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Towards a new division of labour in Southeast Asia: Indonesian and Thai Industrial policy and the electric vehicle value chain in ASEAN

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Abstract: Amidst changes that signify a transition in the automotive industry's dominant design, vehicle manufacturing nations seek to secure their positions within the industry's global value chain for the post-transition era. This investigation will focus on Thailand and Indonesia, ASEAN's two leading vehicle producers. While both countries have a shared objective, they employ different policies towards this objective. Thus, their cases are relevant cases to understand the role of industrial policy in this transition process. This investigation aims to understand how developing countries, which are significant vehicle producers, seek to manage this transition, which is directed by lead firms located in developed countries and China. This research question is relevant as developing countries (including China) today account for the lion's share of global vehicle output, but apart from China, there is little scholarly attention to the question how a complex socio-economic and socio-technical transition is managed via public policies in Asia.

Keywords: industrial policy; global value chain; division of labour; automotive industry; ASEAN.

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1 Introduction

1.1 Electric vehicles as carriers of change in the automotive value chain

The automotive industry is undergoing a major transformation[1], namely the shift from internal combustion engine (ICE) powertrains which use fossil fuels as their energy source to electric powertrains which use electricity stored in batteries as the energy source. This transformation is significant because certain components of or strongly related to the ICE powertrain become superfluous [Davies et al., (2015), p.186]. This shift in vehicles energy source and powertrain marks a departure from the industry's dominant design [Alochet et al., (2023), p.67], suggesting that the industry will undergo significant change in technology, associated know-how, and firms which possess and develop this know-how further. Hence, the transition from ICE to electric powertrains will result in diminished roles or exit of value chain participants linked to the ICE powertrain and the entry of new participants specialised in the emerging electric powertrain. This shift is evolving at different speeds in different regions such as China, Europe, and North America, but it is nevertheless a global trend.[2]

Although this transition's impact on the industry and its organisation is still evolving, it is certain that the automotive industry is undergoing disruptive change. This investigation focusses on the transition to electric vehicles (EV) in ASEAN to highlight how vehicle producing countries in global value chains[3] (GVC) dominated by foreign carmakers and suppliers seek to deal with the transition to electric powertrains. Specifically, it addresses the research question how Thailand and Indonesia are utilising industrial policy to secure a position within the reshaping automotive GVC. This focus is chosen because aside the major exception of China, the role of other emerging countries in this transition received less scholarly attention. Noteworthy exceptions are investigations on Central and Eastern Europe (Krzywdzinski, 2019; Pavlinek, 2022; Szalavetz, 2022) and Turkey (Mordue and Sener, 2022). It needs to be stressed however that the research on Central and Eastern Europe correctly attributes the anticipated shift in production to environmental regulation and equally correctly describes a lack of industrial policy to manage this policy-induced transition. As will be discussed in the following section, this is due to the fact that European 'green' industrial policy was only formulated in 2022. Therefore, studying Indonesia and Thailand as examples of industrial policy utilisation possess meaning beyond their particular cases.

Their cases are also highly relevant due to another industry development. Vehicle manufacturing has been commodified (Mordue and Sweeney, 2017), meaning that production techniques and workers' skill training have become so standardised that emerging countries have occupied the lion's share of global vehicle production. Thus, addressing emerging country cases beyond China has practical relevance for policymakers in such countries and policy-related research. It will be argued that the case of Indonesia highlights that the transition to a new value chain is a window of opportunity that some nations may utilise to change their strategic position within the transforming automotive GVC.

The remainder of this investigation is structured as follows. Section 2 reviews the academic literature on the changing technology paradigm in the automotive industry and its implications for the associated new division of labour. The discussion will pay special attention to the political economy of this process and political economy was a decisive factor in shaping the current division of labour in ASEAN and political economy factors

and thinking underly industrial policies, especially for the case of Indonesia. Section 3 explains the research methodology and data sources. Section 4 explains Indonesian and Thai industrial policies towards the EV industry and place them in historic context to highlight continuities and shifts in strategy or tools. Section 5 presents data on actual and planned investments into EV assembly and battery cell production to evaluate the success (or lack thereof) of Indonesian and Thai industrial policies. Section 6 summaries the findings.

2 Literature review: changing dominant design, industrial policy, and a new division of labour in the automotive global value chain

2.1 Industrial policy vs. innovation policy as drivers of the transition to electric vehicles

The energy source plus powertrain transition in the global automotive industry towards a new dominant design (Abernathy and Utterback, 1978) induced various countries to address this shift through policy. While all countries arguably seek to manage this transition and secure a position for domestic firms and/or production sites, the type of policies and their time dimension deserve attention.

Especially China has been recognised as promoting this transition to a new dominant design, explicitly to challenge the advantage of incumbent global vehicle producers from the EU, Japan, South Korea, and the USA in ICE technology. This policy can be traced back to 1995, thus indicating the long-term strategic approach China took toward the promotion of EVs (Xiong et al., 2022). Other researchers stress that EVs received increased support when it became clear that joint ventures between Chinese state-owned enterprises and foreign carmakers would not result in significant technology transfer (Helveston et al., 2019). In this view, lack of technology transfer led to a strategy that focussed on breaking the advantage of incumbent foreign carmakers in the dominant ICE design, which explains why Chinese government policy and Chinese independent[4] carmakers such as BYD focussed on battery electric vehicles (BEV)s and plug-in hybrid electric vehicles (PHEV)s. In short, Chinese policy and firm strategy aimed to leapfrog towards EVs (Wang and Kimble, 2011) to level the playing field of technologic competition in the automotive industry. While much automotive industry research has focussed on firm or regional upgrading within the ICE value chain (Sturgeon and Van Biesebroeck, 2011; Rodríguez-De la Fuente and Lampón, 2020; Schröder, 2021), China's leapfrogging strategy is based on the creation of the EV value chain, i.e., one that is based on a new dominant design. As industrial development was mainly described as a process where domestic firms adopt production capabilities and novel production technologies (Humphrey and Schmitz, 2002; Özatağan, 2011; Lampón et al., 2022), this process involved foreign lead firms' know-how transfer. As OEMs were often concerned to limited know-how transfer to limit spill-over effects (Hatani, 2009), the Chinese strategy is radical, risky, but logical if the aim is to achieve a leading position within the industry.

A recent assessment of this leapfrogging approach (Altenburg et al., 2022) finds that China successfully leaped ahead in domains such as electric buses and lithium-based EV batteries and caught up in the domain of passenger cars. Thus, while the core aim of spawning a more competitive Chinese car industry has arguably not yet been realised, policy undoubtedly supported the growth a core novel technology, i.e., the vehicle's

energy source. It is crucial to highlight that policy was an important catalyst in this process, yet the emergence of new firms and their strategy to quickly seek vertical integration of activities is another crucial element that explains China's rapid emergence as a leader in BEV technologies, especially traction batteries (Lüthje, 2021; Wang et al., 2022).

Conversely, most other countries have only turned from technology neutral innovation policy to technology specific industrial policy when it appeared increasingly clear that BEVs would be marketed and produced. This can be explained by two factors.

First, incumbent vehicle producing countries, especially those who are the country of origin of original equipment manufacturers (OEMs), arguably did not want to transition too quickly to electric powertrains due to two interrelated motives. First, they benefitted from technology leadership, so the transition to a novel technology would eliminate their advantage. OEMs were effectively locked in the ICE dominant design. For instance, when China became increasingly serious about supporting BEVs and the European Union sought to promote EVs indirectly via stricter emission regulations in the mid-2000 s, it was observed that 'for most vehicle manufacturers, abandoning the ICE-powered car is simply an anti-economic choice' [Orsato and Wells, (2007), p.997], partly because engines had even longer product life cycles than car-body platforms. It should be highlighted that incumbent OEMs behaviour is an example of bounded rationality: as carmakers develop technologies in a given market environment, they anticipate selection criteria applied by this market (Kemp et al., 1998). As the automotive market long relied on performance criteria such as acceleration, top speed, cruising range, and price, these became anticipated selection criteria for *existing and novel* designs. From these anticipated selection criteria, perceived performance deficiencies of EVs vis-à-vis ICE vehicles are cruising range, recharging time, and price. Given carmakers' bounded rationality, governments of car-producing countries such as Germany actively resisted more demanding environmental policy to protect their national carmakers (Gulbrandsen and Christensen, 2014; Pardi, 2021). Because BEVs are still more expensive than comparable ICE models and recharging takes longer than refuelling, the shift from innovation to industrial policy cannot be logically explained by parity between ICE and EV models in market selection criteria.

Second, a number of alternative electric powertrain configurations such as hybrid electric vehicles (HEVs), PHEVs, BEVs, and fuel cell electric vehicles (FCEVs), were developed and partially marketed since the 1990s (Dijk et al., 2013). Hence, from the perspective of incumbent vehicle producing states, formulating industrial policy was difficult due to uncertainty over technology development. Thus, most incumbent producing countries supported all options via technology neutral innovation policy but hesitated to promote one particular electric powertrain[5]. Thus, the turn to industrial policy which promotes the actual production of BEV powertrains[6] only occurred after this design option appeared to become dominant in industry. The Inflation Reduction Act of the USA and the Green Deal Industrial Plan of the EU[7] are probably the best examples for the recent strong shift from technology neutral innovation policy towards technology specific industrial policy.

This shift is certainly promoted via stricter emission regulations. As regulations in most countries focus on tailpipe emissions, i.e., emissions caused by vehicle operation and not total vehicle lifecycle and/or power source emissions, BEVs sales are de facto the least expensive option available that meets these requirements (Pardi, 2021). It should be highlighted that China's policy to almost exclusively promote BEVs and the role of the

Chinese vehicle market as the world's largest plays for many incumbent carmakers undoubtedly influenced the recent focus to this powertrain configuration.

2.2 Towards a changing geography of automotive production?

For ICE powertrain sourcing, Klier and Rubenstein (2021) showed that sourcing was strongly geographically clustered, even more so than vehicle assembly. Their explanation for this phenomenon is that ICE powertrain production plants operate at higher economies of scale than assembly plants, so that one powertrain plant typically serves two or more assembly sites. Based on this insight, they infer that a central question for the emerging geography of the EV value chain will be related to the economies of scale in EV battery production, more precisely battery cell production. If battery cell manufacturing has lower, similar, or even greater economies of scale than engine and transmission manufacturing, the geographic distribution of manufacturing plants could be similar or different from ICE powertrains. While this question is currently not reliably answerable, they nevertheless point out that Tesla as well as other EV start-ups have located their operations outside the existing North American automotive industry cluster, suggesting that firm-level policy could alter existing geographies of production.

For China, Lüthje (2021) observes that firms he associates with disruption of established value chains are mainly located in the provinces of Guangdong and Fujian, which are rather distant from established Chinese car manufacturing clusters such as Changchun, Wuhan, or Shanghai-Jiangsu-Zhejiang.

For Europe, Lampón (2023) observes geographically more clustered production of EVs in comparison to ICEs. He suggests that this clustering can be explained by modular EV platforms which are deployed to mainly achieve economies of scale in contrast to modular ICE platforms which seek to exploit location factors and economies of scope.

These previous studies can be summarised as follows: EV and EV powertrain production are changing the current geography of production in various regions via the emergence of new industry players and clusters or stronger concentration of production. Regarding the latter point, the strong geographic clustering of EV production may be explained by the still relatively low share of EV sales compared to ICEs, so carmakers need to concentrate production if they want to achieve any economies of scale.

2.3 Industrial policy shaping geography of production in ASEAN: past and present influences

Regarding the existing international division of labour in Southeast Asia, it should first be emphasised that the ICE powertrain has been subjected to an intra-firm, inter-country division of labour. Concretely, this means that carmakers set up subsidiary powertrain plants which specialise in manufacturing specific components such as diesel engines, gasoline engines, and transmissions in different ASEAN countries. These plants achieve economies of scale because they manufacture powertrain components for the whole ASEAN region, which is possible due to free trade between member states.

Second, it must be highlighted that this division of labour is the outcome of ASEAN's political economy. While individual member states sought to promote domestic car sectors since the 1970s through import substitution industrialisation policy (Doner, 1991; Doner et al., 2021; Natsuda and Thoburn, 2021), these attempts only were partially successful. All countries suffered from insufficient economies of scale in production of

cars and components. The 1981 initiative to rationalise car production at the regional level as proposed by the ASEAN Industrial Complementation failed (Shimizu, 1999). As rationalisation of vehicle production was unlikely due to political symbolism and ambitions to develop the sector in each member country, Mitsubishi Motors suggested to allow exchange of components between ASEAN members in the so-called brand-to-brand complementation (BBC) scheme of 1988. While OEMs defined this new international division of labour at the component level, their proposals had to be approved by each involved ASEAN member to become effective. Hence, carmakers submitted proposals that distributed production of main powertrain components and other relatively expensive components such as electronics or steering evenly between production locations to receive government approval (ibid.). As all states needed to approve submitted BBC schemes, carmakers had to satisfy the political imperative of balanced distribution of benefits such as employment or trade balance. The BBC scheme must be regarded as a watershed in the development[8] of the ASEAN automotive industry, since it allowed carmakers to implement a regional division of labour consisting of specialised component manufacturing hubs which now achieved economies of scale. The point that powertrain component production has larger economies of scale than vehicle assembly is worth highlighting as it explains why carmakers were content to rationalise powertrain production at the regional level while maintaining separate assembly operations for each market. It is also noteworthy that carmakers arrived at similar specialisation patterns, for instance diesel engines were located in Thailand and transmissions in the Philippines. As the section on Thai policy will show, national policies promoted specialisation in diesel engines, suggesting that national and regional policies interacted to form a particular pattern of intra-regional product specialisation.

Third, this initially politically negotiated international division of labour proofed to be very durable. Schröder (2021) shows that the specialisation of production locations into making specific vehicle components remained stable over the 1990 s, 2000 s, 2010 s, and early 2020 s. Comparing contemporary analyses of ASEAN automotive production networks from these time periods (Shimizu, 1999; Shimokawa, 2010; Kobayashi et al., 2015), one finds country-level specialisation into powertrain components, e.g., the Philippines produce transmissions and Thailand diesel engines. While subsidiaries produced successive generations of specific parts, the role of these subsidiaries inside the intra-regional production network remained unchanged. This finding should not be surprising as specialisation of workers and production equipment as well as production-related know-how accumulation all make reassigning roles economically unattractive. Thus, once established, it is highly unlikely that an international division of labour is drastically altered by lead firms which orchestrate this process as intra-firm production networks.

As observed, the initially politically negotiated, but management defined intra-firm international division of labour within the Southeast Asian automotive industry was durable and only subject to relatively minor modifications. Hence, it can hardly be surprising that ASEAN countries seek to secure their position in the automotive value chain for the post-ICE era as this GVC is undergoing a significant transformation. It must be expected that just like the ICE powertrain plants, plants which are supplying components of the new electric powertrain will be subject to lock-in effects related to high initial investment, specialisation of workers and production equipment, and accumulation of product- and process-specific know-how. Therefore, ASEAN countries' motivation to attract investments into EV and electric powertrain component production

is driven by the fear that failure to secure a position in the newly emerging value chains and their specific international division of labour means losing long-term competitiveness as a vehicle and/or vehicle component manufacturing nation. Further, the very fact that countries have given up old industrial policy instruments such as local content requirements and embarked on the regionalisation of the economy means that they lack the possibility to engage in an essentially politically (re-)negotiated division of labour for EV assembly and EV components.

Besides EV assembly, especially the production of EV battery cells is being targeted by national governments. As EV battery costs currently constitute about a third of total EV costs (Teece, 2018) and the battery cells account for about 75% of total battery costs (Coffin and Horowitz, 2018), targeting a high value and high value-added component is a logical strategy. However, policy focus on assembly and EV battery turns them into a bone of contention between countries.

3 Methodology and data sources

This investigation employs a qualitative research design. First, it analyses industrial development trajectories of Thailand and Indonesia, ASEAN's two leading automotive producers, towards the electric vehicle value chain to extract the aims and strategies of individual states. The latest policies will be placed in historic context to highlight continuities and novel approaches. Basically, this investigation seeks to analyse how the two countries are deploying industrial policy towards the reshaping automotive sector. The use of a comparative case study is appropriate to investigate research questions related to how and why phenomena occur [Yin, (2018), p.9]. Further, as will be shown in the case studies, historical context and path dependence (David, 1985) help to understand how and why the EV value chain is forming in Southeast Asia, which is a situation where case study analysis and historical analysis can be used complementary as they both investigate how and why research questions.

Second, to assess the impact of these policies, investments related to the EV value chain, specifically EV assembly and battery cell manufacturing, are mapped and analysed. This study relies on publicly available data sources such as industrial policy measures, firm statements, news reports, industry statistics, and investment data. For an overview of all used data sources, please refer to the appendix. If sources listed in the appendix are quoted, they are referred to as their source code.

4 Electric vehicle industrial policy analysis: Thai product champion vs. Indonesian resource-based industrialisation

4.1 Electric vehicles as Thailand's next product champion

Basically, Thailand followed its established pattern of designating a product champion to promote EVs. The product champion approach (Natsuda and Thoburn, 2013) encompasses demand and supply side incentives which are focussed on a particular product type, i.e., the product champion. Targeting particular products such as one-tonne pick-up trucks was rather successful in attracting investment and turning Thailand into Southeast Asia's main vehicle production and export hub.

4.1.1 Pick-up trucks: the long route to the first product champion

It is crucial to elaborate on details to illustrate how one-tonne pick-up trucks supported industrial development. This is a protracted development that started in the late 1970s and which only became the product champion approach in the early 2000 s. First, this vehicle type represented roughly 50% of the local market in the early 1980 s and this market segment was not as fragmented as passenger cars, thus potentially allowing to realise economies of scale (Doner, 1991). Thus, Thai policy repeatedly sought to promote pick-up trucks for local production and eventually export. Second, one-tonne pick-up trucks were targeted to utilise Thai-made diesel engines. Thailand targeted domestic diesel engine production since the late 1970s[9] and successfully negotiated with foreign OEMs localisation in the late 1980s (ibid.). It is important to note that while Isuzu-Mitsubishi-Mazda, Nissan, and Toyota participated in the diesel localisation scheme, they all partnered with one local casting firm[10] that belonged to Thai conglomerate Siam Cement Group. Third, the one-tonne pick-up truck and engine projects proved formative as they were the first projects where Thai policymakers targeted exports to overcome limited domestic market size. While initially resisting Thai intentions, Japanese carmakers changed their stance due to developments unrelated to Thai policy (Doner, 1988): The 1985 Plaza Accord led to an appreciating exchange rate of the Yen. Further, voluntary export restraint agreements between Japan and Canada and the USA restricted exports from Japan to these nations. Both developments promoted production outside Japan. Fourth, when the New Automotive Investment Policy of 2002 deliberately targeted one-tonne pick-up trucks as product champions, carmakers responded by making Thailand their main global production hub for these vehicles[11] (Natsuda and Thoburn, 2021): Isuzu and Toyota shifted their complete pick-up production to Thailand, which was later followed by R&D for these products. Auto Alliance, a Ford and Mazda joint venture, also chose Thailand as their main production base for this vehicle type.

Besides demand and supply side incentives, product champion policy is characterised by performance standards which must be met to qualify for said incentives. Examples include export requirements, annual output requirements, and minimum investment. Schröder (2023) provides a detailed list of incentives and performance requirements for each subsequent product champion policy.

4.1.2 Eco-cars and electric vehicles as subsequent product champions

The initial targeting of one-tonne pick-up trucks was so successful that Thai policymakers followed this established recipe to promote so-called eco-cars, i.e., fuel-efficient small cars, and also attempted to transfer this approach to EVs. However, when Thailand launched her EV policy in 2017 along the lines of the product champion approach, there was still competition between EV types and uncertain market demand. Arguably a consequence of this prevailing uncertainty, the product champion policy supported all EV types, although to differing degrees. While a broader support approach is understandable, the policy was made worse by forgetting one of the central industrial policy rules, namely that industrial policy must establish and enforce performance standards to be effective (Amsden, 1989). As the 2017 EV product champion policy failed to establish significant performance criteria for industrial firms, it has been

criticised as degenerated (Schröder, 2023). He also provides an overview over each product champion's performance standards and incentives provided by Thailand (ibid.).

4.1.3 Re-focussing on electric vehicles as the product champion

However, recent updates to the EV product champion policy are rectifying this shortcoming by re-establishing performance standards. In 2022, the Thai government issued a new incentive package that strongly focussed on BEVs.[12] Under the revised policy, concerning investment projects over THB 5 billion (USD 145 million), HEV production is no longer eligible for exemption from corporate income tax, PHEV production is eligible for 3-year exemption, and BEVs for 8-year exemption (P1). Arguably, this shift demonstrates that industrial policy is context dependent and based on learning. While EV technology development and market demand were arguably still in flux when the first EV policy was issued in 2017, by 2022 market demand and especially carmaker strategies were clearly heading towards BEVs, allowing Thai policymakers to target this EV type. In line with the established product champion approach, incentives are aiming at demand and supply side while returning to define performance standards.

Regarding demand, BEVs are supported via three measures, namely *import duty reduction, excise tax reduction*, and *excise tax subsidy*. As for *import duty reduction*, BEVs imported as completely built-up units (CBUs) are subject to lowered import tariffs in 2022 and 2023: First, for BEVs with a battery above 10 kWh and a suggest retail price (SRP) of less than THB 2 million (about USD 62,000) the following rules apply: for CBUs imported under the standard most-favoured nation rate of 80%, the rate is halved to 40%. For CBUs imported under a free trade agreement (FTA) with a rate higher than 40%, the rate will be reduced by 40%. For CBUs imported under a FTA with a rate below 40%, import duty is exempted. Second, for BEVs with a battery above 30 kWh and a SRP between THB 2 and 7 million, the rates are reduced by 20% following the same pattern.

As for *excise duty reduction*, the excise tax is lowered from 8 to 2% for passenger BEVs and pick-up BEVs are exempted.

As for *excise tax subsidy*, passenger BEVs with a SRP below THB 2 million and a battery between 10–30 kWh, buyers receive a subsidy of THB 70,000, and passenger BEVs with a SRP below THB 2 million but a battery exceeding 30 kWh receive THB 150,000 per unit. As for pick-up BEVs with a SRP below THB 2 million and a battery exceeding 30 kWh, they only receive a subsidy of THB 150,000 if they have been manufactured in Thailand.

Concerning supply, OEMs who wish to benefit from lowered import duties must pledge to produce a similar amount of similar BEVs in Thailand until the end of 2024. That is the ratio between imported BEVs and locally made BEVs must be 1:1. This deadline can be extended to the end of 2025, but in this case, carmakers must reach a ratio of 1:1.5 to offset imports. Further, they must pledge to produce at least 10,000 units within three years after commencing production (please just refer to 'P1', the detailed source is provided in Appendix) (BOI, 2022). Recently, this measure has been further modified to extend completion to the end of 2026, but in this case, the required ratio is 1:3 (R1). Further, participating OEMs are required to use a Thai-made battery, which means at least starting production from the battery module stage, from 2026.

Hence, Thailand's renewed EV product champion policy adjusted on two fronts. First, instead of promoting various EV types, policy now clearly promotes BEVs.

Second, the policy measures return to a balance between incentives and performance standards. It is worth highlighting that a previous characteristic of the product champion approach, namely demanding levels of domestic production that were de facto export requirements is not practiced, arguably because the BEV market is not sufficiently developed to require such standards. Nevertheless, Thai policy returned to performance standards that are not overly demanding yet sufficiently detailed to not simply provide fiscal incentives for any kind of BEV investment. Regarding the product champion approach, this suggests that it still can be practiced even in a state of technological and market uncertainty. Simultaneously, Schröder's (2023) argument that these uncertainties make its utilisation more challenging due to the difficulty to establish performance standards in times of technological transition still appears valid.

4.2 From Nickel to electric vehicles: Indonesia's resource cum industrial policy[13]

Before turning to recent policy aiming to nurture an integrated value chain from nickel to EVs, Indonesia's role as an automobile producer should be briefly described. While the country is by far the most populous in Southeast Asia, its automobile industry still lies behind Thailand in terms of production. Nevertheless, Indonesia has production capacity to produce about one million vehicles per year, meaning the country is a significant vehicle producer. In terms of policy, Indonesia supported the specialisation into small car production under the so-called Low Cost Green Car program which followed the basic product champion concept (Thoburn and Natsuda 2018; Natsuda and Thoburn 2021). So far, production was mainly targeted at the domestic market. Beyond the creation of a localised value chain for EVs, the current Widodo administration clearly hopes to turn Indonesia into an export hub in the electrified global automotive industry (Negara and Hidayat 2021).

Indonesia developed a rather unique policy towards securing a position in the newly shaping EV value chain. In short, its policy seeks to utilise domestic nickel resources as an entry ticket to the EV, especially EV battery, value chain.

Resource cum industrial policy is not a novelty for Indonesia as it increasingly sought to utilise domestic resources, both agricultural and mineral, for economic development since the late 2000 s. This policy led some researchers to identify Indonesia as an example of 'new mercantilism' (Humphrey, 2013) or 'resource nationalism' (Warburton, 2017). Basically, Indonesian resource policy aims to stimulate downstream industrialisation instead of continuing unprocessed resource export. In other words, policy seeks to localise downstream processes, i.e., shaping the decision where certain stages of value addition are performed in a GVC. While this approach can be regarded as intrusive in existing GVCs, the application of newly forming ones is arguably easier to accept for firms as there are few established value chain structures such as an international division of labour. Hence, Indonesian strategy to utilise local nickel resources to get a foothold in the EV value chain is in line with both its pre-existing policy stance on resources in general and with the idea that disruptive technology change leading to GVC remoulding are windows of opportunity for nations to influence the new geographical structure and division of labour[14] of said GVC.

But how exactly did Indonesia sought to turn domestic nickel resources into becoming an important link in the EV value chain? In 2009, the Yudhoyono administration revised the Mining Law to allow the government to restrict export of

mineral ores and to require partial divestment of foreign mining firms.[15] One goal among others of the Yudhoyono administration was to induce the creation of a domestic nickel beneficiation industry. Originally, the purpose of building a nickel beneficiation industry was to create forward linkages from mining towards stainless steel which is the main industrial process using nickel. Thus, after revising the Mining Law in 2009, the Yudhoyono administration issued a ban on the export of unprocessed nickel ore to become effective by 2013.

When the incumbent Widodo administration recognised that nickel was experiencing increased demand due to the utilisation in EV batteries, the idea to build forward linkages from nickel mining to making EVs was born. Although sceptical about the prospects of implementation, Indonesian automotive industry experts clearly identified the envisioned linkages between mining, smelting, EV batteries, and BEVs:

> "[Widodo] aims to increase value-added in the manufacturing of products using Indonesia's natural resources. Consequently, his government intends to ban all mineral ore exports from 2023 in a bid to encourage investments in downstream industries such as mineral smelters. In order to create a market for the smelter industry, the government then plans to develop the largest lithium battery industry in the region. The latter is driven by global trends in EV development, in which Indonesia plans to play a key part." [Negara and Hidayat, (2021), p.176]

Hence, when a new and growing nickel-based GVC was identified, Widodo not only sought to secure a foothold in this emerging GVC, but remarkably to completely localise the production of one of its key components. At the time of writing, Indonesia attracted investment projects from CATL, Hyundai- LG Energy Solution, and Vale-Zhejiang Huayou Cobalt-Ford (Schröder and Iwasaki, 2023; Suroyo, 2023). A noteworthy detail is that the former two projects are joint ventures with Indonesia SOEs. While these SOEs only have majority shares in mining projects, downstream production projects have majority shares of foreign investors.

It should be emphasised that this vision remained ideational as the stipulations of the Mining Law were not revised to de facto enforce a localised value chain from nickel to EV batteries or even BEVs. This is important as it marks a disconnect between policy vision and the central policy measure designed to realise this vision. Under the Mining Law, Indonesia only prohibits export of unprocessed ores but allows export of intermediate products which have 8% nickel content. For the EV battery value chain, this means that only initial smelting must be carried out in Indonesia, but other higher value-added steps based on nickel such as precursor, battery material, or cathode production are not legally required. This suggests that Indonesia must be relying on other factors beyond resource policy to secure a position in the EV value chain.

One such factor is to rely on carmakers in their role as GVC lead firms to ensure at least partial localisation of value-adding processes in Indonesia. President Widodo himself actively lobbies lead firms to produce BEVs locally and uses domestic nickel as a bargaining chip. Widodo openly described how he sought to convince Tesla[16] CEO Elon Musk to invest in Indonesia: "I said to him [Musk] that if you invest in Indonesia, I will give the concession of nickel" (Suroyo et al., 2023). This offer reveals much about the political economy of forming the emerging EV value chain. While Tesla is not involved in the upstream activities of mining, smelting, intermediate chemical compounds, precursors, battery materials, and main battery components (cathode, anode, separators, and electrolyte), as a GVC lead firm, it is dependent on access to an important EV battery

raw material such as nickel and further is influencing decisions on how, where, when and by whom value is added inside their GVC (Gereffi and Lee, 2016). While GVC lead firms in general possess strong power over suppliers, this power, including demand for co-location, is well documented in the automotive industry (Humphrey and Salerno, 2000; Humphrey, 2003; Sturgeon et al., 2008; Sturgeon and Van Biesebroeck, 2011). Hence, while Widodo surely knows that Tesla is not actively involved in performing all value-adding tasks in its supply chain, he correctly understands the significant role that lead firms play in shaping decisions of upstream suppliers. Therefore, the strategy to target lead firms may appear misinformed from a purely economic perspective but is perfectly logical from a political economy perspective on GVCs.

Another such factor is the Indonesian nickel itself. While estimates rank Indonesia as having the world's seventh-largest nickel reserves, it was the leading exporter of nickel ore before the export ban became effective. Further, Indonesia was the largest miner in 2020, accounting for almost one third of global output (Home, 2021). The seeming discrepancy between reserves and actual mining activity can be attributed to the fact that different deposits have differing mining costs. Apparently, Indonesia's deposits are situated at the lower end of extraction costs which explains why mining firms prefer to exploit Indonesian deposits. As demand and prices for EV battery materials such as cobalt, lithium, and nickel have increased over the last decade, access to deposits with lower extraction costs is attractive for mining firms and downstream customers. It follows that the ability to utilise resources as bargaining chips does not purely lie in the existence of domestic resources but also in these resources' properties such as extraction costs. As Indonesian deposits are economically attractive, restricting access via an ore export ban is apparently sufficient to encourage forward linkage creation to smelting. However, as elaborated in the preceding paragraph, the export ban alone is an insufficient explanation for why firms invest in Indonesia's EV battery value chain, suggesting that a combination of hard export ban policy and softer, political economy based lead firm targeting strategy is practiced.

5 Electric vehicle and electric vehicle battery value chain formation in Thailand and Indonesia

Concerning EV assembly, Thailand seems to be able to defend its position as Southeast Asia's leading vehicle assembly hub. Both the number of EV investment projects and EV production capacities favour Thailand over Indonesia, including the seemingly emerging dominant design of BEVs (Table 1).

Thailand clearly attracted more BEV assembly production capacity than Indonesia. Remarkably, this trend is driven by Chinese OEMs which seek to gain market share by differentiating their offerings as pure EVs. This strategy is possible because the dominant Japanese market players so far have mainly relied on hybrids. While Toyota has applied to participate under the BEV product champion policy (Bangkok Post, 2022), it is not yet clear what kind of BEV it wants to produce in Thailand. Toyota seems to consider making the bZ4X or a BEV version of its Hilux pick-up truck in Thailand. In other words, while Japanese producers envision a linear but gradual transition from ICEs over HEVs and PHEVs to BEVs or FCEVs, Chinese carmakers are clearly positioning themselves as the vanguard of the dawning BEV era. Further, some Japanese start-up carmakers follow a similar differentiation strategy, but their product offerings are

catering to mobility solutions such as last mile transportation. Remarkably, Japanese OEMs which dominate Southeast Asia's vehicle production and sales are reluctant to commit to BEV production in developing markets and have overwhelmingly opted for hybrid production instead (Table 2).

Table 1 BEV production capacity in Indonesia and Thailand

	Country of origin	*Model(s)*	*Production capacity*	*Start of operation*
		Indonesia		
Hyundai*	South Korea	Ioniq 5	12,000	2022
Mitsubishi	Japan	i-MiEV	n.a.	2024
Wuling	China	Air BEV	10,000	2022
		Thailand		
BYD	China	Atto 3	150,000	2024
Changan**	China	n.a.	100,000	2024
FOMM	Japan	One	10,000	2019
GAC Aion	China	Y Plus	n.a.	2024
Great Wall	China	n.a.	n.a.	2024
Horizon Plus***	Taiwan-Thailand	n.a.	50,000	2024
Mercedes-Benz	Germany	EQS	n.a	2023
MG**	China	New MG4 Electric; ZS EV	50,000	2024
NETA	China	V	20,000	2024
Takano Cars	Japan	TTE 550	800	2021

Notes: *Hyundai is currently expanding the production capacity of the Ioniq 5 to 1,000 units per month, which is more than double the current monthly output. (N1)
**Changan (N2) and MG (N3) reportedly (plan to) produce HEVs, PHEVs and BEVs in Thailand.
***Horizon Plus is a joint venture between Taiwanese Hon Hai, better known as Foxconn, and Thai PTT, a state-owned oil and gas company. Horizon Plus plans to further expand production capacity to 150,000 units (N4). This project is remarkable as Foxconn seeks to extend its contract manufacturing service from electronics to EV manufacturing.

Source: Author's investigation

Thailand attracted more assembly of various HEV or PHEV models than Indonesia. Further, Thailand got a head start over its competitor in terms of start of production. As hybrids are mostly converted ICE designs, they are commonly produced on the same assembly line along conventional ICE vehicles. This however suggests that Thailand's role as the main regional assembly and export hub promotes these investments as they are additive to past ICE investments. Further, in the case German premium brands BMW and Mercedes-Benz, their production is CKD assembly (Kobayashi et al., 2015), meaning that their production volumes and local value added are limited. Chinese carmakers apparently seek to utilise Thailand as their main assembly and export hub in Southeast Asia as well. Great Wall Motors started to export the Havel H6 HEV model from Thailand to Vietnam in August 2023 and plans to enter other markets such as Indonesia and Singapore in the region (N6).

Table 2 HEV and PHEV production capacity in Indonesia and Thailand

	Model(s)	*Production capacity*	*Start of operation*
	Indonesia		
Mitsubishi	Xpander HEV	n.a.	2024
Toyota	Innova Zenix HEV	n.a.	2023
	Thailand		
BMW*	3-series PHEV; 7-series PHEV; X3 PHEV; X5 PHEV; 5-series PHEV	n.a.	2017
Honda**	Accord HEV; City HEV; Civic HEV; HR-V HEV	n.a.	2020
Mercedes-Benz	C-class PHEV	n.a.	2019
MG	HS PHEV; VS HEV	n.a.	2022
Mitsubishi	Outlander PHEV	n.a.	2020
Nissan	Kicks e-Power HEV	n.a.	2020
Toyota	Camry HEV; C-HR HEV	7,000	2018

Notes: *5-series PHEV is produced since 2019.
**HR-V is produced in Thailand since 2021, the Civic since 2022.
Source: Author's investigation

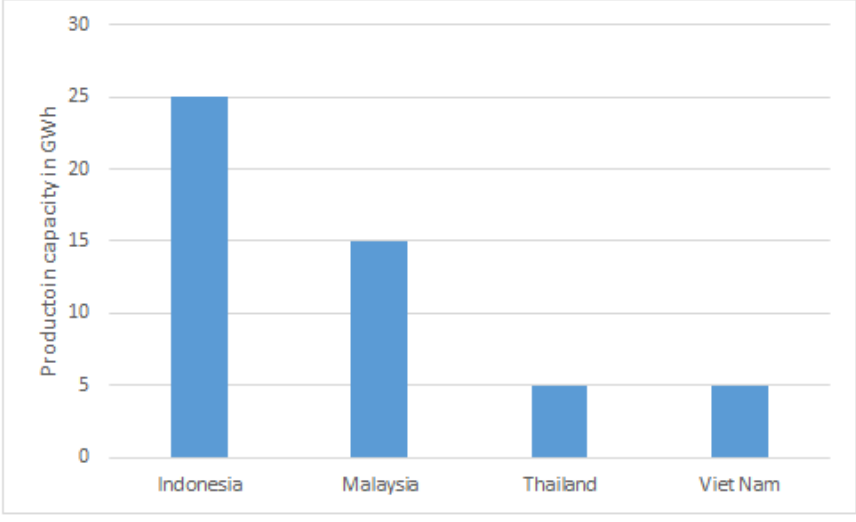
What explains the seemingly continuing dominance of Thailand as the Southeast Asian vehicle assembly hub? First, path dependence matters. The existence of a sophisticated supplier industry in Thailand continues to attract carmakers. Chinese carmakers clearly intend to utilise Thai suppliers for non-powertrain components. 'Everyone that came in want to utilise the Thai suppliers for metal parts, seats, interior systems, plastics. The Chinese are using the same suppliers the Japanese would be. They could be Japanese suppliers or European or American.' (N7) Thus, the established strength of the supplier industry in Thailand still matters even if the dominant design is being transformed. BEVs still need various inputs in which the Thai automotive sector is stronger developed than its Indonesian counterpart. Nevertheless, Chinese carmakers do not exclusively rely on suppliers in Thailand. For instance, Great Wall Motors was accompanied by affiliated suppliers Hycet (powertrain), mind electronics (lighting), and Nobo automotive (seats) which are going to produce components in Thailand (N8). Similarly, a joint venture between supplier Forvia and BYD will open a new seat plant in the vicinity of the planned BYD plant in Rayong (F1). This type of *follow sourcing* (Humphrey and Salerno, 2000; Humphrey, 2003) strengthens and diversifies Thailand's already strong supplier industry. This again highlights that carmakers possess sufficient power over suppliers to demand co-location (Sturgeon et al., 2008; Sturgeon and van Biesebroeck, 2011). It should be highlighted that these cases represent continuity and change: continuity because carmakers still hold power over suppliers to co-locate. Change because co-location used to mean that suppliers from developed countries were required to co-locate in developing countries, but now Chinese suppliers are required to follow their customers to production locations outside China.

Second, Thai policy focussed on attracting assembly as well as components. It should be emphasised that assembly and component production are linked via policy. For instance, one condition for investment incentives is that besides BEV assembly, one out

of three key components – battery management system, drive control unit, and traction motor – must be produced or sourced locally within three years of starting local vehicle assembly. Alternatively, if carmakers locate battery cell production in Thailand or source cells from the country, no other key components must be made locally to be eligible for incentives (R1). This policy measure is important as it represents Thailand's attempt to attract battery cell production via backward linkages from assembly. While BEV assembly is supported via an 8-year exemption from corporate income tax, the duration can be expanded to 13 years if R&D is conducted in Thailand. Further, Thailand provides up to 13 years of corporate income tax exemption for the manufacture of 17 EV parts including battery, battery management system, drive control unit, inverter, and traction motor among others. Whereas Indonesia mainly focuses on establishing an EV battery value chain within its borders, Thailand continued to focus on attracting assembly.

Regarding batteries, Indonesia's policy which utilises its position as the largest nickel mining country seems to outperform Thailand's policy which relies on the established product champion approach. Especially concerning battery cells, Indonesian nickel resources and the government's export ban on unprocessed nickel ore were sufficient to attract the bulk of planned battery cell manufacturing in Southeast Asia (Figure 1).

Figure 1 Planned EV battery cell production capacity in ASEAN by country (see online version for colours)



Source: Bloomberg NEF (2022)

So far, the planned facilities of CATL and LG Energy Solution in Indonesia account for half of all planned EV grade battery cell production capacity in ASEAN, distancing Malaysia with 15 GWh as well as Thailand and Vietnam with 5 GWh, each.[17] This development is noteworthy as it suggests that Indonesia will capture a significant share of ASEAN-based EV powertrain production. It is all the more remarkable as Indonesia has been singled out by industry observers and environmental groups as an unattractive battery cell production location due to the highly polluting mining and smelting processes used plus the fact that over 60% of electricity are coal-based (Maulia, 2022). This suggests that despite reservations about the sustainability of the Indonesian nickel-based

EV battery value chain, firms nevertheless locate most ASEAN production in the country which strongly suggests that despite hard-nosed government policy, Indonesian nickel resources are too valuable for the EV value chain to be ignored.

The current lack of environmental sustainability of most nickel mining operations in Indonesia is an issue for the automotive industry and policymakers. For the automotive industry, the issue lies in the fact that significant environmental pollution from nickel mining contradicts the green, sustainable image the industry seeks to cultivate for BEVs. For instance, when negotiations between Widodo and Musk became known, several non-governmental organisations send an open letter to Musk, urging him to not invest in Indonesia due to environmental concerns (Friends of the Earth, 2022). Thus, as consumers recognise the dissonance between supposedly green cars and environmental degradation due to nickel mining without demanding environmental standards, the car industry may find it increasingly difficult to sell BEVs as green cars. For Indonesian policymakers, this means that the use of nickel in would-be green automobile GVCs may increasingly depend on establishing tougher environmental standards. There are signs that this lesson is learned quickly. In March 2023, when speaking at a joint investment project signing between mining company Vale, battery material producer Zhejiang Huayou Cobalt, and carmaker Ford, Widodo praised the project for sourcing electricity from hydropower plants and suggested that new smelters would only be approved if they used renewable energy sources and that existing facilities would be given deadlines to transfer from coal to renewable energy (Suroyo, 2023). While no concrete policy towards this aim has been issued at the time of writing, one may be cautiously optimistic that policymakers have learned that green cars are only as green as the electricity used to make and operate them, the former including the whole value chain from raw materials to final assembly.

As for a theoretically grounded interpretation of Indonesian and Thai policies towards the electric vehicle value chain, a concept developed by the related global production network (GPN) literature is useful. GPN research has developed the concept of strategic coupling between states, their politics and policies, firm strategies, and economic development outcomes (Coe and Yeung, 2015, 2019).

While this investigation clearly shows that Indonesia and Thailand both seek to achieve couplings between their respective national interests and firm interests, the described differences can be further analysed based on a typology of different state roles (Horner, 2017; Horner and Alford, 2019). These different roles are facilitator, regulator, producer, and buyer. In short, the facilitator role assists firms in GVCs, the regulator role limits firm activities, the producer role means that the state competes in GVCs via SOEs, and the buyer role means that the state procures GVC outputs. The findings of this study show that Thailand is mainly active as a facilitator for automotive lead firms and their suppliers. In contrast, Indonesia combines the roles of facilitator, regulator, and producer in its policies.

6 Conclusions

It has been elaborated how Indonesia and Thailand employ different industrial policies to pursue the same aim, namely securing their position in the emerging EV value chain. Both nations follow established industrial policy patterns. Thailand iterates on its rather successful product champion approach. Indonesia also iterated rather unorthodox and

controversial approach to base industrial policy on domestic mineral resources. While Thai sectoral policy is characterised by sticking to the same approach, Indonesia policy is a crossover from a policy which targeted the steel sector, i.e., outside pre-existing sectoral policies.

Regarding the impact of these policies, it must first be highlighted that this study can only make a snapshot of the current situation and identify current patterns, but the dynamic development of the EV value chain does not allow to infer that these patterns are going to remain unaltered.

As for EV assembly, Thailand apparently can defend its position as the leading automotive production hub in Southeast Asia. Various factors seem to enable Thailand to counter the open Indonesian attack: an existing competitive supplier industry, an industrial policy that balances incentives with performance standards for firms, and higher purchasing power of Thai customers. Interestingly, the Thai case highlights an ensuing competition based on different firm level strategies. While incumbent Japanese OEMs so far preferred a linear, gradual transition from ICE over hybrids towards BEVs or FCEVs, Chinese carmakers challenge this scenario by aggressively promoting a more radical shift towards BEVs. As China has long promoted BEVs to leapfrog incumbent carmakers in the global automotive industry, this strategy can be hardly surprising. From the Thai perspective, it is reinsuring that Chinese OEMs opt to make vehicles in Thailand, mainly because the country nurtured a well-developed supplier industry. Further, there are signs that Japanese carmakers will respond to the Chinese challengers by abandoning the preferred linear, gradual transition scenario to compete in the BEV market more aggressively[18]. If Japanese OEMs would follow-up on previous investment in hybrids by investing in BEVs, Thailand will arguably cement its position as the ASEAN hub for vehicle assembly despite the ongoing shift in the industry's dominant design. In comparison to Thailand, Indonesia is rather unsuccessful in attracting new assembly operations.

As for EV battery cell production, the situation is basically reversed. While Thailand has not been particularly successful in attracting battery cell investments, Indonesia is currently the clear frontrunner in Southeast Asia. As elaborated however, this success cannot be attributed to its resource cum industrial policy alone. In particular, the combination of upstream nickel mining and downstream BEV assembly to promote apparent package deals that aim at localising the completely integrated value chain from nickel mining to EV battery production or even vehicle assembly has at least convinced CATL and Hyundai-LG energy solutions to pledge building such a localised value chain in Indonesia.

Regarding a newly emerging division of labour in the EV value chain in ASEAN, it appears that that Thailand can defend its position as the leading assembly location. However, as Thailand is involved in engine production, it will nevertheless face negative consequences of the dominant design shift as it is not particularly successful in attracting battery cell production. Conversely, Indonesia has so far been remarkably successful in attracting the lion's share of battery cell production capacity in Southeast Asia. While Indonesia lacks success to build forward linkages to EV assembly, it is nevertheless capable to secure an important position inside the EV value chain. While this success is not solely attributable to industrial policy, the obvious utilisation of mineral resources as a bargaining chip towards automotive GVC lead firms hints that the political economy of the newly emerging EV value chain deserves more scholarly attention.

Some implications for policymakers can be derived from this analysis. Both countries are exampling that industrial policy can be utilised to promote the shift towards electromobility. While Thai policy is following a rather common mixture of investment incentives and performance criteria, Indonesian policy based on natural resources is rather unorthodox and may be difficult to replicate by countries with less favourable combination of demand, extraction, and production-related factors. Nevertheless, Indonesia's case is relevant because it shows that industrial policy may be utilised during times of dominant design change to secure positions in a newly emerging GVCs and their international division of labour.

There are clear limitations of this research. First, only the cases of Indonesia and Thailand have been analysed, but Malaysia, the Philippines, and Vietnam which are all part of automotive production networks in Southeast Asia have been omitted. As carmakers have used these countries as specialised production locations for components, e.g., transmissions made in the Philippines, the question how these countries are seeking to deal with powertrain electrification should be addressed by future research. Second, this research is only a snapshot of the beginning transformation. Future research should investigate how Indonesia and Thailand are positioned once the transformation has progressed or fully completed. Third, this investigation focused on country-level strategy and policies to shape the emerging division of labour of EV. It is beyond the limitations of this article to address issues such as the environmental impact of nickel mining, including workers' health and safety, or the question of needed labour skills for the EV age. These issues indeed deserve scholarly attention as they are going to influence the realisation of the strategic state policies covered here.

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Notes

1 Arguably, the industry is undergoing two major transformations simultaneously. First, the transformation of the product, especially its energy source and powertrain, which is the topic of this study. Second, the transformation of the production process and its management through the increased utilisation of digital technologies.

2 Data from the International Energy Agency for 2022 show that China accounted for a global EV (defined as battery and plug-in hybrid) sales share of 60% (IEA, 2023). While China is the world's largest vehicle market with about 32% of global sales (calculated based on data from OICA), her share of electric vehicle sales is significantly higher than her overall share. The USA EV sales share was 10% although her global total sales share was about 12%. Trends in European countries differ strongly, showing a divide between Western European countries on the one side and Central and Eastern European countries on the other.

3 Pavlínek (2018) developed the typology of integrated peripheries to describe countries that engage in automobile production which is characterised by dominance of foreign firms at the head of the GVC, limited technological capabilities of local suppliers, and high export shares of produced vehicles among other parameters. This typology is highly useful but not a good label to apply to Indonesia and Thailand, the subjects of this study. While the first two characteristics apply to both countries, Indonesian vehicle production is predominately for the local market, and although Thailand is a significant production and export hub, its only exported about 60% of production [Warr and Kohpaiboon, (2017), p.9] (while most integrated peripheries have a share higher than 90% and the country with the lowest share is Turkey with 73%) and her exports are destined to rather distant locations such as Australia, Japan, the Middle East, or New Zealand. Thus, while Indonesia and Thailand share certain characteristics with integrated peripheries, this typology is not used.

4 This label is widely used in China's automotive industry to differentiate privately-owned carmakers from joint ventures between state-owned and foreign carmakers.

5 This is certainly the case for Germany (Lane et al., 2013) and Japan (Åhman, 2006). While the USA arguably followed a similar approach, the case of California and the utilisation of her independent emissions regulation to pursue technology transition aggressively (Wallace, 1995; Vergis and Metha, 2012), make a clear-cut assessment complicated.

6 During the innovation policy era, many countries provided consumer incentives for EVs, but these incentives again were often provided to all types so that consumer incentives arguably had little influence on the direction of change.

7 The EU further allowed individual member states to subsidise projects which fall under the Net Zero Industry Act and Critical Raw Materials Act, two parts of her Green Deal Industrial Plan, until 2025. This is a significant departure from EU policy which stipulated that individual member states could not directly subsidise industrial projects, a rule implemented to curtail competition for investment based on subsidies.

8 Nishimura and Kobayashi (2016) point out that BBC was followed by the ASEAN Industrial Cooperation (AICO) in 1995, which extended BBC's principle to the parts-making industry in allowing component suppliers to implement a regional division of labour. Further, they argue that the perceived success of the BBC and AICO schemes promoted the generalisation of regional free trade from the automotive to all sectors in the form of the 1994 ASEAN FTA and the 2003 ASEAN Economic Community.

9 While diesel engines for passenger cars and commercial vehicles would not be produced under the initiative launched in the 1970s, agricultural diesel engines were produced in a joint venture between Kubota and Siam Nawaloha Foundry, a subsidiary of Siam Cement Group [Doner (1991), pp.204–205].

10 Initially, the diesel engine policy aimed that the three different Japanese groups should specialise in particular engine components and to exchange them between OEMs [Doner et al., (2021), p.101]. However, this plan fell apart when OEMs decided to pursue production of their own components.

11 It must be added that derivate products based on one-tonne pick-up truck platforms where also located in Thailand, Toyota's Innovative international multi-purpose vehicle (IMV) project is probably the best-documented example (Nomura, 2015). Thus, it may be argued that Thailand also benefited from the industry trend towards more extensive utilisation of shared product platforms that gained momentum since the 1980s (Cusumano and Nobeoka, 1998). Further, the IMV project is significant because it was an updated version of the intra-ASEAN division of labour at the component level.

12 Under the revised policy, concerning investment projects over THB 5 billion (USD 145 million), HEV production is no longer eligible for exemption from corporate income tax, PHEV production is eligible for 3-year exemption, and BEVs for 8-year exemption (BOI, 2022). Arguably, this shift demonstrates that industrial policy is context dependent and based on learning. While EV technology development and market demand were arguably still in flux when the first EV policy was issued in 2017, by 2022 market demand and especially carmaker strategies were clearly heading towards BEVs, allowing Thai policymakers to target this EV type.

13 This section draws on Schröder and Iwasaki (2023).

14 Note that this conceptualisation of window of opportunity differs from Perez and Soete (1988) who discuss the possibility to use novel technologies for economic catch-up by mastering these technologies as pioneers or early imitators. While their conceptual analysis is valuable, their analysis arguably needs to be modified for a world of GVCs. First, their notion of window of opportunity supposes that emerging countries may nurture integrated industrial clusters around novel technologies. The case of BEVs in China is an example that this is still possible today, which is why their work remains relevant. Second, contemporary GVCs however allow emerging countries to host production processes of advanced and novel technologies so early in the technology life cycle that they may look like early imitators. Inside GVCs however, emerging country firms may play a very limited role in the deployment of novel technologies despite local production. As the discussion on Indonesia will show, its participates in joint ventures with foreign firms that own key technologies.

15 For a detailed treatment on the provisions of the Mining Law, refer to Warburton (2017, 2018). As the name suggests, the law aimed at all mineral resources, including bauxite, copper, gold, nickel, and tin as well as coal which is technically not a mineral.

16 While this example is the one where Widodo explicitly elaborated on his strategy to link BEV production to access to Indonesia nickel, it is well documented that he also is personally involved in discussions with BYD and Volkswagen, which seeks to access this raw material through a venture between German chemical industry giant BASF and French miner Eramet (please simply refer to 'N12') (Shofa, 2023). Based on Widodo's statement and observed government strategy, it can be logically inferred that this political economy linkage is not a singular occurrence but a consistent strategy.

17 Against the background of Indonesia's strategy described above, it is worth pointing out that the Philippines are absent from this list although she was the second-largest nickel producer behind Indonesia in 2021.

18 Toyota, clear champion of hybrid technology, seemingly prepares to transition towards BEVs. In his first press conference as designated CEO and President of Toyota, Koji Sato mentioned electrification as his priority for developing future Toyota and Lexus products (Toyota, 2023). Sato referred several times to BEVs, suggesting that Toyota will transition from the current focus on hybrids towards BEVs. It is also noteworthy that Takeshi Uchiyamada resigned as Chairman of the Board at Toyota, because Uchiyamada is known as the 'father of the Prius'. Thus, the personnel changes at Toyota suggest that the carmaker will more aggressively develop and sell BEVs which signals a significant departure from Toyota's gradual, linear sequential transition approach to electrification.

Appendix

This appendix lists additional sources and documents that have been used to analyse public policies and firm strategies. Not all these sources have been referenced in the article, but they informed the analysis as they contain relevant information, e.g., on investment, production capacity, or produced models.

Document type and code	*Reference*
	Firm statements
F1	Forvia (2023) *FORVIA and BYD to Rev Up their Partnership with the Construction of New Seat Assembly Plant in Thailand*, Forvia Press Release, 20 July [online] https://www.faurecia.com/en/newsroom/forvia-and-byd-rev-their-partnership-with-construction-new-seat-assembly-plant-thailand (accessed 27 July 2023).
F2	Mitsubishi Motors (2023) *Mitsubishi Motors Begins Production of Minicab-MiEV, a Kei-Car Class Commercial EV, in Indonesia in 2024, the First Local Production of the Vehicle Outside Japan*, Mitsubishi Motors press release, 16 February, https://www.mitsubishi-motors.com/en/newsrelease/2023/detail1412.html (accessed 27 July 2023).
	Industry publications
I1	Japan Automobile Manufacturers' Association (2022) *Production Facilities in ASEAN in 2020-21 and Related Data* [online] https://www.jama.or.jp/english/reports/docs/Production_Facilities_In_Asean_2020-2021.pdf (accessed 12 December 2022).
I2	Thailand Automotive Institute (2022) *Thai Automotive Industry: Facts and Figures 2021* [online] https://data.thaiauto.or.th/images/PDF/Navigator/Thai_Automotive_Industry-Facts_and_Figures_2021.pdf (accessed 3 March 2023)
I3	Thailand Automotive Institute (2023) *Thai Automotive Industry: Facts and Figures 2022* [online] https://data.thaiauto.or.th/images/PDF/Navigator/Thai_Automotive_Industry-Facts_and_Figures_2022.pdf (accessed 25 October 2023).
	News articles
N1	Herman (2023) 'Hyundai to double EV production in Indonesia amid soaring demand', *Jakarta Globe*, 15 April [online] https://jakartaglobe.id/business/hyundai-to-double-ev-production-in-indonesia-amid-soaring-demand (accessed 1 May 2023).

	Firm statements
N2	Sullivan, B. (2023) 'Thailand Becomes Changan Auto's First EV Production Base Outside of China', *Thailand Business News*, 6 May [online] https://www.thailand-business-news.com/companies/97713-thailand-becomes-changan-autos-first-ev-production-base-outside-of-china (accessed 25 October 2023).
N3	Apisitniran, L. (2022) 'SAIC Motor-CP eyes new EV battery factory', *Bangkok Post*, 19 January [online] https://www.bangkokpost.com/business/general/2249643/saic-motor-cp-eyes-new-ev-battery-factory (accessed 16 October 2023).
N4	Randall, C. (2022) 'Foxconn and PTT start building EV factory in Thailand', *Electrive*, 14 November [online] https://www.electrive.com/2022/11/14/foxconn-ptt-start-building-ev-factory-in-thailand/#:~:text=It%20is%20scheduled%20to%20start,capacity%20of%2050%2C000%20electric%20vehicles (accessed 20 July 2023).
N5	Bangkok Post (2022) 'Toyota signs agreement for EV incentives', *Bangkok Post*, 29 April, https://www.bangkokpost.com/auto/news/2302542/toyota-signs-agreement-for-ev-incentives (accessed 29 April 2023).
N6	Duc, Tri (2023) 'China's great wall motor wheels into Vietnam market', *The Investor*, 1 July, https://theinvestor.vn/chinas-great-wall-motor-wheels-into-vietnam-market-d5632.html (accessed 13 August 2023).
N7	Obe, M. and Regalado, F. (2023) 'Thailand's motor industry becomes a Japan-China battleground', *Financial Times*, 18 January [online] https://www.ft.com/content/abc79606-5b18-4d4c-b63d-928d7e21b0e5 (accessed 1 February 2023).
N8	Reuters (2023) *Chinese Electric Vehicle Investment Plans in Thailand*, Reuters, July 10 [online] https://www.reuters.com/business/autos-transportation/chinese-electric-vehicle-investment-plans-thailand-2023-07-09/ (accessed 20 July 2023).
N9	Setboonsarng, C. (2022) *China's BYD to Start EV Production in Thailand by 2024*, Reuters, 8 September [online] https://www.reuters.com/business/autos-transportation/chinas-byd-set-up-ev-plant-thailand-2022-09-08/ (accessed 21 July 2023).
N10	Zhang, P. (2023) 'Neta starts construction of its first overseas plant in Thailand, with planned annual capacity of 20,000 units', *CNEVPost*, 10 March [online] https://cnevpost.com/2023/03/10/neta-starts-construction-of-its-first-overseas-plant-in-thailand/ (accessed 20 July 2023).
N11	Apisitniran, L. (2023) 'GAC Aion set to assemble EVs in the EEC next year', Bangkok Post, 12 September [online] https://www.bangkokpost.com/business/motoring/2645370/gac-aion-set-to-assemble-evs-in-the-eec-next-year (accessed 25 October 2023).
N12	Shofa, J.N. (2023) 'Volkswagen, BASF to invest in Indonesia's EV Battery Sector', *Jakarta Globe*, April 17 [online] https://jakartaglobe.id/business/volkswagen-basf-to-invest-in-Indonesias-ev-battery-sector (accessed 25 April 2023).

	Policy documents
P1	BOI (2022) *Thailand BOI Approves New EV Package, and Over 35 Billion Baht in Large Investment Projects* [online] https://www.boi.go.th/index.php?page=press_releases_detail&topic_id=127092&language=de#:~:text=%2D%20Four%20wheelers%3A%20Qualified %20projects%20with,case% 20of%20R%26D%20investment%2Fexpenditures (accessed 22 August 2023).
P2	Government of Indonesia (2019) *Presidential Regulation 55/2019* [online] https://cdn.climatepolicyradar.org/navigator/IDN/2019/presidential-regulation-55-2019-on-electric-vehicles_e6bd4b3fbac79d9e7627188c5 938a87c.pdf (accessed 7 September 2022).
P3	AHK Indonesia (undated) 'Indonesia issues legal framework for electric vehicles', https://indonesien.ahk.de/infothek/indonesia-issues-legal-framework-for-electric-vehicles [17.03.2023]
P4	Indonesia Ministry of Investment (2020) *Brief on EV Investment Opportunities in Indonesia*, Material provided by the Tokyo Representative Office of the Indonesia Ministry of Investment.
	Research presentations
R1	Jeenanunta, C. (2023) 'The case study of EV in Thailand', *Presentation at ERIA Workshop at Waseda University*, 19 October.