. China

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imports three of these elements from RCEP partners; lithium, nickel, and manganese. For Chinese companies to remain competitive in manufacturing current EV batteries and developing future battery designs, they must secure stable supplies of critical raw materials. Figure 4-2 shows the origins of raw materials for China's EV industry worldwide and reveals the heavy dependence on imports. RCEP countries and regions contribute to a larger share of China's EV raw material imports than all other regions combined. China's central position in RCEP will contribute to its productive power development by influencing raw material flows. As a member of RCEP, China not only has increased power to influence structural power through policy legislation, but also by increased leverage and competitiveness within the EV industry.

The graphs from this section come from Wen et al.'s study on the effects of COVID-19 on China's EV industry. EV raw material trade has specific complexities interfering with import tracing within the industry. First, a material may have different forms of import, which would require the analysis of each separate product for accuracy. Such is the case with lithium, which is imported both as spodumene and lithium carbonate. These imports are reported with different HS product codes. Second, the EV industry may only use one subsection of a product, which would require the isolation of the relevant product for clarity in trade analysis. The EV industry may require the ore form or the carbonate form of a product, which would necessitate more concise data. Unfortunately, access and selection of such detailed data requires advanced skill, knowledge, and understanding of raw mineral trade, thus, this study used the proxy of Wen et. al.'s EV raw material import data.

The sources of China's imports of raw materials vary in location and level of dependency. Lithium is the core material for Li-ion batteries, and while the use and combinations of other elements fluctuate, lithium remains in constant demand. As Figure 4-2 shows, China imports most of its lithium ore in the form of spodumene and the rest as brine, and Figure 4-3 confirms China's high dependence on Australia for spodumene imports. For manganese, Figure 4-5 reveals Australia as China's second highest source of imports, with its largest contributor from outside of RCEP. Although China does have some domestic sources of both lithium and manganese, the extremely high import percentage indicates a weakness in acquiring the necessary materials to increase EV production to meet future demand. China imports nearly all of its nickel ore, which Figure 4-6 shows coming predominately from the Philippines and Indonesia. Interestingly, while a large portion of imports came from Indonesia in 2019, the

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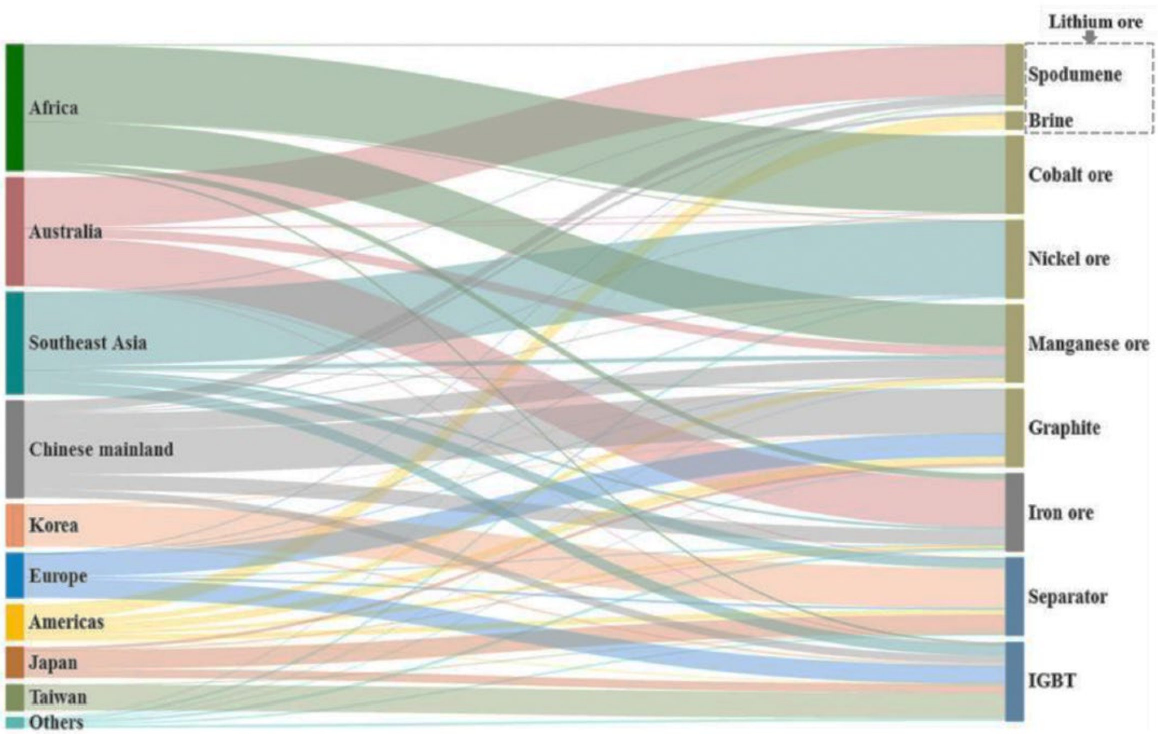
Philippines took over as the overwhelmingly largest import contributor in 2020 due to nickel export restrictions in Indonesia.[1] This supply disruption highlights the need for adaptability during market fluctuations, and, in the case of nickel, China's alternate resource provider prevented an even greater supply shortage.

Figure 4-2 Supply Structure of Key Material and Parts for EV Productions in China (2019)



Source: Wen et al., "Impacts of COVID-19 on the Electric Vehicle Industry: Evidence from China," 7.

China's high reliance on imports for all critical raw materials for EV batteries indicates a major productive power vulnerability. Although China has some domestic lithium and manganese production, their complete lack of cobalt and nickel supplies signals reliance on trade in order to grow their EV industry. To protect their EV productive power, China must maintain stable imports from these key RCEP nations. However, the access and price of these critical materials may also push Chinese firms to develop battery technologies with elements strategically available to it. For example, while the NCA, LCO and NMC Li-ion batteries all

[1] Wen et al., "Impacts of COVID-19 on the Electric Vehicle Industry: Evidence from China," 7.

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require cobalt and nickel, the LFP batteries do not. RCEP gives China one extra advantage over non-RCEP competitors for these key resources within the EV industry. If China can gain from RCEP's direct and indirect benefits to access raw materials at better price points, their domestic EV industry will have a marked advantage in the short and long term.

Figure 4-3 Spodumene Imports to China

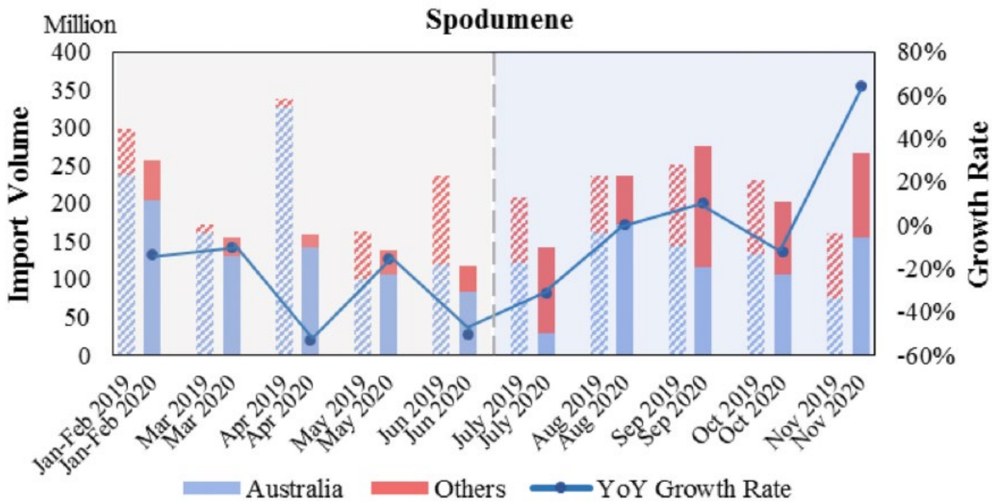
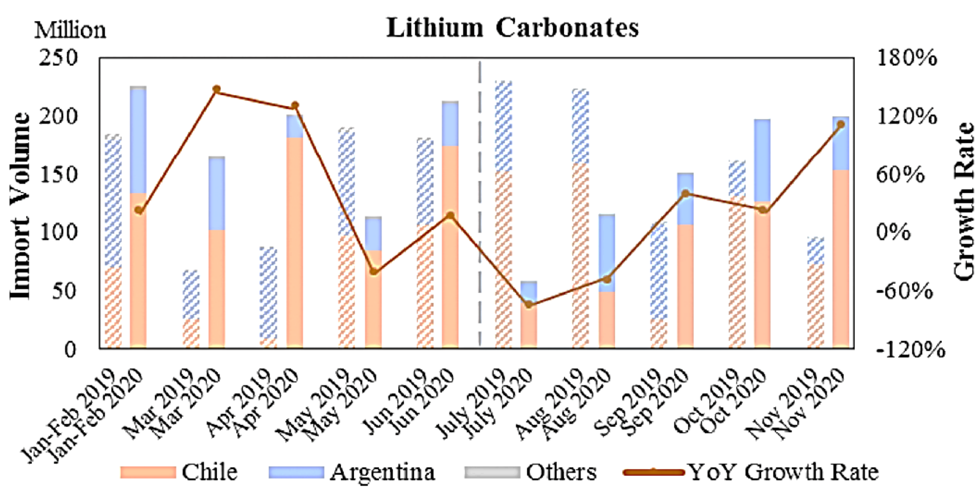


Figure 4-4 Lithium Carbonates Imports to China



Figures 4-3,4 Source: Wen et al., "Impacts of COVID-19 on the Electric Vehicle Industry: Evidence from China," 13.

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Figure 4-5 Manganese Ore Imports to China

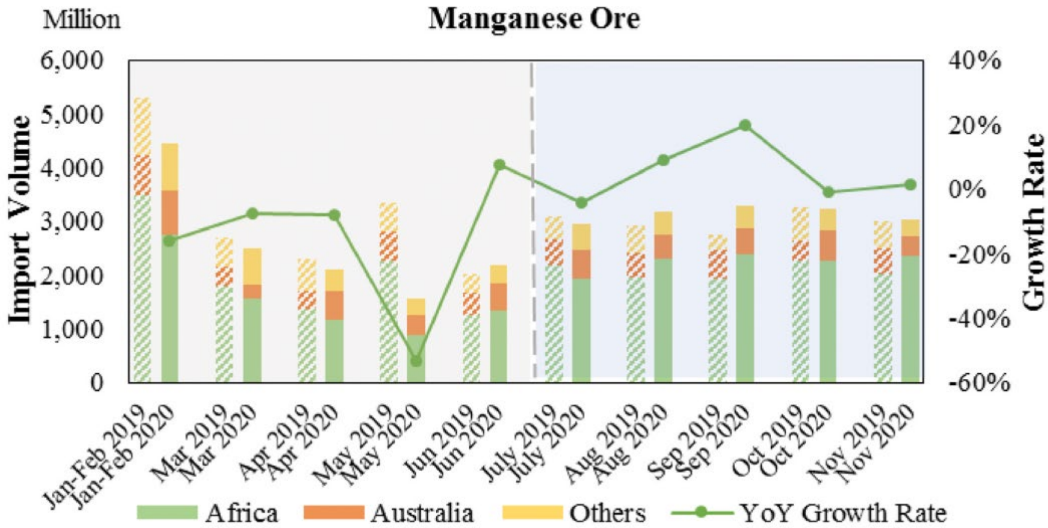
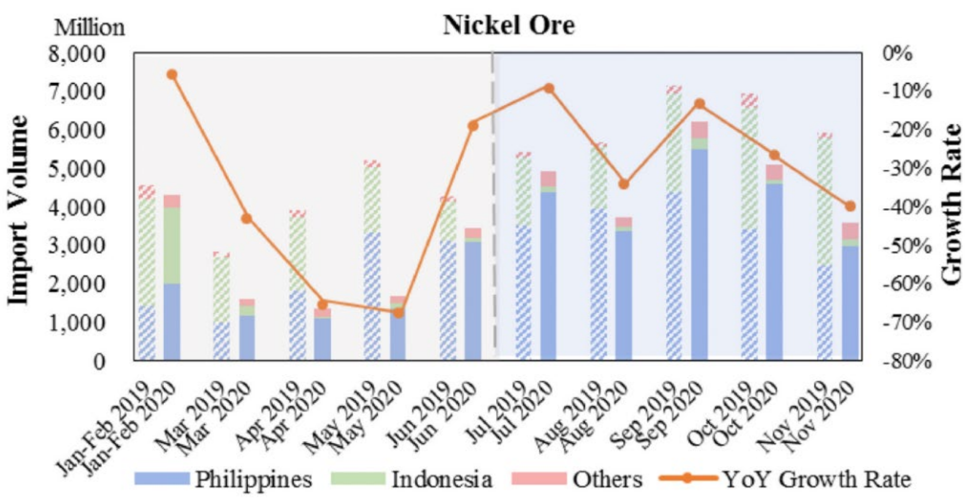


Figure 4-6 Nickel Ore Imports to China



Figures 4-3,4 Source: Wen et al., "Impacts of COVID-19 on the Electric Vehicle Industry: Evidence from China," 14.

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4.2 Lithium Battery Cells

China's position as both importer and exporter within the lithium battery cell trade among RCEP countries reveals its existing manufacturing competitiveness in the market. Figure 4-7 shows that in 2021, China leads the world with 79% of the world's Li-ion battery manufacturing capacity.[2] Even with development of future batteries such as solid-state, industry researchers still predict for Li-ion batteries to dominate the market for at least the next ten years.[3] Within this timeframe, tariffs affecting Li-ion batteries will overwhelmingly benefit China due to their industry dominance. With the rising demand for EV batteries and the support of RCEP free trade policies, China has the opportunity to increase competitiveness in Li-ion battery production. China's ability to simultaneously access advanced EV battery cells and secure a market to sell domestic battery cells would contribute greatly to their productive power.

Figure 4-7 Li-ion Battery Manufacturing Capacity by Country (2021)

Rank	Country	2021 Li-ion manufacturing capacity (GWh)	% of World Total
#1	China	558	79.0%
#2	U.S.	44	6.2%
#3	Hungary	28	4.0%
#4	Poland	22	3.1%
#5	South Korea	18	2.5%
#6	Japan	17	2.4%
#7	Germany	11	1.6%
#8	Sweden	4	0.6%
#9	UK	2	0.3%
#10	Australia	1	0.1%
N/A	Rest of the World	1	0.1%
N/A	**Total**	**706**	**100.0%**

Source: Bhutada "Mapped: EV Battery Manufacturing Capacity, by Region."

[2] Govind Bhutada, "Mapped: EV Battery Manufacturing Capacity, by Region," *Visual Capitalist*, February 28, 2022, https://www.visualcapitalist.com/sp/mapped-ev-battery-manufacturing-capacity-by-region/.

[3] Yangtao Liu et al., "Current and future lithium-ion battery manufacturing," *iScience* 24, (April 2021): 1.

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Evaluating the manufacturing capacity of EV battery cells is difficult when using data encompassing all lithium battery cell trade for a number of reasons. First, a wide variety of products use Li-ion battery cells, to include portable electronics, EVs, and grid storage.[4] Second, the price of such batteries changes drastically depending on the size and technology of the battery. EV batteries are large in size and mostly require advanced technology compared to other batteries that are either smaller or use more mature Li-ion technology. Third, as this analysis uses trade value for analysis, these price differences make understanding the true import and export volume difficult for this specific product. For example, a country with small volumes of EV battery exports could have a similar overall trade value to a country with large quantities of mobile device battery exports. However, despite these difficulties, analyzing lithium battery cell trade still has merit for assessing RCEP's effect on China's productive power. The principle of manufacturing flexibility suggests firms with capital and technology in one product have a greater ability to transition to or incorporate a related product to production lines.[5] In the context of EVs, firms with the manufacturing infrastructure to produce mature lithium battery cells have an advantage in producing advanced lithium battery cells as compared to firms with no prior production experience.

A wide array of RCEP members have both lithium battery cell imports from and exports to China. Figures 4-8, 4-9, and 4-10 depict trade values of lithium battery cells from RCEP countries to China, which reveal many countries with a wide range of import values and two countries with higher export values. The Philippines, Thailand, Vietnam, and Australia all have less than a million USD in battery export value to China, which indicates a relatively low presence in the Chinese market. South Korea and Malaysia both have relatively higher exports to China, however, their export values are significantly lower than that of Japan, Indonesia, and Singapore. Besides Japan and Indonesia, all of these countries have trade deficits with China. Vietnam is the extreme outlier of the group, with nearly triple the import value of lithium battery cells compared to China's next highest RCEP trade partner and a higher value than the rest of RCEP nations combined. Singapore also stands out with only a slight trade deficit and is the only RCEP country with a relatively high import and export value. On the other end of the spectrum,

[4] Liu et al., "Current and future lithium-ion battery manufacturing," 1.
[5] Swamidass, "Manufacturing Flexibility," 117.

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Japan and Indonesia have large trade surpluses with China, both with over 30 million USD in China-bound exports.

The impact of RCEP on the current status of Li-ion battery cell trade is difficult to assess, however, some trends stand out. First, Vietnam's 147 million USD and Malaysia's 53 million USD of imports from China points to extremely strong linkages between these two countries and China. As tariffs eventually drop and firms from each country have a larger platform to communicate due to RCEP, these developed relationships already have a strong foundation to build upon. Japan, Indonesia, and Singapore's high volumes of exports to China also indicate established linkages and a degree of competitiveness within China's domestic markets. Interestingly, Japan and Indonesia have high EV lithium battery cell manufacturing potential for different reasons. Japan has a technological advantage over China, which contributed to their high volume of exports. Indonesia has extensive reserves of type I nickel and growing mining operations.[6] Additionally, the Indonesia government capitalized on their raw material advantage by imposing a nickel export ban in 2020, designed specifically to encourage investment in their domestic EV battery industry.[7] Indonesia obviously has the capacity and access to raw materials to produce market-competitive batteries, making them a potential future contributor to the EV battery industry.

The values of China's trade flows with RCEP countries reveal a robust lithium battery cell trade among members. China has a central position as a major importer and exporter of this intermediate product, and the net trade deficit of RCEP countries indicates an existing dependency on Chinese battery cells. RCEP will allow domestic firms that import from growing EV battery cell industries to take advantage of tariff and ROO benefits, thus lowering the cost of production. China will have greater access to necessary battery cell imports, ideally at increasingly better price points than competitors outside of RCEP. Furthermore, increased competition within RCEP could also push Chinese firms to invest in EV battery R&D and produce higher-quality products. This benefits domestic EV supply chain stability and firm profitability, both of which directly strengthen China's productive power.

[6] Andante Hadi Pandyaswargo et al., "The Emerging Electric Vehicle and Battery Industry in Indonesia: Actions around the Nickel Ore Export Ban and a SWOT Analysis," *Batteries* 7, no. 4 (December 2021): 3, https://doi.org/10.3390/batteries7040080.

[7] Pandyaswargo et al., "The Emerging Electric Vehicle and Battery Industry in Indonesia: Actions around the Nickel Ore Export Ban and a SWOT Analysis," 3.

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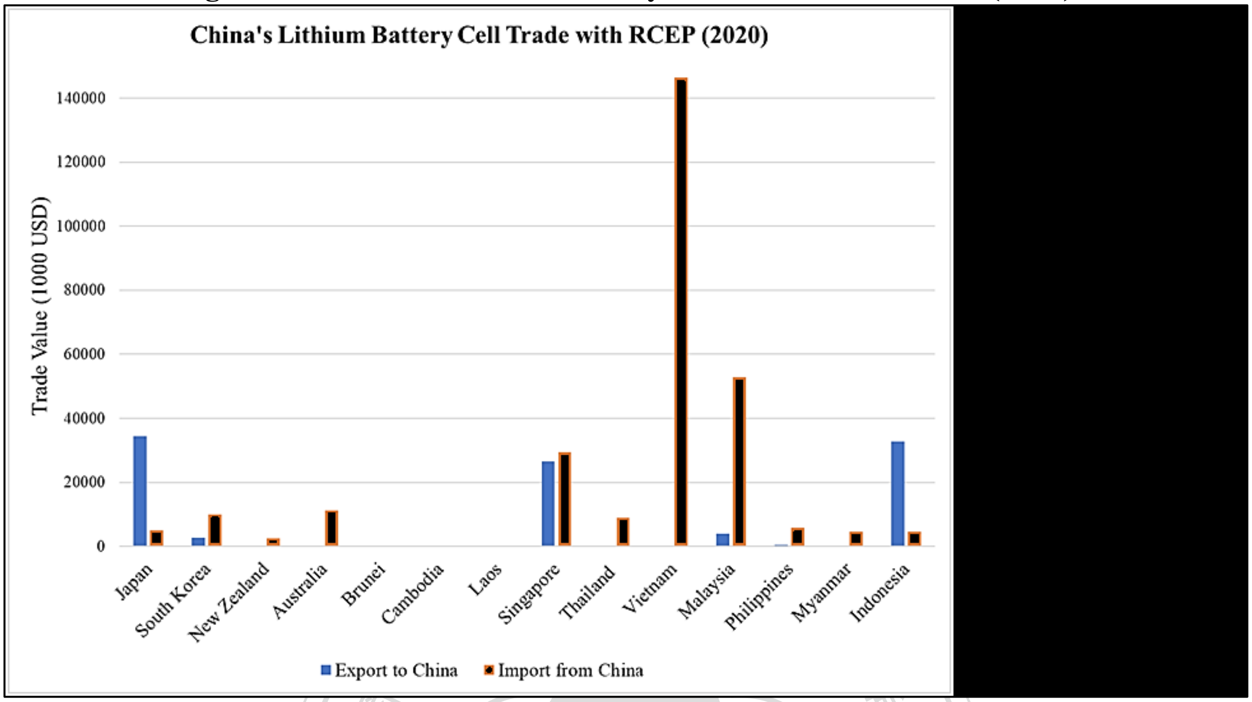
Figure 4-8 China's Lithium Battery Cell Trade with RCEP (2020)



Source: Author compiled from UNCOM trade value data.

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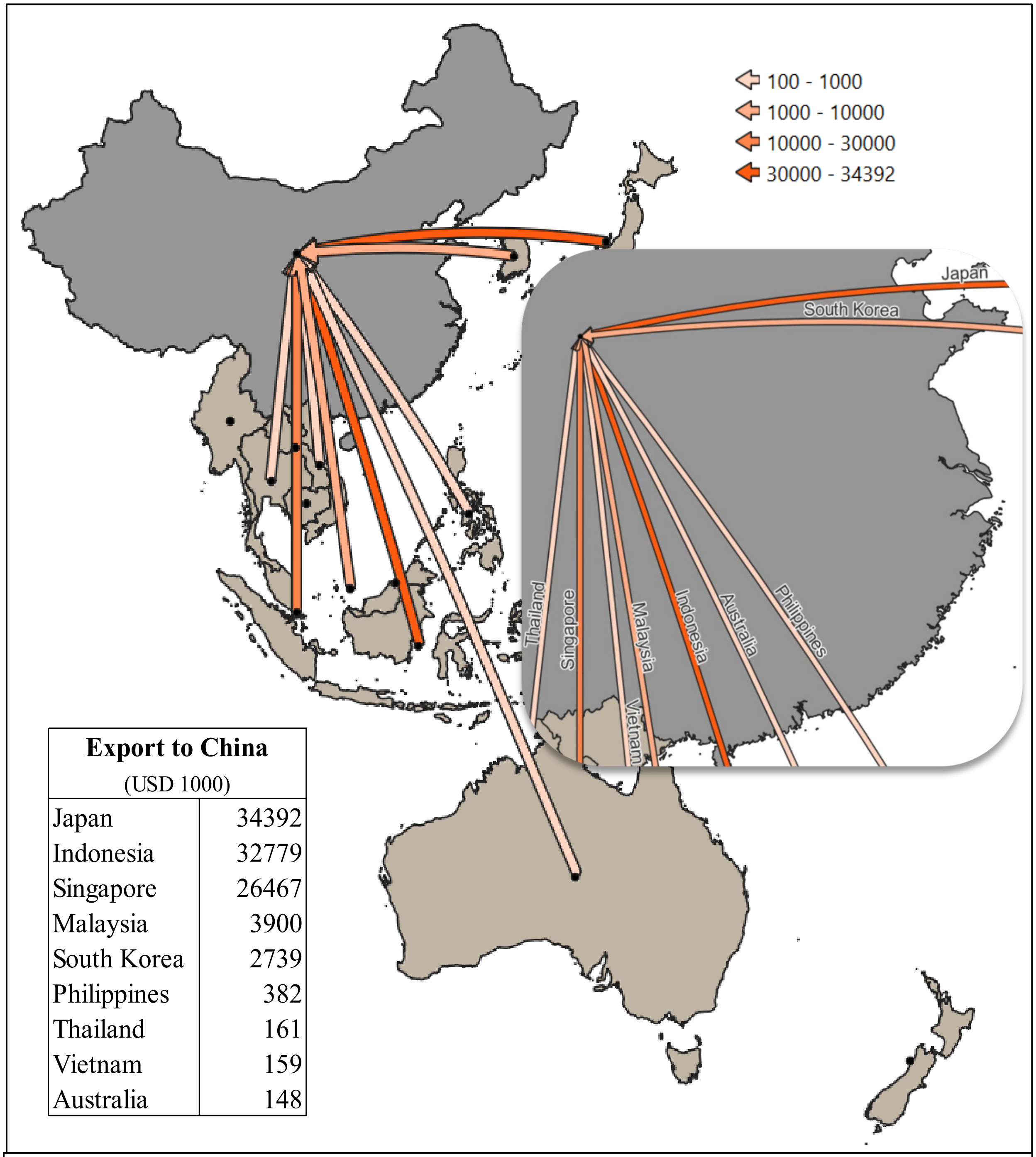
Figure 4-9 Lithium Battery Cell Trade Values from RCEP Countries to China.



Export to China (USD 1000)	
Japan	34392
Indonesia	32779
Singapore	26467
Malaysia	3900
South Korea	2739
Philippines	382
Thailand	161
Vietnam	159
Australia	148

Source: Author compiled from UNCOM trade value data, mapped with QGIS.

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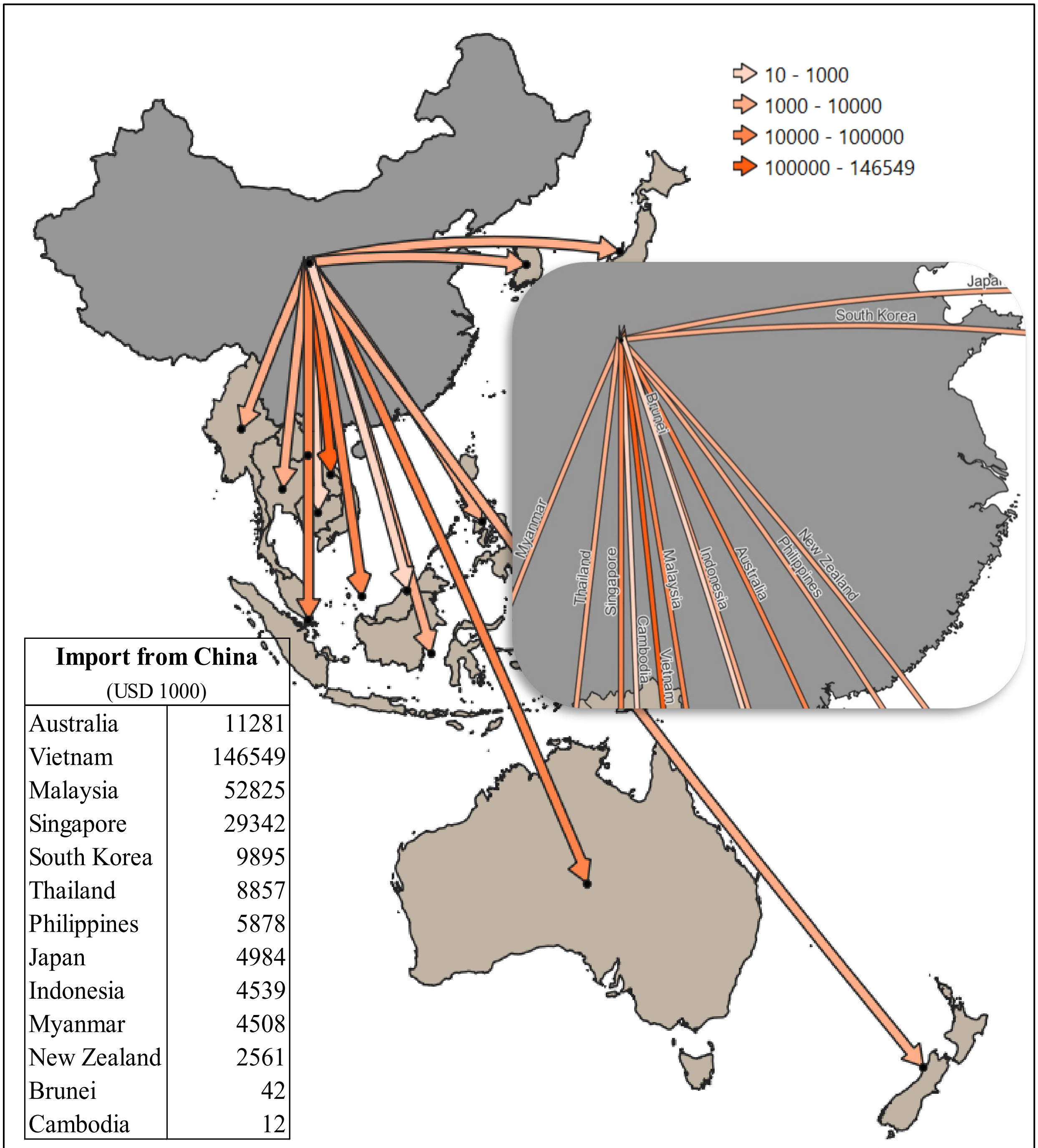
Figure 4-10 Lithium Battery Cell Trade Values from China to RCEP Countries



Import from China (USD 1000)	
Australia	11281
Vietnam	146549
Malaysia	52825
Singapore	29342
South Korea	9895
Thailand	8857
Philippines	5878
Japan	4984
Indonesia	4539
Myanmar	4508
New Zealand	2561
Brunei	42
Cambodia	12

Source: Author compiled from UNCOM trade value data, mapped with QGIS.

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4.3 Pure Electric Vehicles

China's PEV trade reveals a wide export market foundation within RCEP and significant imports from Japan. Similar to lithium battery cells, RCEP will eventually impact automobile tariffs and increase firm to firm interactions within member countries. For the EV industry, such interactions lead to increased opportunities for partnerships, JVs, and in some cases, technology transfers. Additionally, as an end product, the lowering of tariffs for EV components, some of which take effect immediately, and the inclusion of key countries along the supply chain under the same FTA have compounding benefits for China's domestic EV industry. FTAs are widely considered as market-opening mechanisms, and as EV firms compete to capture vehicle market share worldwide, RCEP could assist competitive Chinese firms to break into both higher-income markets such as Japan, Korea, Australia, and Singapore, or contribute to EV market development in lower-income southeast Asian countries. RCEP supports the development of China's productive power by using some free market forces to induce the development of competitive products and capture regional markets.

PEVs are at the frontier of EV technology. Unlike plug-in hybrids (PHEV) and other new energy vehicles (NEV), PEVs by definition do not use oil and rely entirely on battery power. As governments face increased pressure domestically and internationally to lower carbon emissions, fight pollution, and lower fossil fuel dependency, PEVs are the key to an eventual solution. To develop PEVs with equal or better performance than PHEVs and ICEVs require cutting-edge and future technology. Thus, focusing on PEV trade values contributes to the assessment of the most advanced type of NEV with the greatest potential for future development. In short, PEVs are the future of vehicles. Firms have invested in battery R&D to improve the range, power, and safety of these vehicles. China has a technological window of opportunity to break into the PEV industry by developing cost competitive options that meet consumer needs.

China's PEV trade data shows domestic EV exports breaking into multiple RCEP markets. According to Figures 4-12, 4-13, and 4-14, all countries involved in the trade of PEVs with China have deficits except for Japan. Of the three RCEP countries that report any exports of PEVs to China, Japan leads with nearly 52 million USD, followed by South Korea with about 450 thousand USD. China's import value from Japan exceeds its export value to all RCEP countries combined and exposes Japan as the leading RCEP competitor in PEVs within China's

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domestic market. China has PEV exports to 11 out of 14 RCEP partners, with South Korea, Australia, Japan and Thailand the top four export destinations.

All three countries with exports of PEVs to China have developing EV manufacturing facilities and industry advantages.[8] As a global leader in EVs, Japan's high export value suggests an elevated level of penetration in the Chinese market, with product quality and costs rivaling Chinese counterparts. This makes sense, especially considering the high number of EV related patents filed by Japanese companies. South Korea's exports, while significantly lower than Japan's indicates some level of competitiveness within the Chinese market. The lowest of the three, Australia has some automotive manufacturing infrastructure from their ICEV industry and the advantage of possessing significant EV battery raw materials.[9] As the demand for EVs grows, all three countries could become major competitors to challenge China in RCEP's EV market. Although these countries present challenges to China's productive power by capturing market share, their presence in China's domestic market could offer opportunities. With the eventual lowering of tariffs, China's domestic companies must prepare for less market protection and develop advanced technology on-par with competitors. Although China does not have the same level of technological prowess, bilateral RCEP-inspired policy adjustments encourage partnerships between Japanese and South Korean tech firms and Chinese vehicle manufacturing companies.

The import values of PEVs from China to RCEP members indicate EV market development potential and align closely with the World Bank income level categorization in Figure 4-11 of countries. The six countries with the highest import values all have either high-income or upper middle-income status. This makes sense, as EV prices remain out of range for lower-income individuals, and countries with higher average income have better charging infrastructure to facilitate the transition to PEVs. As the RCEP FTA imposes market-driven trade over time, firms' survivability will increasingly depend on developing competitive products. If China can continue to develop high quality PEVs with sufficient range at a reasonable cost, these higher-income markets could contribute to domestic firm profitability that can be re-invested into

[8] Johnna Crider, "EV Market Share Reaches 2.4% in Australia, Tesla Leads EV Sales," *CleanTechnica*, January 30, 2022, https://cleantechnica.com/2022/01/30/ev-market-share-reaches-2-39-in-australia-tesla-leads-ev-sales/.

[9] Royce Kurmelovs, "Electric Cars Touted to Recharge Australian Manufacturing Sector," *The Guardian*, February 7, 2022, https://www.theguardian.com/environment/2022/feb/08/electric-cars-touted-to-recharge-australian-manufacturing-sector.

DOI:10.6814/NCCU202201039

R&D and manufacturing infrastructure. Chinese PEVs also have a presence in some lower-middle income countries. The sales to countries with lower income populations indicate some degree of interest in participating in the global shift to EVs, especially as prices fall to affordable levels. These linkages to lower-middle income countries constitute an important opportunity for China to capture market share early on, and as these countries develop charging infrastructure, China will already have the metaphorical foot-in-the-door to respond to increasing demand. Lower-income countries within RCEP could also provide opportunities for China's LSEV industry, which has a much lower price point and has proven useful in local Chinese' transportation needs. Current PEV sales to RCEP countries with a variety of income levels indicates China's versatility in the regional PEV market, and RCEP's strengthening of these pre-existing linkages will likely provide a boost to their productive power.

Figure 4-11 World Bank Income Level Categorization of RCEP Countries

Country	Income Level
Australia	High Income
Brunei	High Income
Cambodia	Lower Middle Income
China	Upper Middle Income
Indonesia	Lower Middle Income
Japan	High Income
Laos	Lower Middle Income
Malaysia	Upper Middle Income
Myanmar	Lower Middle Income
New Zealand	High Income
Philippines	Lower Middle Income
Singapore	High Income
Vietnam	Lower Middle Income
South Korea	High Income
Thailand	Upper Middle Income

Source: Author compiled data from World Bank.

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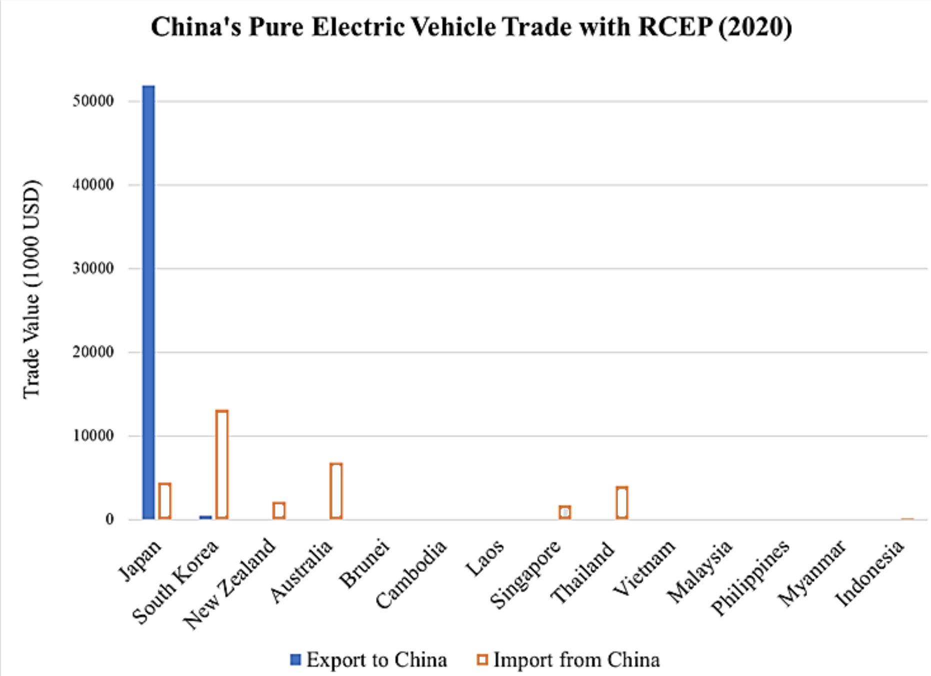
Figure 4-12 China's PEV Trade with RCEP (2020)



	Export to China (USD 1000)	Import from China (USD 1000)
JP	51902	4408
KR	448	13192
NZ	0	2127
AU	45	6,842
BN	0	0
KH	0	114
LA	N/A	N/A
SG	0	1,762
TH	0	4062
VN	0	27
MY	0	39
PH	N/A	N/A
MM	0	18
ID	0	125

Source: Author compiled from UNCOM trade value data.

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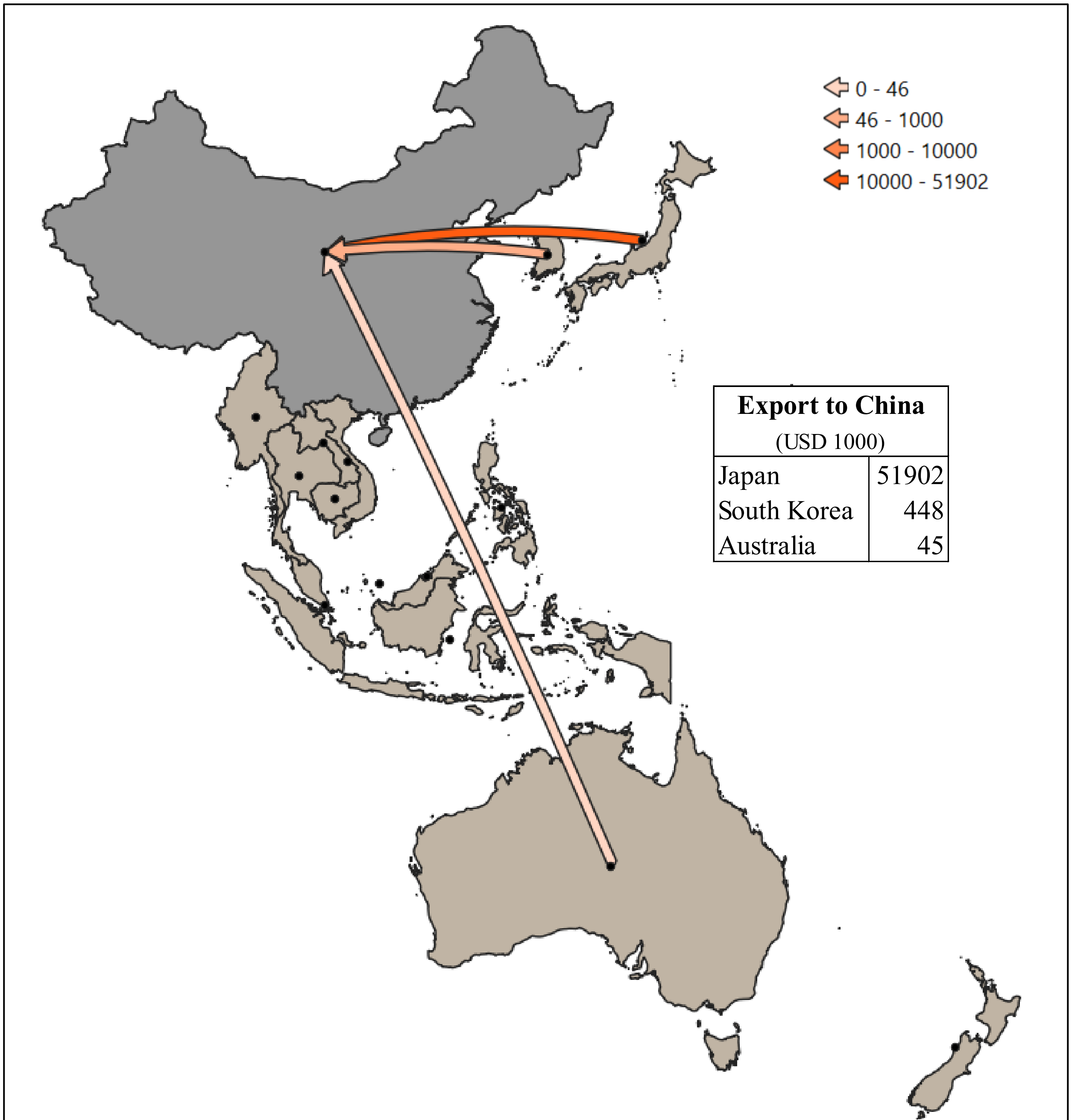
Figure 4-13 PEV Trade Values from RCEP Countries to China



Export to China (USD 1000)	
Japan	51902
South Korea	448
Australia	45

[redacted]

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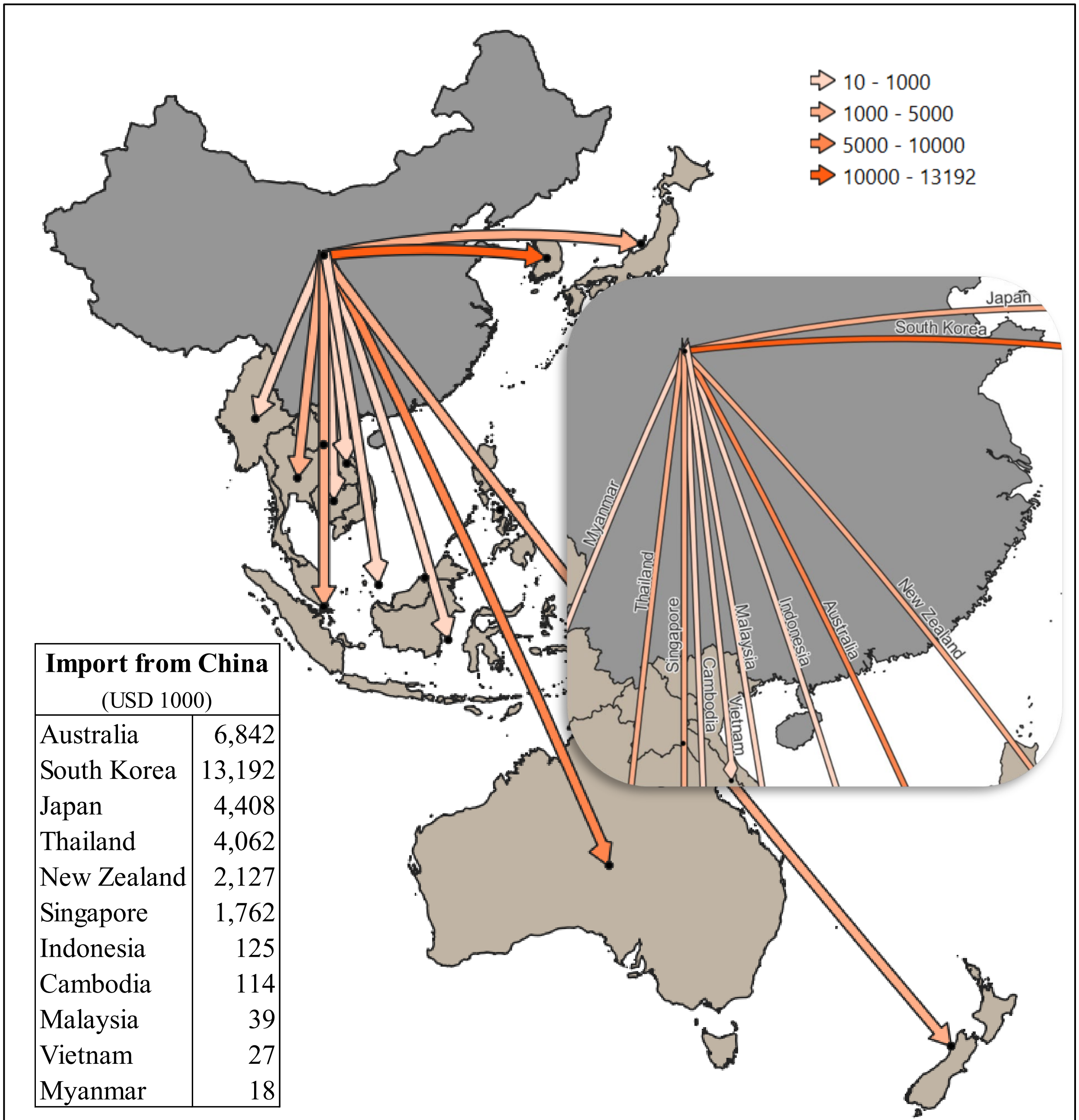
Figure 4-14 PEV Trade Values from China to RCEP Countries



Import from China (USD 1000)	
Australia	6,842
South Korea	13,192
Japan	4,408
Thailand	4,062
New Zealand	2,127
Singapore	1,762
Indonesia	125
Cambodia	114
Malaysia	39
Vietnam	27
Myanmar	18

Source: Author compiled from UNCOM trade value data, mapped with QGIS software

DOI:10.6814/NCCU202201039

CHAPTER 5. Conclusion

5.1 Discussion

Within the last decade, China has risen as an economic and technological power. As a latecomer, China was forced to catch up to automotive industry incumbents while constrained by mature patent environments. The EV industry gives China the opportunity to start off as a front-runner in an emerging industry by developing their own technology and building a favorable trade structure. Joining RCEP assists domestic industries reach international standards with China as a leader in technology development and manufacturing capacity. RCEP moves China closer to a free-market system, which necessitates firm efficiency and profitability without reliance on previously enacted protectionist policies. Although market liberalization will inevitably cause some companies to fail and others to succeeds, implementing savvy economic strategies will assist promising firms in driving domestic industry development.

Susan Strange's productive power definition emphasizes the interaction between the factors of production for a country to increase productive power. Within advanced technology industries, capital and technology variables interact in a circular fashion on industry development, as depicted on Figure 5-1. As firms become more profitable, they have more funds to invest in R&D, which increases the probability of developing advanced technology and enhancing product quality. These technological developments allow firms to move up the GVC due to their more advanced products with greater value added. Firms with higher quality products that meet consumer demands increase their market share, whether through entering into new markets or overtaking competitors within developed markets. Capturing market share increases sales, which leads back to profitability. With greater profitability, firms can either invest in business expansion such as building infrastructure and using higher quality products, or reinvest in R&D. Ideally, the continuous upward trend in productive power would require each element to build upon the last in a cycle of improvement.

FTAs enhance the cycle of industry development through direct and indirect measures. Tariff liberalization and ROO are two main components of FTAs, which directly affect industry development by lowering cost and increasing profitability. They also contribute to market share access, as ROO expand tariff benefits within the FTA. FTAs also have indirect effects on

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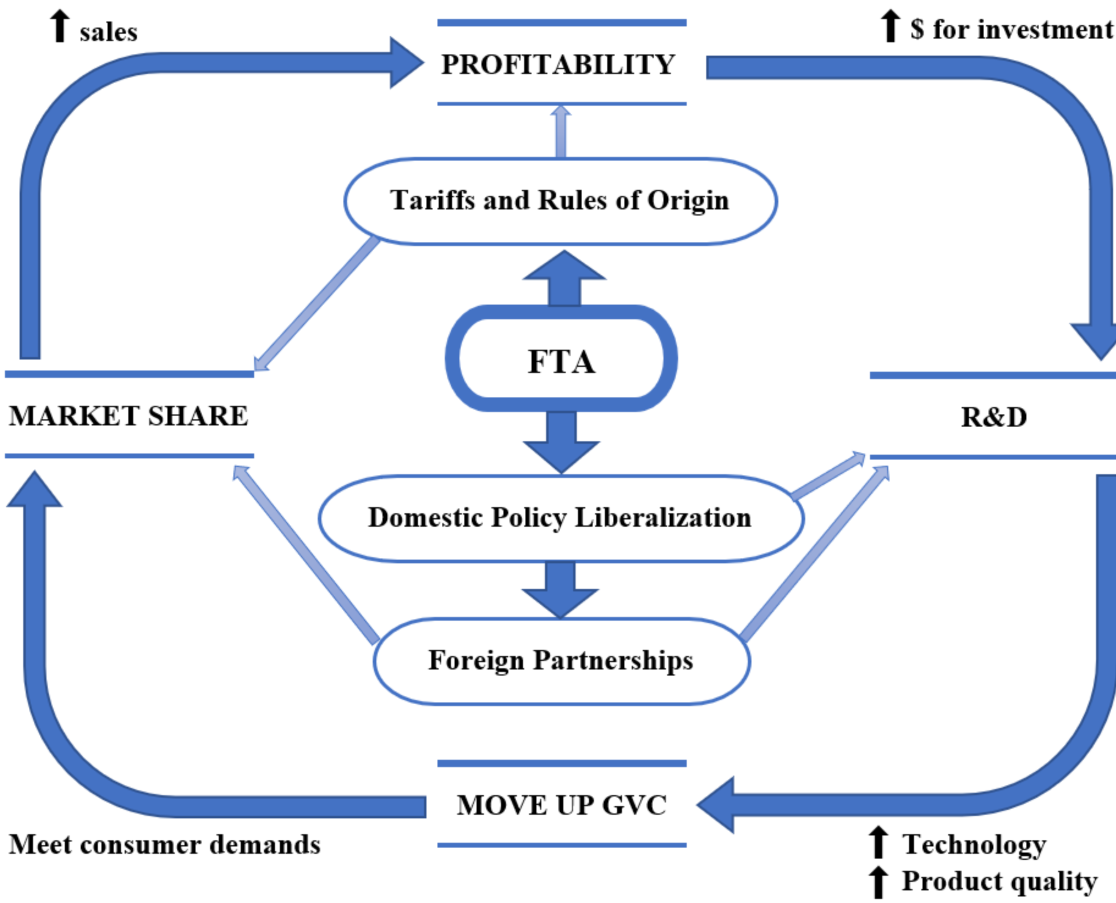
Figure 5-1 FTA Effect on Industry Development



Source: Author's own information.

industry development. In preparation for initiation, a country may need to implement certain liberalization policies, which potentially contribute to shifting the domestic economy in a free-market direction. As a result, domestic firms lose favorable protections from foreign competition and are forced to increase investment in R&D to survive. Domestic policy liberalization also increases the likelihood of foreign partnerships due to the friendlier investment environment. These foreign partnerships contribute to the domestic industry technological development through direct and indirect knowledge transfers and also assist in capturing market share. FTAs augment key elements of the industry development cycle and support industry growth.

Within the EV industry, China has a comparative advantage in land and labor, and a relative weakness in capital and technology. Leveraging RCEP to improve certain elements of the EV

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industry's development cycle will increase China's productive power, and take them one step closer to a leading position.

RCEP affects China's industry development through significant tariff reduction in EV parts and raw materials, which directly benefits firms' profitability. Additionally, RCEP ROO allow Chinese firms greater flexibility in EV parts and export markets, which also increases profitability and market share. Considering China's reliance on raw material imports and significant battery cell imports, they stand to benefit from both tariff and ROO changes. In the years leading up to RCEP, China passed domestic liberalization policies with key provisions for access to foreign investment, IPR protections, ownership laws, and other measures aimed at creating an attractive operating environment for foreign businesses. Equal treatment laws lift some market protections, signaling the government's shift in focus to efficiency and product quality. Although some of these policies were necessary to accommodate RCEP, the overall effect of market liberalization has attracted foreign firms globally, leading to R&D and market share contributions. Chinese firms already have PEV products within developed and developing countries, illustrating China's role in replacing traditional ICEV markets with EVs. By enhancing domestic firms' profitability and competitiveness in the international market, RCEP is assisting China in evolving the entire automotive industry toward EVs.

Using the productive power framework allows this study to focus on elements of FTAs with an impact on the structural environment countries operate within. RCEP inevitably alters the structure of the supply chain, whether through linkages that allow cheaper or more secure access to raw materials, or decreasing supply chain vulnerabilities. China has joined RCEP as a means of increasing power, with effects on the factors of production allowing China to gain greater control over their own economic strengths and weaknesses. China has power as a manufacturer and as a market, and policy decisions such as joining RCEP contribute to China's economic gravity within the international market. In an interdependent trade environment, China must take advantage of supply chain connections with other countries and use their growing consumer market as leverage to create path dependencies, especially within emerging industries. Furthermore, building power through structural methods inspires sustainable development, giving China long-term economic tools for solving future problems such as rising labor costs or accessing new technology. This study relies on the productive power framework to assess the

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effect of RCEP on emerging industries and the structural methods for China to sustain their rise as an economic power.

Focusing on China's role in RCEP has certain limitations. The narrow concentration on China's industry leaves out the bigger picture of RCEP's effect on other countries and their potential changes in trade advantages. Many of the benefits to Chinese firms also apply to other member countries, which may take away from relative gains. For example, as China develops increasingly advanced technology, foreign firms could use RCEP to leverage technology transfers from Chinese firms to benefit their own domestic industry. Additionally, as RCEP expands selection choices, foreign firms may choose to turn supply chains away from China for other reasons. These intervening variables limit the ability to definitively determine RCEP's impact on China's domestic industry development. However, the evaluation of industry development does not always necessitate zero-sum gains; China's increased competitiveness at most paves the way for supply chain dominance and at the very least solidifies their place at the table of industry leaders.

Assessing RCEP's potential effects on China's EV industry contributes to the understanding of early mechanisms for state-led economies to join FTAs. The United States has left a void in international economic diplomacy leadership as they stall on major FTAs such as the CPTPP, and China has stepped up in defending the global trade system. Based on evidence from RCEP, China has gathered leverage within the EV industry that international firms cannot ignore, which influences more than merely productive power. First, China already leads the world in EV manufacturing, and also has the largest market share of EV consumers globally.[1] According to a report by top consulting firm McKinsey and Company, China's EV market will continue to grow well into 2030, and domestic firms will tailor their products to meet local demands.[2] As the top market and manufacturer, China has significant rule-setting power, allowing them to manipulate the market. Within RCEP, the lowered tariffs on EV parts and components already reveal one opportunity for China to dictate the rules of free trade to benefit their own domestic industry. When China's EV market share increases, so does their trade power and overall economic influence. Second, with the continuous push for liberalization, both in international markets and domestic economic policy, China gains the reputation as a champion of

[1] Dabelstein et al., "Winning the Chinese Electric Car Market."
[2] Ibid.

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free trade. This gives China a strong hand at the international negotiating table, especially with the added weight of their immense market size. China increases their ideational power by signaling their commitment to the liberal world order, which allows them to strengthen relations for economic and political purposes. Third, countries will develop trade dependencies with China within the EV industry. As they develop manufacturing power for EV products, international firms will increasingly center their supply chains around China, and RCEP will contribute to this effort by incentivizing member countries to take advantage of lower tariffs and other FTA benefits. This eventually creates path dependencies with China as the linchpin for global EV production. The expansion of structural power ensures changes to the Chinese industry will affect all actors within the supply chain internationally. By pushing to lead the EV industry and simultaneously promoting the liberal world order, China firmly entrenches itself as a dominant economic and political force in the coming decade.

5.2 Suggestions for Future Research

The focus of this study is to assess the effect of RCEP on China's productive power, and more research is needed to develop a deeper understanding of this relationship. As this study focuses on capital and technology, assessing RCEP's influence on China's land and labor variables would contribute to a more holistic understanding China's productive power development. Especially with rising labor prices and environmental concerns, comparing China's land and labor advantages to ASEAN countries could yield interesting results. Furthermore, this study is confined to online research and statistical analysis for empirical evidence. Future research including field work, such as interviews of EV firm leaders or industry and policy experts, would add dimension to the conceptual development of this study.

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