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The Cost of Myanmar's Coup d'état and Ongoing Civil War

Richard Takhun

The cost of Myanmar's civil war has yet to be analysed and discussed thoroughly in academic literature. There is no sign of a resolution to Myanmar's 1 February 2021 military coup d'état, which is currently devolving into a full-scale civil war. Consequently, the country has become a hotbed of absurdity, conflict, and extreme economic hardship. This article attempts to examine the economic cost of Myanmar's civil war from 2021 until mid-2023, employing the analytical framework for assessing the American Civil War. This study shows that civil wars, such as the one in Myanmar, have a longer-lasting impact than interstate conflicts. The opportunity costs and long-term economic effects of war have been grossly underestimated in certain studies. The main argument of this article is that the civilian population, rather than combatants or military personnel, bears the brunt of the devastating effects of such a civil war. Moreover, many of these ramifications may continue to have an impact after hostilities have ended.

Keywords: Myanmar coup, economic cost of civil war, opportunity cost of civil war, reversed development, spillover impact, authoritarian economic apparatus, social cost

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1. Introduction

Will the civil war in Myanmar permanently alter geopolitical, intra-economic and financial structures of ASEAN? Conflict shatters life, health and living standards; hence, there is a direct causal link between conflict and poverty, claim Miguel et al. (2004, p. 727). Unavoidably, a significant death toll will impact the economy of Myanmar. After two and a half years under a military coup, it should be self-explanatory that the effects of the Myanmar civil war will not only be tremendously destructive, extensive and long-lasting for its own nation but also impactful for neighbouring nations with "spillover" consequences such as refugee flows, chaos and the illicit trade in minerals, weapons, and drugs.

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This paper investigates the economic consequences of Myanmar's protracted civil war. It attempts to cover the economic cost of Myanmar's civil war from the 1 February 2021 military coup to mid-2023 according to the theoretical framework for analysing American civil war costs laid out by Coclanis (1996, pp. 163–75) and Goldin and Lewis (1975, pp. 299–326). Uncertainties at this stage are enormous, and risks to the people of Myanmar and neighbouring economies are at an unprecedented level. The main objects of this analysis seem strongly biased towards the downside. Although it may be readily apparent that Myanmar's protracted civil war has triggered the most devastating economic storm and tremendous cost to its people, this topic has yet to be extensively debated in academic literature. This paper does not completely answer the question of the comprehensive overall cost of the Myanmar civil war; however, it hopes to contribute a starting point for further research, and is organized as follows:

Section 2 addresses the main methodological framework and provides the estimated cost of Myanmar's civil war (from 1 February 2021 to 31 May 2023); section 3 delves further into the economic consequences of such a civil war; and section 4 outlines the possible quantifiable and unquantifiable economic, political, social, and environmental costs.

This paper concludes that civil wars conducted on a country's own soil cause a massive loss in GDP per capita, that civil wars have more lasting impacts than interstate conflicts, and that some traditional research may have greatly underestimated the opportunity cost and long-term economic impacts of war. Furthermore, by delving deep into the available data and analysis, this paper argues that there are broader issues than quantifiable costs concerning the economic impacts of the war.

The Root of Conflicts in Myanmar

Ethnic conflicts in Myanmar are as old as the nation itself. Fêted as independent from the British in 1948, Myanmar (or "Burma", as it was then named) began its journey of ethnic disputes over autonomy and federalism. As early as 1949, the Karen ethnic group started their civil war against the central government, the year after attaining independence (Steinberg 2001, p. 5). Not long after Myanmar gained independence from the British, arguments over federalism began to brew in the courts. The Attorney-General argued that Myanmar's political system of government was "federal in theory and unitary in practice" since most minority groups would pursue their own ethnic interests and agendas to preserve and protect their cultures in their territories against policies of "Burmanization" emanating from the central government. This ignited a large circulation of discussions and arguments, followed by misunderstandings, misinterpretations, attempts of revolt and calls for autonomy and independent states.

The young administration of Myanmar was, at the time, led by U Nu's democratic administration, and he assumed that those misunderstandings and misinterpretations, coupled with armed anti-democratic and anti-freedom movements, threatened the nation's fragile government and its constitution (Christian 1951, p. 51). To maintain stability and restore law and order, the government resorted to using force, giving power to the military to unite the country under one central government, instead of political dialogue and engagement by political means to reach a resolution agreed upon by all the actors. Soon, clashes officially began between Ethnic Armed Organizations (or) Militias (EAOs) and the Myanmar central army, which excessively employ war crimes, rape, and burning villages as their main tactics to eliminate their assumed enemies, who are also Myanmar nationals.

This malpractice caused ethnic minorities to lose faith in the "national identity" (Silverstein 1996) and the "federal system" proposed by the central government, which has steadily become controlled by a "Burman" majority from 1962 to the 2010s. During this short period of control, military leaders ranging from General Ne Win to Senior General Min Aung Hlaing realized that they could capitalize on their unique position to perform military coups in the name of different causes under campaigns titled "Unite the Country", "Burmese Way to Socialism", the "Roadmap to Disciplined Democracy" and "Electoral

Fraud". Since then, Myanmar has been ruthlessly ruled by the military (also known as the Tatmadaw) which assumes, under the guise of fallacious logic, that it is itself "the protector" and that only "military praetorianism" (Croissant 2021) can preserve the unity of the state.

Its tight grip on power, ruthless takeovers and involvement in politics are probably the most durable in the world. Its creation of the longest civil war against minorities has severely plagued the country's development pattern and constrained the country's democratic transformation (Silverstein 1993). The Tatmadaw's main assumption of nation-state identity went wrong when they employed ruthless force and pursued unity of all ethnicities under one umbrella without proper regard for ethnic history, identity, culture, language, religion and economic resource-sharing. Many institutions, including the UN Human Rights Council (UNHCR), have extensively documented that the Tatmadaw has, over these six decades, committed gross human rights violations, crimes against humanity, and crimes against ethnic minorities (World Bank 2022a).

A cycle of instability and national failure has inflamed every phase of governance since a few years after the nation gained its independence. The country currently exemplifies the World Bank's concept of a "conflict trap", where a civil war is waged following a military takeover in 2021 (World Bank 2022b). At present, it does not appear to be an all-inclusive plan for a negotiated settlement. Instead, tensions are escalating as political violence and repression spread across the country.

What led to these state failure cycles, and are there any means of altering these patterns? The solutions may be simple and obvious; all the nation's issues are fundamentally political, and until there is meaningful discussion and agreement on reforms that are inclusive, equitable and just, there will never be long-term stability and socioeconomic advancement that would benefit all of Myanmar's citizens. This, however, appears to be easier said than done because complications, mistrust, political avarice, and resentment have accumulated over time and changed, creating a never-ending cycle of conflict.

1 February 2021 Military Coup

It all started with Myanmar's military establishment staging a coup and reinstating the apparatus of violent military dictatorship by deposing the democratically elected government led by Aung San Suu Kyi and several senior leaders based on allegations of electoral fraud, for which there was no documented evidence (*New York Times* 2021). The hard power employed to restore sovereignty by the Tatmadaw against dissidents was tremendously destructive to economic infrastructure, ruined the lives of its own citizens and reflected "dehumanized military objectives".

The coup has derailed Myanmar's democratic transformation and thrown the country back into a dark era of authoritarianism. Despite the torture and terror tactics of the military, which include mass killings and the burning of villages and towns that are designed to instil fear in the population, the military's aim to take over the government and governance functions in a short and quick coup remains unrealized due to the persistent actions of dissidents, armed revolutionaries, resistance and the shadow government (Lee et al. 2021).

Proponents of the civil war in Myanmar frequently use the rhetoric that such a war on its own people is a vital catalyst for social progress and a necessary instrument for consolidating a "military-imposed nationalist ideology" (Steinberg 2021). This coup has met with an unprecedented level of resistance from almost all strata of society—including ethnic minorities, students, government employees, farmers, doctors, nurses, teachers, lawyers, engineers, businessmen, young and old, rich and poor, educated and uneducated (*Al Jazeera*, 1 February 2022). It is self-evident that the irrational reality of the Tatmadaw's ultra-nationalist ideology never seemed to have much influence beyond the barracks of the army. Nevertheless, the protracted civil war in Myanmar is wreaking havoc on both the social and economic fabric of the nation.

Current Civil War Dynamic

At first glance, Myanmar's internal conflict seems to have only two sides to the coin: perpetrators and victims; the military against its citizens. However, there seem to be many different actors on the side of resistance. After the coup, the people of Myanmar felt robbed of their country and their future. The relative freedom and improving quality of life the Myanmar people had enjoyed for a decade were now gone, and their economic expectations for the future were violently reversed (USIP 2022).

Under the command of coup leaders, Myanmar's military soldiers and police forces have ruthlessly carried out a nationwide "war-like" attack on the civilian population with impunity. It is widely documented that the junta has murdered masses of civilians, killed children at schools, bombed hospitals, used rape as a weapon, imprisoned thousands, systematically tortured detainees and persecuted political opponents. Millions of people have been forcibly displaced and forced into hiding. According to Davies (1962), in such an appalling situation, citizens will resort to political violence and insurgency.

The revolution in Myanmar against the military coup began peacefully, with people banging on pots and pans every night to express their discontent with the coup, followed by nationwide demonstrations with millions of participants. At the same time, a Civil Disobedience Movement (CDM) began, with civil servants refusing to work, further undermining the military's ability to consolidate power (Bociaga 2021).

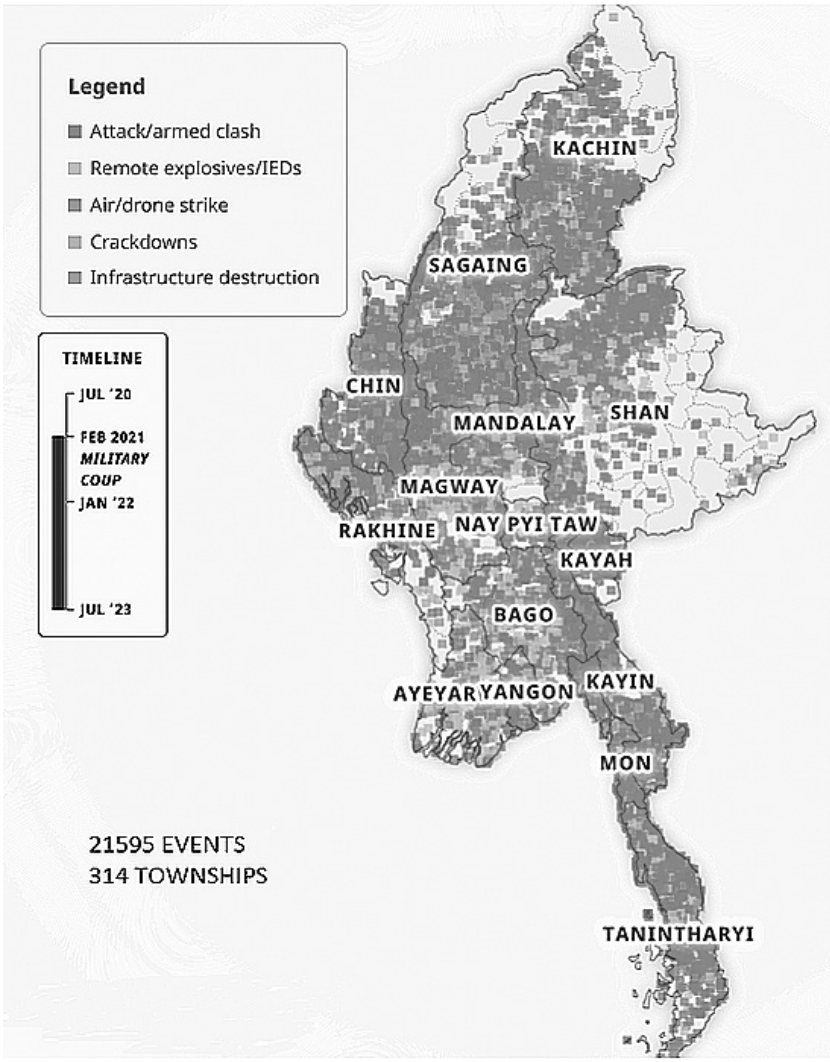
As the military intensified its crackdown against protesters with deadly force, Myanmar's youth initially responded with nonviolent tactics. After a few months, the revolution devolved into an armed conflict as shown in Figure 1. As solidarity against the regime built up, it gave way to battles with riot police and light infantry, with protesters using whatever weapons they could lay their hands on. A coup leader may have held hard power as their ultimatum, a few EAOs and business elites on the inside, and a few autocratic countries on the outside. In the opposition, the NUG (National Unity Government), the shadow government, armed dissidents, unarmed dissidents, and EAOs could all be labelled as revolutionaries.

Resistance to the military coup is broadening Myanmar's complex typology of conflict actors. Excluding EAOs, there are more than 400 People's Defence Forces (PDF) battalions and local defence forces scattered across the country, each with 200–500 troops. While some emerged as early as April 2021 in Yangon in the aftermath of the military crackdown, many, but not all, of them professed allegiance to the NUG immediately after it announced an uprising and the formation of PDFs in September 2021. The well-armed PDFs are working alongside EAOs in the southeast. However, most members of the resistance forces in the country as a whole have not been provided with a firearm (Hein 2022).

Since the coup, up to 314 of Myanmar's 330 townships have reported some kind of armed, violent battle, according to an analysis by the International Institute of Strategic Studies (Nicola 2023). Around 21,595 incidents and battles have occurred from February 2021 to June 2023, (ibid.), according to data from the Armed Conflict Location and Event Data (ACLED 2023). In the 24 months following the coup, ACLED (2023) found that political violence killed around 32,000 people, including over 20,000 killed in battle and over 7,000 killed in explosions. Northwest Myanmar had 19,000 casualties, accounting for 60 per cent of all post-coup deaths, demonstrating the shifting character of the conflict there. 13,000 occurred entirely in the Sagaing Region, while 4,000 occurred in the Magway Region. The other fighting hotspot in southeast Myanmar has also reported 6,500 confirmed fatalities, accounting for 20 per cent of the overall wounded.

During such a civil war, Myanmar society diverts the majority of its resources from productive pursuits to violence, e.g., the Tatmadaw allocating public funds to its military operations, and the resistance obtaining war funding through local contribution groups (International Crisis Group 2022). Consequently, Myanmar society suffers twice. The diverted resources are lost to productive activity,

FIGURE 1
Myanmar Conflict Map from February 2021 to June 2023



SOURCE: International Institute for Strategic Studies (IISS).

which economists refer to as rent-seeking. Because much of the increase in Myanmar civil war spending is on government troops paid for using government funds, resources are being diverted disproportionately from the government's provision of important public goods like health care, education, and civilian safety. However, whereas rent-seeking behaviours are just unproductive, a nationwide increase in violence is deadly. A portion of society has to gather resources and funds for both sides of the civil war, hoping one will win, but they are destroying one another in the same country on the exact same soil, utilizing resources endlessly.

The majority of the expenses of civil conflict are never returned to Myanmar as a factor of productivity because most guns and ammunition supplies were sourced from foreign countries such as China and Thailand borders. In Myanmar, the gun's power replaces civil rights. Men armed with weapons, can rob and murder with impunity. Beyond, the collapse of order grants impunity to criminal and antisocial activity behind a veil of chaos. Fleeing is the most common-sense reaction to the threat of theft, rape, or murder (Khattab 2022). People attempt to move their assets to safety while fleeing.

Certain limitations and caveats of this research are worth mentioning. Despite occasionally acknowledging casualties, the Tatmadaw never discloses casualty numbers. Most research institutions and organizations, such as ACLED, ISP, or DATA Myanmar, rely heavily on the news reports from Khit Thit Media, Myanmar Labour News, Democratic Voice of Burma, the Ministry of Defence, NUG, and so on. In the meantime, the NUG releases daily statistics and asserts that opposition forces have killed nearly 20,000 junta soldiers while only losing 2,000 fighters. It is difficult to confirm this, and realistic evaluations contend that these numbers may have been manipulated for propaganda. The death toll statistic is questionable, but there seems to be no other more reliable data available, so most researchers of the Myanmar civil war have to rely on these sources.

Estimating the Economic Cost of Myanmar's Civil War

When studying the cost of war, other than quantifiable direct and indirect costs, scholars are confronted with troubling questions such as: the cost of war-induced immobility, the transaction cost of psychological damage to one's life and its consequences (African Union 2006), or the cost of a deceased son, daughter, mother, or father from the perspective of the one left behind. Furthermore, quantifying the sense of severe insecurity and other unquantifiable figures behind the scenes is nearly impossible. Calculating the probable cost of the Myanmar civil war necessitates not only questionable assumptions, interpolations, and extrapolations, but also pricing the priceless—putting a monetary value on human life. However, it is critical to understand how costly Myanmar's civil conflict is, and the mechanism by which civil conflict damages the domestic economy.

First, this article calculates the direct and indirect costs of the Myanmar civil war. On top of COVID-19's economic decline, the military takeover in 2021 unleashed the country's most devastating economic storm (UNDP 2021). This research assumes that since both sides of the war incurred tremendous costs for the nation, the direct measure is computed by adding up the actual war expenditures of both sides. However, simply adding up the costs of the war effort and the value of lost physical and human capital does not adequately reflect the overall cost of the battle because it does not account for the costs of instability, business disruption, and other economic variables. Even though no comprehensive estimate of such costs has been conducted, various news organizations have vaguely speculated on the extent to which the civil war has harmed the economy. Furthermore, by equating war costs with total capital damage and military expenditure, the calculations may have overlooked both potential additional costs to the overall economy as well as instability, commercial risk and other negative consequences associated with the war (Goldin and Lewis 1975).

The military has consistently demonstrated its blatant disrespect for fundamental human rights as well as a propensity for systematic and sadistic violence against civilians. For more than six decades, it has regularly used this against ethnic groups like the Karen, Kachin, Chin, Rakhine, Shan, Rohingya and many more with complete impunity. However, the civil war after the 2021 military coup seems to have more assassinations and unintended fatalities as the fight rages on (UNHRW 2021).

The first and most serious consequence of the war is the tremendous loss of human lives. Human casualties should be included for various reasons; however, some scholars who investigated these conflict costs have overlooked them. There are several methods for calculating the number of lives lost. A human

capital approach seems reasonable if one wants to determine how much the war's effects on GDP or another measure of economic activity (Boag 1916).

2. Methodology

The cost accounting approach for the economic consequences of conflict is possibly the most direct method and is the main one used in this research. In this method, the financial value of civil war's direct and indirect expenses is simply summed together. Direct cost estimates are based on verified data from public accounts, press releases, news and statistical databases. For indirect costs, the estimate normally includes capital destruction and the compounded value of subsequent production loss (Abadie and Gardeazabal 2010).

Since other methods of war costing require a counterfactual estimate, often derived from a regression model, as well as a theory regarding the interest rate to be used in computing the combined value, such production loss estimates are open to criticism (Goldin and Lewis 1975). Therefore, the straightforward approach of determining war costs, which involves adding up all costs and losses associated with the war and is referred to as the "direct" estimate, is preferable for calculating Myanmar's civil war estimate, given that there is no concrete information available on both Tatmadaw's and the opposition's sides. This statistic takes into account war expenditures as well as the loss of both human and material capital during combat.

The Direct Cost of the Myanmar's Civil War

In general, the direct estimate of the cost of the war covers all war expenses, including those incurred by the Tatmadaw and the resistance, as well as the value of lost human lives and physical capital. However, this article does not account for the losses owing to the disruptive impacts of the conflict, and any large spillover effects from Myanmar's civil war. The direct economic cost of conflict can be defined as a decrease in output from some initial equilibrium condition. Most obviously, the approach includes explicitly accounting for human losses and infrastructure destruction, but it does not account for misery, anguish and increased uncertainty (Collier et al. 2003).

The most significant economic losses from civil war, however, result not from the waste created by diverting resources from production, but from the damage triggered by diverted resources when employed for violence. The greatest apparent cost is the direct damage to public infrastructures and over 80,000 civilian houses (ACLED 2023). Resistance troops also assault physical infrastructure during the fight and sabotage their enemy's communication support lines, such as telecoms, electricity grids, highways, and bridges (Davis 2023). Aside from strategically destroying important infrastructure, Tatmadaw soldiers plunder and destroy residences, schools, and health care facilities (Abuza 2023). Since infrastructure is an essential determinant of economic growth (Canning and Pedroni 1999), such an extensive loss of infrastructure is destined to have a significant impact on the overall economy of an emerging Myanmar.

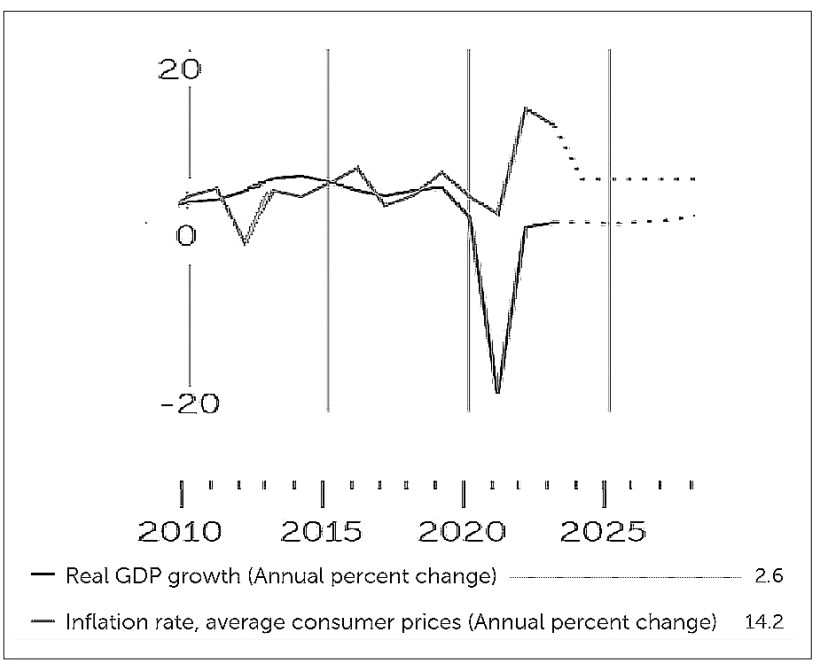
The direct cost of the war to the Tatmadaw is much simpler to calculate than that of the resistance's. Since there are no reliable sources or records on the resistance's side, this paper has made possible estimates based on available data. Despite being at war, both Tatmadaw and the opposition belong to the same nation and are fighting on the same soil, suggesting that their combined military budgets should be pooled because the cost incurred in this civil war is on the nation. According to the data that is currently accessible, the opposition appears to have a budget of roughly US$100 million, compared to the Tatmadaw's enormous budgets of US$2.10 billion (2001), US$1.78 billion (2022) and US$2.70 billion (2023), for 2021, 2022 and 2023 respectively (Knoema Data 2022; *The Irrawaddy*, 10 April 2023a).

It is vital to remember that this is only an estimate and is not accurate. Numerous aspects, like the contributions of local donor cells to this fight and numerous unquantifiable elements, are outside the reach of this article.

Reduced GDP as an Opportunity Cost

Opportunity cost is defined as the value foregone when making a specific choice (Buchanan 1991), and Myanmar's full-fledged civil war had, or is having, a huge opportunity cost on its real GDP (Figure 2). In the end, the primary indicator of current economic conditions in this paper is annual GDP per capita income, owing to its near universal availability rather than overarching theoretical considerations. A straightforward addition of direct and indirect costs does not provide a sufficient estimation, so this paper creates an opportunity measure using the "GDP" difference. An estimate of the cumulative loss of output over 2021–23 can be obtained by valuing the deviations of actual real Myanmar GDP from trend real GDP, which is assumed to have been attained in the absence of the war. The methodology for calculating the opportunity cost of war is based on the assumption that the pre-conflict allocation of the area's resources is efficient and that the conflict disrupts this equilibrium—primarily by the diversion or destruction of these resources. The Myanmar civil war's short-run output losses are thus determined by the diversion, depletion, and destruction of the initial resource base, whereas the long-run losses are mostly dictated by the rate with which the pre-conflict growth path is regained by reallocating the resources. Such resource

FIGURE 2
Estimated GDP Growth in Comparison with Consumer Prices



SOURCE: IMF (2023).

allocation adjustments, even if fully reversed later, result in deadweight and irrecoverable losses (Judd and Schiavo-Campo 2005).

War has a propensity to lower GDP per capita as measured, in addition to the loss of life and damage of physical and human resources that national income accounting ignores. War-torn nations perform worse than other nations both in terms of production and consumption. GDP per capita declines as a result of lower labour and total factor productivity, which is most likely brought on by the depletion of already-existing physical and human capital, a lack of investment in the creation of new physical and human capital and decreased gains from both domestic and international trade (Collier 1999).

Estimated Cost of Myanmar Civil War

Due to the severe limitations of data availability and the secrecy of Myanmar civil war actors, only a broad range of cost estimates are possible. Using the above civil war accounting technique and assuming a substantially lower direct economic conflict cost throughout the "high and low intensity" conflict period of February 2021 to June 2023, the direct output loss from the Myanmar civil war can be hypothetically calculated at between US$25 billion and US$26 billion (as shown in Tables 1 and 2).

Tables 1 and 2 show an estimate of the cost of the Myanmar civil war which factors in direct war appropriations (both parties' estimated cost), human capital loss and destruction of civilian properties and humanitarian aid cost as well as an opportunity cost.

3. The Economic Impact of the Military Coup in Myanmar

Development in Reverse and Resuming Authoritarian Economic Apparatus

Civil wars have far-reaching economic, social, and environmental consequences. Because of large-scale population displacement, significant losses, and millions of refugees, civil conflicts are often more deadly than foreign battles (Collier 1999; Janus and Riera-Crichton 2015). The assumption that civil wars involve substantial economic losses and high opportunity costs of warfare is not exaggerated (Besley and Persson 2009), especially in Myanmar. Myanmar's political economy after the coup can be best described as adverse to growth and backward in development. As the country's economy developed from a closed-door economy towards open-door policies between 2011 and 2020—during the short period of democratic transformation—Myanmar enjoyed the highest growth of GDP in its history (World Bank 2022), and real income per head was multiplied potentially more than three times.

There is evidence that the junta is reinstating an authoritarian economic apparatus. After the coup, military leaders began to take control over the country's economic decision-making, and all economic policies were started within authoritarian central control rather than being market-driven. In the long term, the authoritarian cabinet instituted by the Tatmadaw will have profound impacts on the nation's policy infrastructure (Turnell 2023). More broadly, the authoritarian junta has reduced the effectiveness of many critical economic institutions, including the central bank, the ministry of finance, tax authority, and commercial courts. Institutional and economic disruptions were many times more costly than capital destruction in the Myanmar conflict. The Myanmar state economy began to function without economic fundamentals, resulting in the formation of a massive black exchange currency market and informal trading practices governed by nepotistic patron-client relations between the military, the state, elites and companies. Such interruptions to economic progress are associated with falling levels of investment, a dried-up foreign exchange rate, poor harvests and depressed trade.

Ever since the coup leaders replaced the directors of the Central Bank of Myanmar (CBM), the central bank has changed. The CBM has allowed the junta to check all the bank deposits, accounts, and

TABLE 1
The Direct Cost of Civil War in Myanmar (from 1 February 2021 to 31 June 2023)

The Direct Cost of Civil War in Myanmar	*US$ million*
Tatmadaw's Military Expenditure[a]	5,230.00
EAOs' War Expenditure[b]	150.00
PDF Forces Own Expenditures[c]	50.00
NUG's War Expenditures[d]	100.00
Human Capital Loss[e]	4,672.00
Destruction of Civilian Properties[f]	819.00
Destruction of Public Infrastructures[g] (roads, bridges, electricity grids, schools, hospitals)	200.00
Humanitarian Aid Cost[h]	152.92
Total	11,373.92

NOTES:

a. Tatmadaw expenditures are based on two and a half years of military operations (2021, 2022, and the first half of 2023).

b. It would be unreasonable to exclude EAO expenses when estimating Myanmar's civil war cost, despite the fact that some EAOs have been fighting Tatmadaw for more than 70 years. However, the following facts are assumed in this study. From 1 February 2021 to 31 June 2023, there have been approximately 20 EAO groups with approximately 80,000 professional military personnel. According to ACLED data, EAOs fought in 2,584 violent battles against the Tatmadaw over this time period. Their battles had been larger and greater in significance than guerrilla warfare of PDF. The conservative estimate for the cost of these fighting engagements and the entire welfare of 80,000 troops, such as uniforms, meals, ammunition, training, medication, and so on, is expected to be US$$150 million, but can reach US$1-2 billion.

c. Resistance fighters and supporters have amassed significant funds both inside and outside the nation to fund their battles aimed at undermining the junta. The majority of it has been raised online. Their reliance on crowdfunding, in particular, contrasts with the established EAOs, which prefer to derive cash from taxes within their own region. There are few options to crowdfund in Myanmar's post-coup resistance, which is primarily done online. Most PDFs raised funding individually and therefore could equip themselves and make battles against the Tatmadaw. The following facts are assumed in this study. From 1 February 2021 to 31 June 2023, there have been approximately 500 PDF groups with approximately 65,000 professional soldier personnel. According to ACLED data, PDFs engaged in over 10,000 violent battles against the Tatmadaw over this time period. Basic food expenses for 65,000 people for one year already cost a staggering sum of over US$21 million if we assume US$1 per person. Therefore, their own source of funding before receiving NUG support is estimated at least US$50 million conservatively.

d. During the period, the shadow government has already raised over US$100 million.

e. Another element of the cost resulting from civil war deaths is taken as the expected wage rate of those killed. This is summed up over all years. Hypothetical earnings for those who were killed are calculated using weighted averages of actual minimum wages of 2023. There were over 32,000 people killed in this civil war according to ACLED data.

f. According to ISP-Myanmar data, at least 81,899 houses and buildings (including religious facilities) have been burnt and destroyed in violent riots since the military coup from February 2021 to June 2023. 24,138 of them were destroyed by fire in the first six months of 2023, accounting for about 30 per cent of the total. This paper assumes that the average cost of a house ranges from 10,000,000 (US$3,000) to 50,000,000 kyats (US$15,000) without accounting for inflation.

g. During the indicated period of Myanmar's civil war, according to the *Asia Times*, economic infrastructure such as bridges, electricity grids and water utilities, education and health facilities as well as communication towers

and grids have been destroyed, resulting in lower productivity and revenue creation. Infrastructure destruction exacerbates a variety of socioeconomic repercussions on health, politics, technology, society, economy and education. The exact data on infrastructure destroyed is beyond this paper's reach, and therefore estimated conservatively only US$200 million although infrastructure and all the reconstructions could amount up to over US$1 billion nationwide.

h. Since the military takeover on 1 February 2021, Myanmar's people have encountered unprecedented political, economic, human rights, and humanitarian challenges as a result of security and conflict dynamics. Almost half the population is expected to be impoverished by 2023, wiping off the development achievements recorded since 2005. Since 1 February 2021, about 1.2 million people have fled their homes, bringing the total number of internally displaced persons (IDPs) in Myanmar to a startling 1.5 million as of 26 December 2022, with no signs of slowing down in 2023. Although local donation organizations contribute some additional resources on this, this study exclusively takes data from UNHCR publicly released statistics.

Sources: Trading economics, World Bank, *The Irrawaddy*, UNOCHA, UNHCR, *Bangkok Post*, Institute for Strategy and Policy – Myanmar, *Frontier Myanmar*, ACLED, *Asia Times*.

TABLE 2
The Loss from Overall Economy, GDP

The Opportunity Cost of Civil War in Myanmar	*US$ million*
Opportunity cost (the loss GDP 2020–21)[a]	13,840.00

Notes:
In calculating the opportunity cost of the Myanmar coup, this paper only considered GDP differences between 2020 and 2021. However, as previously stated, there can be many other opportunity costs, and while some can be valued in monetary terms, a significant proportion are extremely difficult to quantify (see No. 6 and Table 3 for more information).
Sources: Trading economics, World Bank, *The Irrawaddy*, UNOCHA, UNHCR, *Bangkok Post*, Institute for Strategy and Policy – Myanmar, *Frontier Myanmar*, ACLED, *Asia Times*.

safe deposit boxes (Central Bank of Myanmar 2022). One example of arbitrary and erratic economic policy was the CBM's shocking directive of within a 24-hour conversion from foreign currency to kyats, which left people perplexed about how to proceed with any businesses, exports, or imports, as well as engaging with foreign experts and firms (*The Irrawaddy*, 6 April 2022a). That was a desperate attempt by the CBM to limit the foreign currency outflow and regain control over the entire economy through a clear authoritarian control mechanism. As the destructive momentum of the conflict grows, the country finds itself resource-constrained, and the junta increases its extraction of revenues from the population, such as by raising communication and Internet taxes, hijacking all US dollars in banks with a set exchange rate much lower than the real rate, tightening imports and exports, forcibly exchanging foreign workers' remittances, and so on.

In recent years, Myanmar has been assessed by various international metrics as one of the most dangerous countries for doing business, and it is on the verge of collapse because of its authoritarian

governing apparatus (VOA News 2022a). Myanmar's economy was beginning to gain momentum in 2015–20, and most economic decisions were then governed by free-market mechanisms and a floating exchange regime scarcely interrupted by the government. The coup leader's planning cabinet now imposes restrictions and determines what to import; what is produced, and how; who will get electricity; who will be allowed to get the foreign currency; and how fuel will be imported and distributed. Myanmar's economy has become an arm of authoritarian rulers whose primary goal is controlling "power" rather than societal needs. The Myanmar economy now is "less predictable, less clearly communicated, and characterized by more discretion" (World Bank 2022b), as it functions in a hierarchy and is subordinate to the commanding power, which has harshly reversed the process of the country's economic development.

The macroeconomic crisis in Myanmar is enormous. Since the Myanmar conflict is a civil war, both sides' expenses were forced to be extracted from the country's resources. Given its control of the CBM, the assets of the state, and its ability to exert pressure on the private sector, the military administration has a considerable economic advantage over the resistance (International Crisis Group 2022). It has, however, had difficulty sustaining economic stability as a result of an amalgam of strong political resistance to its rule, external influences, economic sanctions, its depleted foreign exchange reserve, the severe economic shock of the coup and its own economic mismanagement. By enforcing severe capital restrictions, restricting imports, printing more money and holding the exchange rate unrealistically high, the junta has made the problem worse, further weakening trust in its competence.

Economic Impact on the People: Living in Myanmar Is Now Absurd

The civil war has brought reduced incomes, extreme inflation, rising commodity and fuel prices, extreme electricity shortages and difficulty accessing cash that further compound food insecurity, particularly for the common people at the bottom of the pyramid who have almost no savings. Soaring prices and movement restrictions, combined with persistent insecurity, have left the most vulnerable people struggling to access even basic food and supplies, which are becoming increasingly scarce, while their safety, well-being, and quality of life have drastically declined. Prices for key household commodities in some states and regions, such as Chin State, Rakhine State, and Kalay Region, have risen significantly, up to three or five times more since the coup, making some food items increasingly unaffordable. For most people, after losing their jobs because of the conflict, selling assets became an increasingly popular coping mechanism over time.

According to the World Food Program (2023), 15.2 million people (about 25 per cent of the population) are estimated to face food insecurity in Myanmar, and half the population is now below the poverty line. COVID-19 impacted the consumption of people in the bottom 40 per cent of the distribution and saw a 14 per cent drop from 2019 levels. However, after the coup, consumption was even further reduced among the vulnerable bottom 40 per cent and dropped by 25 per cent further (Karamba and Salcher 2022). More specifically, 36.9 per cent of households towards the end of 2022 and 42.1 per cent by mid-2023 relied on asset sales to mitigate the impact of the income shock. As some of the items sold were means of production (e.g., cattle) or earning money (e.g., a motorcycle and a boat), households risk remaining in poverty for an extended length of time (UNDP 2021).

Under the mismanagement of military coup leaders, Myanmar is now back to an even darker age (literally) as compared to 2010 and is now facing a severe shortage of electricity, with only 2–3 hours available per day even for big cities like Yangon and Mandalay (VOA 2022b). A severe shortage of electricity pushes up the cost of production and restricts the fundamentals of economic activity in the market. All the businesses have to rely on their own generators for electricity, so running businesses becomes extremely expensive.

Even as global inflation rises as a result of Russia's war on Ukraine, the kyat's value continues to fall against the US dollar, as shown in the Appendix. Therefore, Myanmar industries' supply side was enormously impacted by the coup's shock. This "lost value" of the Myanmar kyat pushes foreign exchange rates very high (*Frontier Myanmar* 2022), and all the input costs for production and all imports rise along with fuel costs. Hence, most commodity prices in the consumer market saw a three- to fivefold increase in many areas of the country.

The effects of the coup leader's mismanagement of the economy are felt most intensely by consumers wrestling with the impacts of the civil war. Myanmar's people are more vulnerable than before the coup, and now most spend a relatively large proportion of their income on food. However, the relative incomes of Myanmar's people have become 15 per cent lower than before.

The rising cost of supply and very low demand in the market compelled some factories to shut down, and workers lost their jobs in massive layoffs. The International Labour Organization (ILO) estimates that over 1.6 million workers have been laid off (ILO 2022). Workers with faltering confidence returned home to their villages, adding the pressure of financial difficulties to the village families. The majority of them may eventually be forced to look for low-wage jobs in neighbouring countries, particularly Thailand, China, Singapore and Malaysia (*The Irrawaddy*, 18 August 2022b). This coup's aggregate shocks have immensely wounded business, household and individual incomes, on top of existential threats.

Since the 2021 military coup, more than 80,000 villager homes have been blasted and burned to the ground. Their goods, including motorcycles, bicycles, and furniture, as well as food storage, were looted (ACLED 2023). Their animals had been stolen, slaughtered or burned alive by soldiers who killed them to instil terror. One of the four "cut" strategies of coup plotters in warfare is cutting all the supplies, food and medicines, including the Internet and mobile data. Internet and communication outages usually occur after the military intensifies its raids on villages (*Myanmar Now*, 4 March 2022a). According to the Global Centre for the Responsibility to Protect (GCR2P 2023), disruptions to the Internet and communication systems severely limit information availability throughout the country. Coup plotters have ordered all telecom operators to cease service "indefinitely, especially in the military operation areas, while tripling the price of mobile data nationwide" (Nachemson 2022). Internet access has been restored in military-controlled places such as Yangon and Mandalay, although outages and blockages remain in anti-junta strongholds. As of September 2022, 54 of the country's 330 townships were without Internet (*Myanmar Now*, 4 March 2022a).

The severe impact of long-term communication disruption is first felt by the most vulnerable people, especially when they need medical assistance; secondly, on the transportation and distribution of basic goods such as medicine and food to affected communities, as drivers are unable to judge how safe the roads are to travel on; and thirdly, on the whole economy with far-reaching consequences because of the internal complexity and high levels of interdependence between infrastructures, communications, electricity, and the effectiveness of the division of labour.

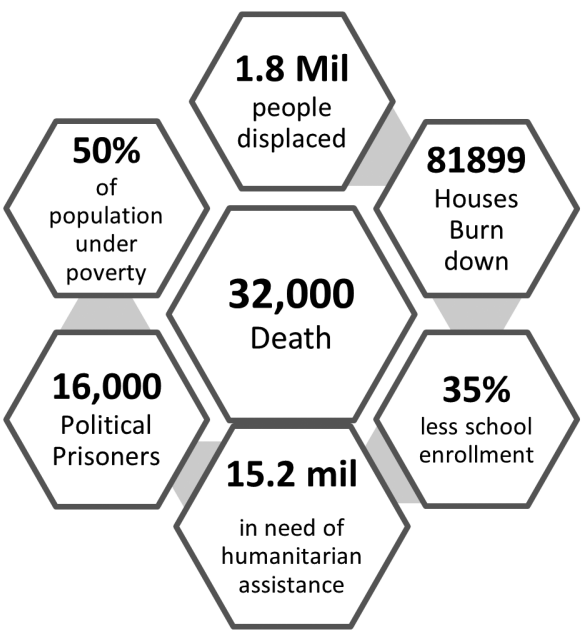
When faced with the threat of such losses, people tend to protect their assets by relocating capital abroad, if possible (Fielding 2004), and wealthy Myanmar citizens have purchased condominiums in Bangkok, Thailand during this crisis (Katharangsiporn 2023). On the other hand, it is rational that most investors are likely to pass on Myanmar, where market fundamentals such as security, law enforcement, and basic infrastructure, are lacking. Coup leaders may already be on their way to agreeing to some Chinese projects, such as dams, power plants, and seaports. They are negotiating future Russian deals for fuel and are allowing currencies such as Thai baht, Russian ruble, and Chinese yuan for trading and exchange purposes. This, however, does not mean that the US dollar is not necessary, especially to buy weapons for further military operations (Reuters 2022). The majority of these projects, however, do not generate economic benefits or a factor of productivity for the country because of high levels of corruption and rent-seeking.

Social and Humanitarian Crisis of Myanmar's Civil War

Civil war's most direct human consequences are fatalities and the displacement of people. Approximately 90 per cent of the casualties resulting from the Myanmar civil war are civilians. It has intensified, and before the end of this tremendously destructive and fierce battle, Myanmar could fall to pieces. People in Myanmar are now facing serious challenges as a result of lost jobs and diminished livelihoods. Challenges also include providing widespread access to basic services and social safety nets, creating the necessary fiscal space, and containing the conflict that is spreading throughout the country and resulting in growing insecurity among civilians. This current conflict has left 15.2 million people in dire need of humanitarian support, according to the United Nations Office for the Coordination of Humanitarian Affairs (UNOCHA). Clashes and targeted attacks between actors continue across the country. The number of casualties has increased, while many villages, small towns, houses and other civilian properties have been burned down or destroyed. As a consequence, this situation has pushed a tremendously large population (1.8 million people) into displacement and the trend is on the rise (Figures 3 and 4) (UNOCHA 2023a). The country is now set back into a poverty trap and nearly half of Myanmar's population is now living below the poverty line (Figure 5) (UNDP 2022).

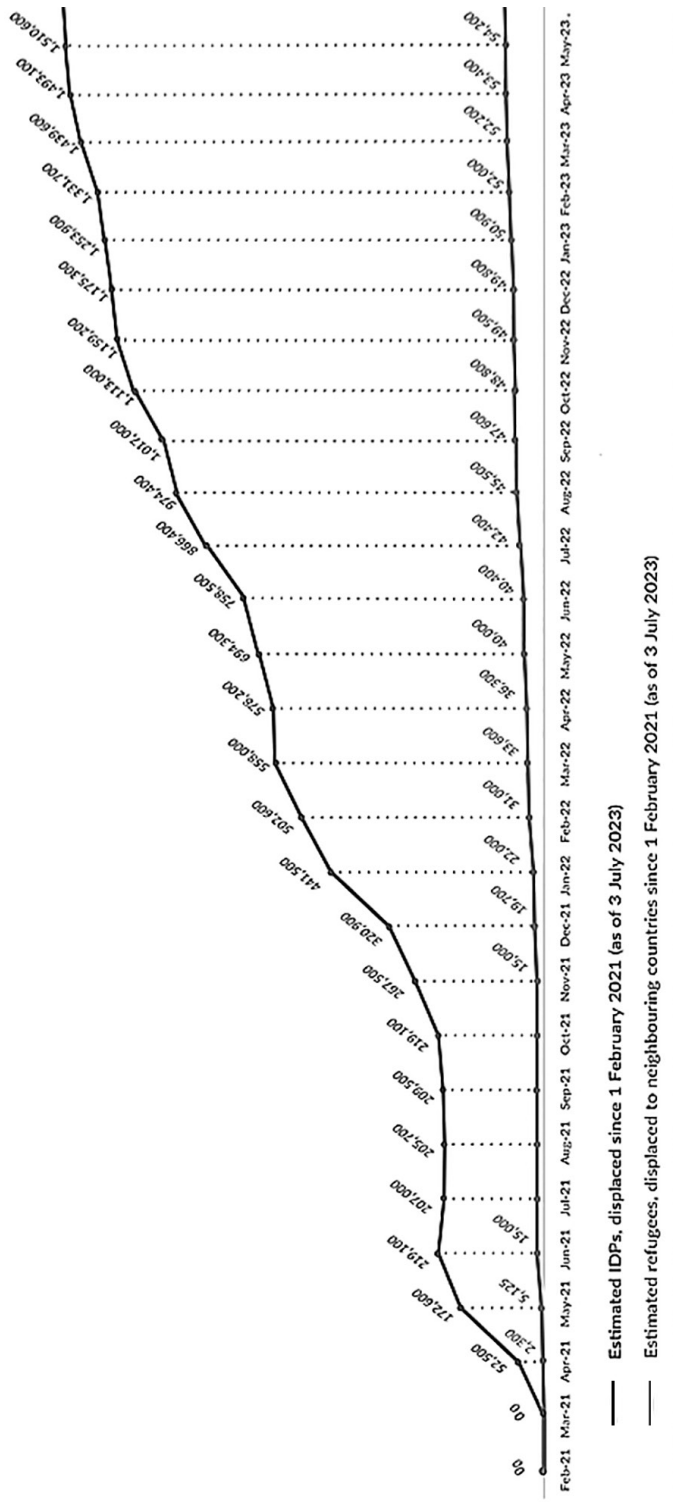
The northwest part of Myanmar, including Sagaing, Magway, and Chin (as well as Thai border areas), has recorded the highest level of conflicts and new internal displacements, followed by the southeast part of Myanmar (Kayin, Kayah and Shan). These vulnerable displaced populations face significant challenges

FIGURE 3
Social and Humanitarian Crisis of Myanmar's Civil War



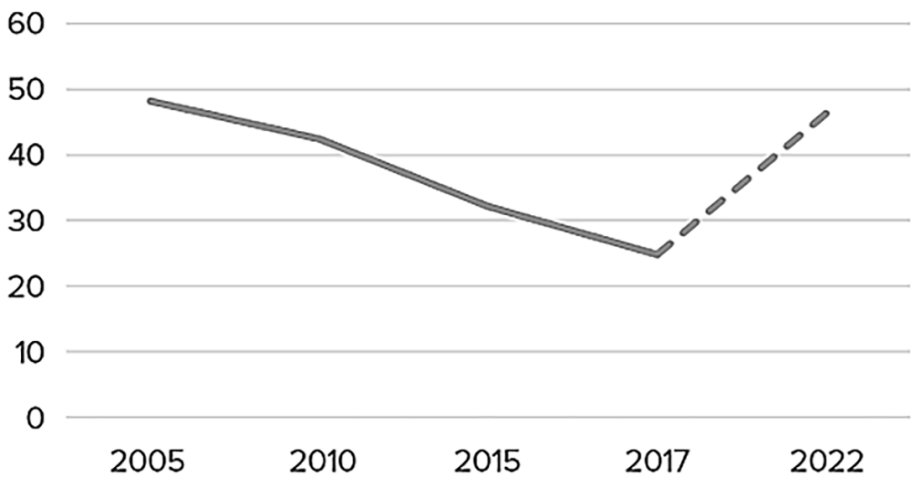
Sources: AAPP (2023), ISP Data (2023), ACLDE (2023), UNHCR (2023), WFP (2022), UNDP (2023).

FIGURE 4
Displacement Trend



SOURCE: UNHCR (2023).

FIGURE 5
Myanmar's Poverty Headcount (%), 2005–23



SOURCE: UNDP (2023).

in accessing basic needs, specifically food, healthcare, shelter materials, clean water, and sanitation facilities. Women, children, and persons with disabilities (PWDs) are particularly vulnerable amid this crisis, exposing them to risks of exploitation and abuse. In particular, children are facing all forms of conflict-related violence, including killing, physical injury, trafficking, recruitment and use in armed conflict, sexual violence, arbitrary arrest, and unlawful detention of adolescent girls and boys. Although the impact of the Myanmar crisis could be somewhat comparable to the extent of the parallel crisis in Ukraine, the aid received in Myanmar seems to be less than 10 per cent of that in Ukraine, and only 28 per cent of the needed humanitarian response has been funded, according to UNOCHA (2023b). The Myanmar conflict's urgency and its humanitarian situation are dire, but even agreements on humanitarian corridors are holding.

According to the INFORM Risk Index (2023), Myanmar scores highest with a 10/10 for hazards and human conflict exposure, 9.2/10 for hazards and exposure, and 5.5/10 for vulnerability, with development, deprivation, and inequality being the most serious problems. Its institutional capacity became too low after the coup and ranks a 6.1/10 lack of coping capacity for hazards, exposure, and vulnerability.

Opportunity Costs and Other Costs of Myanmar's Civil War

Civil war has a political rationale for resistance forces in Myanmar; it serves as a catalyst for societal change. It is a revolution to end militarism and establish federal democracy. For the Tatmadaw, the definition of "nationalism" is confined to the Tatmadaw, the ultimate leader of the nation, and it is primarily supported by soldiers. Hence, most fighters might accept the terrible costs incurred and collateral damage suffered during the war as a high but necessary price to pay for future reforms. However, it is far from

being a catalyst for beneficial change; the civil war in Myanmar seems to leave a persisting legacy of poverty and misery.

There is a huge opportunity cost and other costs (Table 3) as a consequence of such a military coup. The total loss of income, including direct costs, opportunity costs, and other costs as mentioned in Table 3, during the Myanmar civil war could be around 50 per cent of a year's GDP. This is significantly greater than the loss directly caused by the extra government military spending, implying that the majority of the costs of war are due to the negative effects of violence rather than simply the waste of money.

What if, on the other hand, the military coup could have been prevented, and we assumed there was no civil war in Myanmar? What kind of economic opportunities would there have been in democratic

TABLE 3
The Cost of February 2021 Coup and Conflicts (as of June 2023)

Physical cost	Over 32,000 people killed (both parties)
	Above 13,000 people detained
	Thousands injured
	Above 400 villages and small towns looted by the military
	Above 38,000 residences, houses burned down by the military
	Over 1.6 million lost jobs
	Destruction of infrastructure
	Over 1.5 million people displaced internally
	Severely reduced mobility
	Increased cost of veterans' care and disability
Psychological cost	Moral degradation
	Insecurity
	Fear
	Suicidal ideation
	Risk of mental challenges
	Risk of psychological distress
	Post-traumatic stress disorder (PTSD)
Direct economic cost	Economic shrinkage of 30 per cent and counting
	Loss of international investments and FDI
	Soaring unemployment
	Hyperinflation
	Economic sanctions
	Banking crisis
	Raised national debt
	Doubled or tripled commodity prices
	Near failed economy
	Inflow of foreign currency restricted
	Collapse of many SMEs
	Surmounting war expenses (Tatmadaw, PDFs, EAOs)
	Electricity shortages

continued on next page

TABLE 3 — *cont'd*

Indirect cost	GDP losses Raising poverty Food shortages for 14.4 million people Collapse of the healthcare system Crippled education system Emergent of large black-market economy The rise of corruption, rent seeking, elitism, cronyism Future cost on the borrowing Future interest on war borrowing
Social and political costs	Serious human rights and civil liberty violations, including detention without trial, rape, torture, arrest, killings and burning civilian houses Tremendous increase in surveillance, and racial profiling Weaponizing laws against citizens Psychological destruction of millions of women and children Media and communication restrictions Reduced availability of doctors Reduced availability of medical care Less school enrolment Shortage of teaches Shortage of government staff
Environmental costs	More trees cut down Over-exploitation of natural resources Collapse of regulatory and environmental oversight institutions Frequency of heatwaves, floods, cyclones, droughts, and rising sea levels
Spillover impact on neighbouring countries	Illicit trade Borderline chaos Arms trade Drug trade Human Trafficking Refugee inflows

Myanmar under the NLD government? While there can be a lot of speculation and a lot of would-have-been scenarios, most economists will agree that the Myanmar economy would have improved further. Therefore, the opportunity cost assumption would include investing war dollars in alternative sectors and the normal rate of increase of the Myanmar economy (GDP) if there is no coup.

Some of the facts are unjustifiably and unquantifiably complex, e.g., psychological transaction costs, and the social cost of reduced doctor availability. A general understanding of the budgetary costs of the Myanmar civil war is further limited by the secrecy of local revolution units, faulty accounting and the deferral of current costs. The current civil war in Myanmar has been financed almost entirely by Myanmar nationals, both inside and outside the country, mainly raised online and through crowdfunding;

transactions have been secretly made to the dispersed armed cells. War spending has resulted in enormous opportunity costs for the Myanmar economy because most arms and artillery were sourced from the black market and from neighbouring countries. Military spending in Myanmar does not create jobs but rather reduces them by up to 1.6 million, resulting in the total failure of healthcare and schools, on top of the macroeconomic cost of normal GDP growth. Furthermore, non-military public infrastructure investment, such as roads and schools, has not increased but has decreased as much as the investment in military infrastructure.

Regarding the psychological cost, as lived experiences in this civil war show, it has caused severe psychological distress among communities of Myanmar people. War-related deaths are just the tip of the iceberg, but mental disorders and psychological illnesses are paramount on top of endemic poverty, malnutrition, infirmity, and economic and social deterioration. There is a growing corpus of studies highlighting increased mental distress in such a war, such as sexual abuse, issues of safety, fear, instability, health, sickness, the economy, and so on (Murthy and Lakshminarayana 2006). This civil war has changed the way the subordinated side sees itself, its worldview, and its political opinions, from ordinary citizens to dissidents. This reversal in identity and perception opens the door to the possibility of normative and behavioural shifts that could impact the subordinated side's political system. If we can conduct a thorough study on such psychological costs, it would be beneficial to conduct more research on uncertainty and mental anguish in Myanmar. Many studies in other countries show that trauma, as seen in conflict and post-conflict situations such as Myanmar, causes significant mental stress and associated social problems, as well as medically defined PTSD syndromes, anxiety, and depression, all of which cause significant morbidity and retard development even after the war has ended.

In addition to instilling terror in the population, the Myanmar military is able to manipulate laws in its favour. In the hands of the leaders of the military coup in Myanmar, laws became weaponized and were manipulated as part of the dictatorial apparatus that criminalized doctors for saving lives, teachers for teaching children, young people for peacefully protesting and donors for donating to the IDP camp. The entire legal system has been overhauled, and most of the laws used by former dictators have been reinstated. There are no longer civil rights to privacy and security that would protect against arbitrary arrest, search, or seizure. The junta has also amended the Penal Code (505) to crack down on civilians who speak negatively about the coup and the military, and to suppress supporters of the "civil disobedience movement" (Kyaw 2022). It has also amended the Ward and Tract Administration Law, which dates back to the British colonial era, to reintroduce mandatory registration for overnight guests, which means that police can enter any house at any time of day or night and search anyone without a warrant. With the amendment of the Criminal Procedure Code (Human Rights Watch 2021), anyone can now be arrested without a warrant in Myanmar. In addition, to control the flow of information on social media, mainly targeting 22 million Facebook users, the Electronic Transactions Law was enacted (*Myanmar Now*, 19 February 2021), which allows the arrest of anyone for spreading information in cyberspace, including criticizing coups and dictators. Simply put, the junta can now put anyone in jail for Facebook and other social media activity if it deems it necessary.

Furthermore, the military takeover of Myanmar in 2021 has severely interrupted the education system of Myanmar, forcing many current and prospective university students to pause their studies, and increasing fears among educators about the country's learners' future. Such a war will likely also have negative effects at the school level in terms of the number of teachers, instructional quality, and the provision of educational activities, which are exacerbated by lower education budgets as local, regional and federal government resources are transferred to the war effort (Jones et al. 2022). Since the military coup in 2021, schooling has been disrupted by the following factors: recruitment into the armed forces or organized youth movements; destruction of school infrastructure and records by occupying forces; inability to concentrate on education due to trauma and stress; and loss of educational aspirations due to

fears of prolonged insecurity. It is now projected that the school enrolment figure has decreased by more than 35 per cent.

Besides having an extremely small budget compared to the military budget, Myanmar's public health system has basically collapsed since the coup, with many healthcare personnel jailed or targeted by the military for their association with the civil disobedience movement (CDM). Before the coup, people with healthcare needs could be managed by local clinics and hospitals. Now, many healthcare providers, doctors, and nurses are taking part in CDM, and universities are closed due to faculty shortages of teaching staff in clinical fields caused by CDM involvement (Sarli, D'Apice, and Cecchi 2021). People must now seek assistance and pick up daily medications (e.g., hypertension, diabetes and/or HIV medication) in surrounding towns. When neighbourhood clinics run out of medicines, patients are forced to travel further, only to pay even higher fees for their medications. Travelling to remote areas, however, is not always possible due to a scarcity of gasoline and increased casualties. Treatments in privately run hospitals are now extremely expensive because of high inflation (Insecurity Insight 2022). Due to this situation, many Burmese have relocated to neighbouring countries for healthcare, and those who are unable to travel have abandoned their healthcare. Although there are no statistics yet available on deaths due to a lack of healthcare, the death toll from such a lack of care is significant and on the rise.

On the environmental front, Myanmar has a long history of state-sanctioned overexploitation of natural resources ranging from minerals and precious stones to forests and oil and gas, which has resulted in a polluted and degraded environment, human rights violations and decades-long conflicts. Because of its vast coastline, which stretches approximately 2,000 kilometres on its western side, the country has always been subject to the effects of natural calamities. The majority of the population lives in low-lying areas where poverty is prevalent. However, after the military coup of 2021, civil society groups and organizations that used to encourage the government to be more equitable and environmentally friendly have been silenced. Some of them have fled. These environmental advocates are targeted by the military, which seeks to suppress criticisms of the junta's environmentally harmful actions and corruption-ridden infrastructure projects. Myanmar was ranked second most vulnerable to extreme weather occurrences in the 2021 Global Climate Risk Index out of 183 countries. Climate change poses a serious danger to livelihoods and sustainable development by increasing the frequency of heatwaves, floods, cyclones and droughts, as well as rising sea levels, all of which influence production, food security and land scarcity. Since the coup, regulatory and environmental oversight institutions have collapsed, leaving local populations with nowhere to turn to file concerns about the consequences of extractive projects on their land rights, local environment and livelihoods (Kyed and Chambers 2023).

Nations bordering Myanmar are experiencing "spillover" consequences from refugee flows, sickness, chaos, and the illicit trade in minerals, weapons, and drugs (De Groot 2010). Myanmar is becoming a region of instability and disorder as a result of the multilayered coup crises and destabilizing forces in power, with consequences that reach beyond its boundaries. Previously, such military coups have resulted in instability and spillover, but the expanding scope of this iteration makes the situation far worse for Myanmar's neighbours than before. The Myanmar-Thai border, Myanmar-China border, and Myanmar-India border regions have seen an unprecedented increase in drug trafficking this year since General Min Aung Hlaing seized power on 1 February 2021. Myanmar's post-coup civil war and cash shortage have reduced narcotics enforcement capacity and allowed traffickers free rein (Reed 2021). Myanmar's regional stability, regional security and long-term development are jeopardized due to the impact on confidence and social cohesion. The crisis has also spread to these bordering countries, causing problems that are expected to persist, such as economic strains caused by hosting refugees. Countries bordering Myanmar's high-intensity conflict zone experienced a decrease in economic activity, except for a few positive economic gains such as brain gain and asset movements from vulnerable people.

4. Conclusion

As of June 2023, the direct and indirect costs of Myanmar's civil war ranged between US$25 billion and US$35 billion, and they continue to rise. As illustrated in Table 3, there may be many more aspects to consider when calculating the total cost of the coup. Even though this study has examined only the possible costs of civil war within Myanmar (within its limited reach of data), it has been shown that the majority of suffering caused by civil war occurs to non-combatants, mainly villagers, who are generally powerless to negotiate or settle the conflict. Therefore, civil war inevitably destroys far more than just physical plants and infrastructure. The essence of the damage is done to society's economic fabric and, moreover, to the very fundamentals of social capital: trust among actors.

After the coup, Myanmar's economic policies were reset by the junta, with major changes to the country's policy apparatus such as replacing the floating exchange rate with a fixed exchange rate, like in the old authoritarian military era. The Tatmadaw's governing apparatus became the primary reason for the country's dysfunctional economy, with the military exercising excessive control over economic policy as "they see fit". Without "trust" in the future of the market, economy, and ruling government, Myanmar's nascent banking industry faces a "crisis". Due to dried-up foreign exchange, economic sanctions, civil war and mismanaged bureaucracies, demand sharply declined while the supply of raw materials and imports became extremely limited and many times more expensive. Therefore, the military was not able to cope and cannot hope to in the near future with the shortage of foreign reserves and its overspending on "military operations" to eliminate threats. Consequently, coup leaders can no longer provide the basic fundamentals for the day-to-day functioning of the market, such as electricity and fuel supply for market activities, and are likely to form for several more years to put additional pressure on the businesses running inside the country.

For the future, the military's intent with its economic policy-making apparatus is clear. It will pursue ultra-centralized control; its policies will be centred on "maintaining power" rather than addressing society's needs. The coup leaders might resolve the economic wounds of the coup with short-term solutions such as selling bonds and "excessive money printing" (which will have a long-term impact on the economy with high inflation, undermining trust, higher prices in inputs and imports, and less productivity, therefore having an overall tremendous negative impact on the economy), siding with like-minded countries like China, Russia and Thailand, while many businesses have collapsed and many are on the brink of shutting down. Should there be a longer period of such pressure from civil war and economic mismanagement, the Myanmar economy is likely to withdraw back towards the level of how it was during the time of the old junta (2000–10) and descend back to that of a least-developed country. Even if Myanmar's civil war is ended now and the democratic process is revived as before, the long-term impacts of the destruction of infrastructure and other losses are so immense that it would take many years for the recovery and social progress to occur. Many of the war's costs will be passed on to future generations and continue to mount even after it has ended.

Recommendation

It is strongly urged that establishing humanitarian corridors for civilian evacuation and humanitarian aid delivery is the most urgent matter parallel to stopping such a civil war. At the bare minimum, safe evacuation routes should be provided for civilians who are being forced to flee by the worsening situation. Myanmar must be granted access to safe humanitarian corridors. However the world's leaders have chosen to approach Myanmar's problem over the last two and a half years, it has not stopped the civil war in Myanmar, for which ordinary people suffer tremendously. Therefore, there is a most urgent need for a change of tack—not to deepen the crisis but to end this death drive as soon as possible through diplomacy, accountability, de-escalation and multilateralism.

APPENDIX
Case Study—Exchange Rate, Loss of Foreign Exchange, and Depleting Investments

The coup has had a devastating impact on Myanmar's economy and institutions. As the Tatmadaw exerts control over political and economic activity, institutions such as the judiciary, police and civil services become highly corrupt. The conflict in Myanmar has also resulted in high inflation and exchange rate pressures. Myanmar's fiscal spending and credit are now being redirected to the coup plotters' decision table. More broadly, the authoritarian junta has reduced the effectiveness of many critical economic institutions, including central banks, ministries of finance, tax authorities and commercial courts. Institutional and economic disruptions were many times more costly than capital destruction in the Myanmar conflict. Coup plotters have caused very high inflation in Myanmar because they didn't know better. The government's rejection of "neo-liberal" economic ideology and the concept of the market, as well as its contempt for specialists with academic training (who were either put in jail or terminated), led it to rely on policymakers with little if any formal background in economics. In contrast, there seems to be no economist occupying the main economics position in the cabinet; the Central Bank president is neither an economist nor did he hold any other significant position. There is not a single economist among the members of the Central Bank board (*The Economist* 2022). Coup leader Min Aung Hlaing himself argued that the greed of the traders, class struggle, and coordinated international economic sanctions were the main drivers of inflation rather than monetary policy.

There are also restrictions on fund inflows to the junta, sanctions and the exodus of investors from Myanmar; it hurts all walks of life in Myanmar. The flow of foreign funds into the country has slowed since the 2021 coup. This was partly caused by the impact of targeted economic sanctions but is mainly due to some international organizations scaling back their presence and investors suspending their business activity. State revenues have also been hit hard in the country by falling payments of taxes and non-utility bills nationwide as part of the civil disobedience movement, which people have withheld to express opposition to the military takeover (Robinson and Wallace 2021). After the coup in 2021, the World Bank and Asian Development Bank froze funding in order not to support the coup leaders and stopped ongoing projects worth billions of dollars due to the recent developments in Myanmar. When various Myanmar government reserve fund accounts in various countries, including the United States and Singapore, were also frozen, the depleted flow of foreign hard currency into Myanmar was almost the single most damaging factor to the junta's survival. International economic sanctions alone may not be as damaging to the junta's survival because Myanmar's revenue is still based mostly on resource extraction. Nevertheless, Myanmar is now witnessing a lot of foreign investors leaving on the grounds of "prospects and business ethics" and threats to their business continuity in such a dangerous environment. These investors used to capture the benefits of the economic frontier after the military's grip was loosened in 2010, and there were tremendous changes in the inflows of capital and investment (World Bank 2022).

However, the well-worn path of economic mismanagement and structural backwardness was already evident shortly after the military's brutal coup. Conducting business in Myanmar now exposes any investor or firm to significant reputational, financial, existential and legal risks. Giant investors in different markets, such as Telenor in telecom; Chevron, Woodside, Total and EDF in the oil and gas sector; Kempinski in hotels; Kerin in beer; H&M; and many more are leaving Myanmar now (Oo and Liu 2021). Therefore, it is inevitable that the foreign private sector may be unable to provide the desired investment flows. Most projects valued in the billions of dollars are likely to be paused or reconsidered in times of crisis (Associated Free Press 2022). Possibly, the pain of the economic struggle is even more devastating than the coup itself for millions of people in Myanmar.

The United States unveiled a new set of sanctions in late June 2023. By including the Myanmar Foreign Trade Bank (MFTB), Myanmar Investment and Commercial Bank (MICB) and Ministry of Defence on its list of sanctioned entities, the US Treasury effectively blocked any of their transactions that go through a US bank in order to restrict "transactions between the military regime and foreign markets", particularly for the "purchase and import of arms" (Miller 2023). Sanctions against MFTB and MICB could cost the junta an estimated US$2 billion per year and force the junta government and Myanmar enterprises to conduct business in the US dollar. It is likely the most devastating blow to the junta, even more so than all the violent strikes (*Frontier Myanmar* 2023b). Nonetheless, it also causes considerable economic harm to the people of Myanmar through higher inflation.

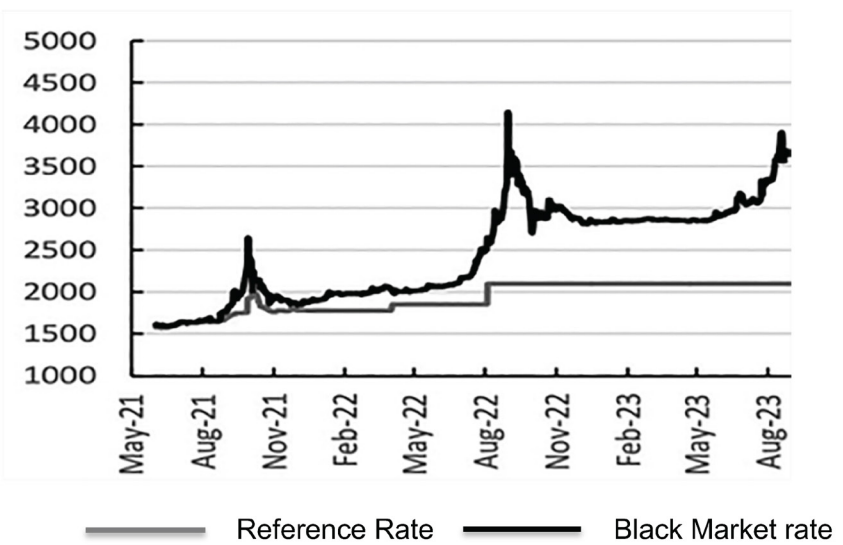
The junta seems to counter this sanction threat with the policy they know best: more money printing and connecting with currencies other than the US dollar, such as the Thai baht, Chinese yuan, and Russian ruble. On 31 July 2023, the junta-controlled Central Bank of Myanmar issued new 20,000-kyat banknotes, which are worth twice as much as the current highest denomination of 10,000 kyats (*Banknote World* 2023). The introduction of new banknotes has sent a shock of inflation hysteria through Myanmar's financial markets, raising concerns among businesses and the Myanmar people about further economic turbulence and hardship.

Even as global inflation rises as a result of Russia's invasion of Ukraine, and the kyat's value continues to fall against the US dollar since the 2021 coup (as shown in Figure 6), the exchange rate against the US dollar, which was MMK1,300 prior to the coup, has risen to MMK3,300 as of September 2021. The Myanmar kyat has lost its value by up to 75 per cent. The normal price for 1 litre of diesel before the coup was only MMK850, at an alarmingly high rate of MMK2,400–2,500 in March 2022 (Money Exchangers 2022). It has grown even more since two banks were sanctioned, fuelling fear in the market to the point where even the middle class in Myanmar struggles to make ends meet. By 18 August, the exchange rate had hit a new high of MMK4,005 for US$1.00 (Money Exchangers, 2023), and fuel and other commodity prices had risen 1.5 times, if not twice, overnight.

The kyat's exchange rate against the Thai baht and the Chinese yuan has fluctuated significantly. Such fluctuating rates make routine trading incredibly difficult. There is a distinct sense of fear in the market. The junta's decision to issue a new 20,000-kyat bill in July significantly damaged public trust in the currency, generating disruptions in gold and foreign exchange markets as well as inflationary fears. The decision by Singapore's United Overseas Bank (UOB) to suspend transactions with all Myanmar accounts due to US sanctions has also contributed to the kyat's depreciation. There is no faith in the coup leaders, and fixing exchange rates is impossible (*The Irrawaddy*, 17 August 2023b). Despite CBM fixing the rate now at MMK2,100 against the US dollar, almost half of the kyat's actual price is in the market; the real market trade and exchange happen outside the governing laws, which creates a large illegal dollar trade and a black market. CBM also revoked the licences of many currency-exchange companies, with the intent of restricting dollar exchange in the market and dollar outflow. However, this just opens the door to a large black market exchange rate since no one is trading with CBM's rate.

Myanmar's currency issue highlights the complexity of a country dealing with civil war. As the destructive momentum of the conflict grows, the country finds itself resource-constrained. The junta is increasing its extraction of revenue from the population, such as by raising communication and Internet taxes, hijacking all US dollars in banks with the set exchange rate, which is much lower than the real rate, tightening imports and exports, and forcibly exchanging foreign workers' remittances (*Mizzima*, 5 June 2023). The junta continues to tighten its grip on power with daily killings, restricting foreign currency flows, and resuming authoritarian apparatus in the market economy; therefore, a failed economy seems not too far away.

FIGURE 6
US Dollar to Myanmar Kyats Exchange Rate After February 2021 Military Coup



SOURCE: World Bank, Money Exchangers.

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Implementing TVET Reform in Vietnam
Insights from the SOE Reform Process

Ari Kokko and Tam Thanh Nguyen

Vietnam needs to raise labour productivity and upgrade its position in global value chains to sustain its successful economic growth. Vietnamese authorities have therefore introduced various reforms to strengthen university education and technical and vocational education (TVET). However, many of the reforms have not been implemented as intended (or at all) and skilled labour is therefore a scarce resource in the country. This article asks why reform implementation has been slow and how it could be accelerated. After summarizing some of the reform requirements and the government's responses, we provide a selective summary of the literature on policy implementation and argue that Vietnam's problems are related to the commanding body system. All public education institutes have a designated "owner" within the state with some control over strategic decisions. These "owners" are often unwilling to give up their privileged positions and have the power to block attempts by schools and universities to become more autonomous. To explore possible ways forward, we examine experiences from Vietnam's state-owned enterprise reforms which have been slow for similar reasons: vested interests have been able to block or delay many of the intended reforms. We conclude by outlining what is needed to reduce the power of commanding bodies and to move ahead with the necessary reforms of the TVET sector.

Keywords: TVET; education reform, implementation; SOE reform, equitization

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1. Introduction

During the past thirty years, Vietnam has become one of the main success stories of economic development. Thanks to market-oriented economic reforms and inflows of foreign direct investment (FDI), Vietnam

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reached middle-income status in 2009, and medium-term growth projections remain optimistic. Vietnam was one of few economies in East and Southeast Asia to record positive GDP growth during the COVID-19 pandemic in 2020 and 2021 and continued inflows of FDI are expected to help growth rates rebound to over 6 per cent in the next few years (ADB 2022; World Bank 2022). Given its low labour costs and the trade frictions between China and the US, Vietnam has become an attractive alternative to China for export-oriented foreign investors.

However, to sustain its rapid development beyond the next few years, Vietnam does not only need more FDI, but it must also upgrade its position in global value chains from a mere source of cheap labour for assembly operations to an active participant in higher value-added activities. This will be a major challenge. Although Vietnam has a labour force of nearly 55 million people, there is an acute shortage of skilled workers (GSOV 2017). Literacy and numeracy are high, but analysts have for several years complained that Vietnamese workers to a large extent lack the skills required for advanced jobs (Bodewig et al. 2014; OECD 2020). In fact, Vietnam's labour productivity in 2018 was ranked the second lowest in Southeast Asia, ahead of Cambodia but behind countries like Laos and Myanmar (ESCAP 2023).

Both outside observers and Vietnamese policymakers have recognized the need to strengthen the skill level of the labour force to achieve this necessary upgrading, and a number of decrees, decisions, resolutions and laws have been issued since the early 2000s to reform the country's technical and vocational education (TVET) system. In particular, the reform proposals have aimed to strengthen the autonomy and quality of the country's vocational schools and colleges so that they will be better able to adjust to the changing needs of society (Harman et al. 2010, Hayden and Chinh 2020). It is understood that equipping the workforce with the right skills is a prerequisite for sustainable growth and modernization (Bodewig et al. 2014). Similar reform proposals have focused on the university system where problems related to autonomy, quality and insufficient attention to market demand have also been highlighted.

One result of the many reform initiatives is that the number of universities and TVET institutes has increased and the enrolment rates in higher education have risen. However, neither the autonomy of educational institutions nor the quality of education has improved at the desired pace: Vietnam is still far from the international and regional benchmarks identified in various policy documents (Hayden and Chinh 2020). Many university graduates are unable to find work because they lack the skills demanded by the market (OECD 2020). The status of TVET programmes is low and there are weaknesses related to relevance and skill mismatches because of resource constraints. Without effective reforms, Vietnam is in danger of being caught in a stagnant phase of development where upgrading is slow because of the scarcity of human capital and where value-added growth falls short of what is needed to support sustainable increases in incomes and living standards (Ohno 2009; Otsuka et al. 2017).

The objective of this article is to understand why the Vietnamese government's reform initiatives (and the many reform proposals from external assessments of the TVET sector) have not been implemented effectively. Drawing on the extensive literature on the topic, we aim to see what could be learned about reform implementation from Vietnam's state-owned enterprise (SOE) reform programme which has moved through various stages since the early 1990s. We argue that this comparison is relevant because the Vietnamese state has exercised its ownership of SOEs and public education institutes in similar ways through the "commanding body system". Like Vietnamese SOEs in the past, all public vocational schools, colleges and universities are formally governed by a commanding body which is a government ministry, agency or other organizational unit that has been appointed to represent the state's ownership interests in management. These commanding bodies wield substantial power over "their" schools and universities and have often opposed reforms that would reduce their influence or harm their economic interests. In the SOE sector, reforms have been slow partly because of ideological opposition to privatization and reduced state control but resistance from commanding bodies trying to hold on to their privileges has also been

important. Hence, SOEs and TVET institutes have faced similar pressure from vested interests resisting reform and some of the experiences and insights related to the SOE reform process are therefore likely to be relevant also for the TVET sector. This does not necessarily mean that the specific reforms carried out in the SOE sector are relevant for TVET institutes. For example, equitization and privatization have been central long-term objectives in the SOE sector but are not necessarily equally important in the education sector.

Section 2 provides a summary of the broad conclusions and reform recommendations regarding the TVET sector from recent analyses by Vietnam's international development partners, as well as a brief look at Vietnam's formal policy responses. The focus is on TVET but the summary will also touch on higher education reform in general; the laws and decrees often cover universities as well as technical and vocational schools and colleges. Section 3 reflects on the existing international literature on reform failure and describes the commanding body system in Vietnam's education sector. For clarity, we also highlight some of the consequences of the commanding body system for the management of educational institutes and some reasons why the system survives despite its drawbacks. Section 4 discusses Vietnamese SOE reform to illustrate the attempts to break the power of vested interests in this sector. A major feature of the SOE reform processes has been its gradual and stepwise character where reform initiatives have often been neutralized or transformed by the responses of commanding bodies and related interest groups. As such, the actual outcomes of reforms have fallen short of plans and intentions. Section 5 concludes by highlighting some of the insights from SOE reforms and discussing what would be needed to move from nominal statements to implementation of the Vietnamese TVET reform agenda.

2. Technical and Vocational Education in Vietnam: Challenges and Proposed Reforms

2.1 External Assessments of Vietnam's TVET Sector

While the challenges and reform requirements in Vietnamese higher education in general have been widely discussed in the academic literature (see, e.g., Harman et al. 2010; London 2011; Tran et al. 2014; Nguyen and Tran 2019; Phan and Ngoc 2020), contributions focusing on TVET are relatively scarce.[1] However, several multilateral and bilateral aid organizations have studied the challenges in Vietnam's TVET sector in recent years. For example, the World Bank argued that one of the main deficiencies of the TVET system was its weak market responsiveness, caused by the lack of connections between employers, students, universities and vocational schools (Bodewig et al. 2014). The reason, according to the World Bank, was imperfect and asymmetric information among stakeholders and their inadequate capacity and weak incentives to make good use of information. This market failure made the system less responsive to the changing technical skill needs in the economy. The lack of decision-making autonomy of educational institutions also reduced their ability and incentives to act in those cases where relevant information was available. Hence, most vocational schools followed formal directions from various authorities regarding curriculum content and study programmes even when it was understood that local adjustments would be appropriate and possible. The inability of the tertiary education system to respond to market signals was also a main finding in World Bank (2022).

Another problem identified by Bodewig et al. (2014) was rent-seeking and corruption in education where "unofficial payments" undermined the information value of nominal grades and diplomas. Potential employers will not pay much attention to a diploma if they suspect that it does not reflect the true qualifications of the job applicant. Similarly, students will have weak incentives to invest in good performance if they expect that potential employers will not trust their formal grades and diplomas. Both students (and their parents) and TVET institutes were also found to face various kinds of capacity

constraints. For students, the constraints were mainly related to the affordability of the direct and indirect costs associated with education. For the school and training institutes, the main capacity constraints were insufficiently trained teaching staff and managers, inadequate curricula and in some cases a lack of knowledge and experience on how to act on information. The roots of these problems were primarily found at the macro level, linked to the overall level and efficiency of public funding for higher and vocational education. Similarly, World Bank (2022) emphasized the negative consequences of the shortage of public funding for the quality and relevance of higher education.

According to ADB (2014), the TVET sector was burdened by: (i) insufficient enterprise-based training, (ii) wrong skills taught, (iii) skills not properly taught, and (iv) inequitable access to education. The same four challenges were recognized also by ADB (2020). The causes of these problems were traced back to weaknesses in the organization and management of education at different levels of the system. At the macro level, management structures were highly fragmented and scattered among thirteen line ministries, sixty-three provincial People's Committees, diverse socio-political organizations and private enterprises. One consequence was a lack of coordination across the different agencies, for example in the allocation of the state budget for TVET. In addition to insufficient funding, the Asian Development Bank (ADB) emphasized the lack of transparency in public funding.

At the micro level, the key problem highlighted by ADB (2014) was the lack of entrepreneurial capacity to manage TVET schools, because managers were almost exclusively recruited from the pool of teachers and administrators and received very little support for professional development. There was no comprehensive national TVET management information system, which could help individual actors align the supply of education to labour market conditions and to develop the technical and pedagogical skills of teachers. Investments in enterprise-based training were insufficient and the Ministry of Labor, Invalids and Social Affairs (MOLISA)—the highest governing body for TVET—still saw state-owned vocational schools as the key agents that should coordinate the participation of enterprises in school operations and training delivery. ADB (2014) argued that it would therefore be difficult to attract enterprises to collaborations where they would be subsumed under vocational schools with a weak reputation for quality and performance.

More recent assessments by OECD (2020) and Germany's Federal Institute of Vocational Education and Training (BIBB 2020) present similar descriptions of the challenges in the TVET sector. The emphasis in OECD (2020) is on the consequences of rapid technological change. Technologies and globalization are jointly creating new tasks and changing existing ones. It is estimated that 70 per cent of jobs in Vietnam are at a high risk of automation and that workers with only primary school qualifications are more than three times more likely to be in a high-risk occupation than those with some tertiary education (*Vietnam News* 2021). Future jobs will require not only simple job-specific skills but also generic skills that can be used in a wide range of occupations. At present, Vietnam's universities and TVET institutes are not sufficiently responsive to these rapidly changing needs of the society and economy because of the limited participation of non-government stakeholders—in particular, business enterprises—in the management and implementation of vocational education programmes (BIBB 2020).

Taken together, the policy recommendations set forth by these institutions outline a comprehensive reform agenda for the Vietnamese vocational education sector. The central reform proposals include:

- Defining the specific roles and mandates of the public and business sectors in the management of the TVET sector. This includes a shift in the role of the government from controlling inputs (enrolment quotas, curriculum and teaching methods) to incentivizing better outputs (qualifications and competencies of graduates).
- Increasing the autonomy of decision-making and the accountability of vocational schools.
- Facilitating the flow of information between students, vocational schools and enterprises as well as

providing appropriate incentives to vocational schools to encourage stronger responsiveness to market development.
- Encouraging partnerships between vocational schools and enterprises in setting occupational standards, expanding on-the-job training and strengthening skill development and innovation.
- Supporting TVET institutions to adopt effective pedagogies to develop the knowledge and skills that students need to succeed in the labour market.

2.2 Vietnamese Reform Efforts

Neither the diagnosis of the weaknesses limiting the efficiency of the education system nor the proposed solutions appear to be controversial to Vietnam's top leadership. The government is aware of the problems and recognizes the need to improve the efficiency of the education sector (ADB 2020). A series of reform initiatives has therefore been launched over the past decades to address some of the obvious weaknesses. For example, the Higher Education Reform Agenda launched by the government in 2005 aimed to build an internationally competitive higher education system by 2020 and promised a thorough reform of governance structures in higher education, including stronger autonomy for colleges and universities (Harman et al. 2010). A new Law on Vocational Education in 2014 and amendments to the Law on Higher Education in 2018 confirmed these ambitions and declared that the autonomy and quality of universities, vocational schools and colleges must be strengthened. Several decrees, resolutions and decisions at various levels support these objectives.[2]

In addition, policymakers have introduced various administrative and structural reforms in preparation for more comprehensive action. A pilot programme on financial autonomy was introduced in 2016, including three public vocational colleges and new management while information systems were introduced in some other colleges (ADB 2020). In 2018, MOLISA's Party Affairs Committee issued Resolution 617-NQ/BCSD on plans for continued improvement of vocational education. Until that time, top-level responsibility for the TVET system had been shared between the Ministry of Education and Training (MOET) and MOLISA. Now, responsibility was concentrated on one central government agency, the Department of Vocational Education (DVE) under MOLISA. The efforts to strengthen vocational education also resulted in several important international collaborations and pilot programmes with development partners from Canada, Germany, Australia, Japan and Denmark.

On paper, many of these reform initiatives look good. In particular, the Law on Vocational Education 2014 strengthened the legal basis for fundamental reform of Vietnam's complex TVET system. It includes important clauses on high-quality TVET institutes for national, regional and international focal occupations, revised specifications on key inputs (mainly teacher and manager qualifications), principles and procedures for mandatory quality accreditation, rights and obligations for enterprise participation in TVET and basic regulations for implementing autonomy of schools and colleges. Official statements on the progress in the TVET sector also give the impression of rapid advances. For example, the political report on the implementation of the ten-year socio-economic strategy 2011–20, presented at the 13th Party Congress in 2021, claimed that vocational education had enjoyed remarkable changes, including the institutionalization of new mechanisms for autonomous administration of TVET institutions and training and retraining of teaching and managerial personnel (CPV 2021, pp. 20–21).

However, outside experts assess these achievements as "largely basic or yet embryonic" (ADB 2020, p. 91). Many of the policy initiatives on vocational education have had limited tangible effects. In some cases, reforms have not been implemented at all and in other cases, progress has been slow and contradictory because of unclear or inconsistent regulations. One example is the Vietnamese debate on the autonomy of educational institutes. In most Western economies, the general view is that educational autonomy comprises four closely linked dimensions of governance: organizational autonomy, staffing autonomy,

financial autonomy, and academic autonomy.[3] Financial autonomy is typically not understood to mean full self-financing but rather that the education institute has the right to decide how the contributions from the state budget are best used. However, in the Vietnamese case, financial autonomy has been interpreted to mean financial self-sufficiency in return for partial autonomy regarding operational decisions. With this definition of autonomy, it is not surprising that most managers of TVET institutes have been hesitant to embrace the concept. In this context, it is noteworthy that there is no official information on outcomes and learnings from the three vocational colleges selected as pilots for financial autonomy in 2016—to what extent could tuition fees cover operational costs, and what other sources of financing were they able to secure? As a broad generalization, it can be argued that many of the projects and good policies mentioned above are still waiting to be fully implemented. "The longest road in Viet Nam is the one from speech to action" as noted by delegate Vu Tien Loc at a National Assembly meeting discussing the implementation of the country's socio-economic development plan in April 2016.[4]

3. Why Are Reforms Not Implemented?

3.1 Literature Review

Vietnam is not the only country where reforms fail or are difficult to implement. Analysing civil service reform across several countries, Polidano (2001) argued that most attempts to reform the public sector fail, not because "once implemented, they yield unsatisfactory outcomes. They fail because they never get past the implementation stage at all. They are blocked outright or put into effect only in tokenistic, half-hearted fashion" (ibid., p. 346). Education reform is no exception (Rowell 2020). Reform implementation is not only a challenge for developing countries with weak institutional capability but also a concern for developed economies where policies are commonly not implemented as planned or fail to reach the desired outcomes (Viennet and Pont 2017).

Research on policy implementation started early. Surveying the literature in the field, O'Toole (1986) covered over 100 studies that identified a broad range of potential determinants of policy implementation (see also O'Toole 2000, O'Toole 2004). Summarizing much of the recent debate on policy implementation in the education sector, Viennet and Pont (2017) suggested that the many determinants can be grouped into four categories dealing with policy design, stakeholders, context and implementation strategy. The most challenging of these are likely to be related to stakeholders and context which are largely pre-determined. Policy design and implementation strategy also require careful attention but can more easily be adjusted.

Several research fields have examined the role of stakeholders in policy reform. For example, organization theory and public administration literature stress the importance of overcoming resistance from stakeholders and building support for proposed policy reforms (Fernandez and Rainey 2006). The literature on the political economy of reform identifies the specific interests of different stakeholders and highlights the risk that specific interest groups will resist reform. In the context of a developed country, this may refer to the need to engage teachers, school leaders and other actors in the reform process to ensure that they understand and share the policy objectives (Fullan 2015). In a developing economy context, with limited transparency in policy-making, weakly developed institutions and pre-existing distortions, this becomes a more complex challenge.

Kingdon et al. (2015) highlighted two major themes related to the political economy of education systems in developing countries: rent-seeking and patronage politics and decision-making and the process of influence. They defined rent-seeking and patronage politics as "an attempt to gain economic rent by influencing policies or their implementation and support provided to specific groups, for instance rewarding individuals or organization for their electoral support" (Kingdon et al. 2015, p. 21). The education sector is likely to grow in a setting where clientelism, patronage and corruption determine the allocation of

resources—it is in the interest of powerful interest groups to channel funds into the education sector—but there is a high probability that the efficiency of investment will be low (Corrales 2005). Zengele (2013) illustrated patronage politics with the example of teacher unions in South Africa which have control and power over teacher promotion decisions and can therefore establish a "client base" of teachers who provide political support in return for current or expected favours. Gupta et al. (2001) highlighted the negative effects of corruption on education quality: corruption drains resources meant for education and distorts data on government expenditure, making it difficult to assess the efficiency of resource utilization. Kingdon et al (2015, p. 21) argued that it is easy to expand educational coverage in a system driven by the politics of patronage but much more difficult to "fix existing inefficiencies within the system—the former involves spending on political actors whereas the latter may involve reducing resources allocated to underperforming political stakeholders".

Discussing decision-making and political influence, Kingdon et al. (2015) also emphasized the role of "vested interest" such as teacher unions, in distorting political processes. For example, studying the education sector in South Africa, Mahlangu and Pitsoe (2011) found that the bargaining between government and union officials diverted funds intended for educational programmes which ultimately led to a decline in public education and an increase in poverty. In his summary of civil service reform failures, Polidano (2001, p. 346) came to a similar conclusion, suggesting that "the problem is not simply that of reformers not knowing how best to manage change. Reformers are subject to institutional pressures or incentives that may well push them into taking the wrong decisions even though they know it."

3.2 The Commanding Body System

In line with the patterns identified in the literature on the political economy of reform implementation, it is likely that one of the main obstacles to effective TVET reform in Vietnam arises from the vested interests dominating the country's TVET system. We assert that the most important of these is the "commanding body system" (*cơ chế cơ quan chủ quản*) that determines who exercises the state's ownership rights in specific TVET institutes.

The commanding body of a public educational institute is the organization or agency assigned by the Government to directly administer the institute in all aspects of its operations including finance, organizational structure, personnel decisions, governance, academic matters, international collaboration, politics and ideology. The state budget allocation to the educational institute is not transferred directly to the institute but rather to its commanding body which then provides the funding for the institute's operations according to plans and agreements. In the education sector, the commanding bodies are not only the two ministries specializing in education and training (the MOET and the MOLISA). In 2023, there were commanding bodies also in twenty-seven other line ministries and equivalent ministerial agencies, sixty-three Provincial People's Committees, seven socio-political organizations (such as Vietnam General Confederation of Labor, Vietnam Women's Union Central Committee, Ho Chi Minh Communist Youth Union Central Committee, Vietnam Peasants' Union) and fourteen large SOEs. In 2023, Vietnam had a total of 1,205 public TVET institutes at all levels. One-quarter of these (301 institutes) had commanding bodies belonging to the central government (including line ministries, large SOEs and socio-political organizations) while the remaining three-quarters (904 institutes) were under commanding bodies belonging to local governments (DVE 2023). In addition, there were 683 registered private TVET institutes in Vietnam. It should be noted that these private institutes lie outside the commanding body system since they do not receive any funding from the government.

The commanding body system is not only applied in educational institutes but also in many other kinds of organizations and can be found in other former command economies. A line ministry may have under its commanding structure universities and vocational colleges as well as hospitals,

banks, commercial enterprises, media, entertainment centres, hotels and guest houses. For example, the Vietnamese Ministry of Industry and Trade, as an example, administers thirty-four educational institutes (including universities and vocational colleges), one information centre, one medical centre, three media agencies, five commercial enterprises, and a number of other affiliated organizations.[5] This administrative model has its source in a mindset of "self-sufficiency" originating from central planning where all major organizational units aimed to reduce their dependence on external resources, including human capital.

Similar systems were in place in the Soviet Union and China. Russia still upholds parts of the educational model of the former Soviet Union. Public higher education institutes are affiliated to and fall under the administration of 24 federal ministries: in 2018, the Ministry of Education and Science controlled 337 institutes, the Ministry of Agriculture had 58 institutes, the Ministry of Health had 52 institutes while the Ministry of Culture managed 45 institutes (Kopnov et al., 2018). China initially followed the Soviet model by instituting a system with "governments allocating higher education resources, appointing university leaders, assigning graduates jobs and deciding enrolment numbers for individual institutions" (Cai 2011, p. 21). As a result, early higher education institutes developed primarily along specialization lines with several ministries, provincial governments and specialized agencies operating higher education institutes to train professionals for their own specific needs. A gradual reform process started after the beginning of China's market-oriented economic reforms in the early 1980s (Cai 2013). Although China has been highly successful in reforming its top universities, problems remain in other parts of the higher education system. Many of the smaller provincial universities suffer from insufficient funding, weak human capital and excessive interference from local authorities. This applies in particular to the country's TVET sector which has been governed by seven different ministerial-level actors and their local and provincial branches since 2004: The Ministry of Education, the National Development and Reform Commission, the Ministry of Finance, the Ministry of Labor, the Ministry of Personnel, the Ministry of Agriculture and the Poverty Alleviation Office. Stewart (2019) argues that the sector's administrative structure is still so complex that nobody fully understands the details of the hierarchy and suggests that the success of China's top universities may actually have reduced the status of vocational education. Over time, this may cause new problems for China's economic growth and political stability.

3.3 Consequences of the Commanding Body System

The hierarchical governance structure where the commanding body represents the state and manages the state budget allocation on behalf of an affiliate (e.g., an educational institution) and has formal decision-making power regarding a wide range of its activities, is likely to cause two types of interrelated problems. First, the relationship between the state and the commanding body is a principal-agent relationship which will result in various agency costs (Gailmard 2014; Gauld 2016). The agent—the commanding body—is expected to act in the interest of the principal—the state—when it governs the educational institutes under its command. However, because of multiple objectives and information asymmetries, the agent will have substantial independent power and may be able to maximize its own utility rather than maximizing public utility. Second, the hierarchical relationship between the commanding body and the education institute under its command can be characterized as patronage politics (or, in Vietnamese, *to ask – to give*, *xin – cho*). Hence, the state provides resources intended for education, but the commanding body may be able to internalize some of these for its own purposes either by not disbursing the full amount or by distributing it in a way that benefits its own interests or its supporters in the education institute. The internal relationships between the patron (the commanding body) and its client (the TVET institute) determine how the budget is distributed between them. In many cases, the patron channels resources

to its affiliate in return for benefits: for example, "thank you" money or loyalty when management positions in public agencies are filled through voting by the subordinates.[6] In other instances, such as the case involving the Vietnam General Confederation of Labor (VGCL) and its "affiliate" Ton Duc Thanh University, media reports in 2019 suggested that the VGCL requested the university to pay up to 30 per cent of its net income as a formal management fee.

Interventions from the commanding body may influence many decisions related to recruitment, remuneration and working conditions in the educational system. This contributes to many of the weaknesses identified in the analyses by the World Bank, the ADB, and OECD. For example, the commanding body may complicate the development of new and innovative training programmes and training methods or collaborations with local enterprises if these changes are not in its interest.

Difficulties in the mobilization of talent, both internally and externally, illustrate some of the challenges. The recruitment of staff for public vocational schools is formally carried out according to the Law on Public Employees 2010 (amended in 2019) but the nominal qualification standards are low and often unrelated to the job requirements. In many cases, there is no fair and transparent competition for positions. Instead, jobs are allocated according to instructions from the commanding body rather than based on merits and qualifications. Moreover, hiring decisions are not always made by local managers but often by people higher up in the hierarchy who favour their friends and relatives.[7] When managers are hired, candidates are almost exclusively selected from the pool of employees that is already under the administration of the commanding body even when qualified external candidates can be found.

One consequence of the lack of objective criteria for hiring decisions is that most employees "owe" their positions to people higher up in the hierarchy and are therefore expected to be loyal to their patrons, for example, in connection with elections for top management positions. Another outcome is that most education institutes are often unable to hire people with the competencies needed to improve performance but are instead obliged to hire those designated by their superiors.

Furthermore, even those talented individuals who manage to find positions in public vocational schools are unlikely to excel given the lack of performance-based incentives and meritocracy. Staff members in public agencies (including vocational schools) typically have low nominal wages but they also have opportunities to earn additional income, both legally and illegally, subject to the discretion of their superiors. This obviously detracts attention from core activities such as teaching and curriculum development.

Vietnam's relatively low scores in the Global Competitiveness Index for flexibility, meritocracy and incentives in the labour market reflect these weaknesses (Schwab 2019). For example, Vietnam was ranked 118 of 141 for the indicator "reliance on professional management". One of the survey questions in this section of the Index is "In your country, who holds senior management positions in companies?". In the educational sector, it is not uncommon that the chairmen, presidents and Chief Executive Officers (CEOs) of commanding bodies are also presidents and rectors of the universities and colleges under their control. For example, between 2014 and 2019, the president of the Vietnam General Confederation of Labor (VGCL) concurrently held the position of president of the University Board of Tôn Đức Thắng University (which is an affiliated unit of the VGCL). Similarly, the chairman of the People's Committee of Quang Ninh Province was the rector of Ha Long University (an affiliated unit of Quang Ninh Province People's Committee) over the 2020–25 term. The Vice-Director of Binh Dinh Province's Department of Labour, Invalids, and Social Affairs also served as the Principal of Quy Nhon Vocational College (under his command) in the early 2020s.

In addition to the structural problems related to the commanding body mechanism, Vietnamese education—like many other parts of the public sector—is also burdened by widespread corruption. The sizeable state budget for education scattered among many commanding bodies (i.e., ministries,

provincial People's Committees, socio-political organizations and large SOEs) with weak monitoring and auditing mechanisms, creates information asymmetries and opportunities for graft and corruption. For obvious reasons, it is not possible to document how severe this problem is, although it has been widely acknowledged for many years and at many different levels (Transparency International 2011; McCornac 2012; Gregory 2016; Tromme 2016).

3.4 Why Is the Commanding Body System Not Abolished?

Although the commanding body system is not the only problem in the Vietnamese TVET sector, it is one of the critical obstacles to the implementation of the reforms that have been proposed and, in many cases, translated into laws, decrees and resolutions as outlined in section 2. In particular, it is notable that the Higher Education Reform Agenda from 2005, the Law on Vocational Education 2014 and the Law on Higher Education 2018 all promised increased autonomy to higher education institutes and that the system of line-ministry (i.e., commanding body) control should be abolished. However, commanding bodies are still powerful actors on the higher education scene. Full implementation of the promised autonomy is still pending.

A major reason for the weak implementation is resistance from the commanding bodies. As noted by Khanh and Hayden (2010), opposition from commanding bodies could be foreseen already at an early stage of the reform process. They argued that the control of higher education institutes offered various benefits and privileges to line-ministries and other commanding bodies:

> Personnel departments within these ministries reap considerable gain from being able to recommend academic staff for senior appointments, including to the position of rector. Finance departments are similarly placed because of their capacity to influence budget allocations. With line-ministry control removed, access to these benefits and privileges will disappear." (Khanh and Hayden 2010, pp. 136–37)

Moreover, Khanh and Hayden (2010) suggested that internal opposition to reform could also be expected. Although the rectors of higher education institutes had to follow MOET regulations related to the curriculum and other academic matters, they did control some of the institute's funds and could influence various issues related to the career opportunities of individual staff members. Since they were generally appointed by the commanding body, it was likely that the changes to the governance system would also challenge their position and power. More autonomy and new governance structures would introduce new challenges that would be hard to manage for many incumbent rectors, in particular those whose main qualifications were their personal relations to the commanding bodies.

Looking back at these arguments fifteen years later, it can be concluded that the commanding bodies and allied vested interests have successfully been able to fend off many of the reform attempts that have threatened to harm their interests. The list of reforms needed to lift the Vietnamese TVET sector to regional and international standards in terms of quality and relevance is therefore still long. Many of the necessary reforms have already been identified in section 2 but most of the recent contributions to the reform debate say little about how to overcome the resistance from the interest groups behind the commanding bodies. The following section will therefore review the past thirty years of SOE reform which has also been characterized by ambitious reforms that have been resisted by the commanding bodies of the reform targets—the SOEs. Particular focus will be on the cycles of reforms and responses to reforms that have shaped the structure and challenges in the current Vietnamese SOE sector. A similar process may be expected also in the education sector, which suggests that it is not easy to predict exactly how Vietnam's higher education system will look in the future.

4. Vietnam's SOE Reforms

4.1 The SOE Reform Process as a Model for Education Reform

To respond more effectively to the changing needs of society, universities, vocational schools and other educational institutes need to become more autonomous. To achieve this, it will be necessary to minimize the distortions caused by the commanding body system which in turn requires limiting the influence of vested interests in education policy and lawmaking.

A central question is how to rein in the vested interests. What can be done to break the power of commanding bodies and how long will it take to see results? There are no set answers to these questions, but Vietnam's own experiences of SOE reform offer some relevant insights.

Vietnam's SOE reforms commenced already in the early stages of country's market-oriented reform process and have continued until the present. Many of the challenges related to SOE reform are similar to those in the education sector. In both cases, the objective of reforms is to enhance efficiency by increasing transparency, making "producers" more autonomous and responsive to market signals and introducing stronger incentives for good performance. Discussions about ownership and control are central in both sectors. Vietnam's development partners have been actively involved in supporting reform in both sectors. Although Vietnam's economic reform programme *Đổi Mới* was introduced in 1986 without much advice or pressure from outsiders—it was mainly a unilateral response to pressure from below and the failure of the command economy (Fforde and de Vylder 1996)—the World Bank, IMF and other multilateral actors have generously shared their analyses and policy recommendations for SOE reforms with Vietnamese authorities since the early 1990s (World Bank 1992, 1993, 1994, 1995, 1997; IMF 1998; Riedel and Turley 1999; Srinivasan et al. 1996). In some instances, this has involved notable political pressure. For example, the World Bank and IMF offered funding for structural adjustment in the mid-1990s under certain conditions, such as privatization of SOEs and restructuring of the banking system (Cling et al. 2013). Vietnam has occasionally disagreed and refused to go as far as their development partners would have liked but the implementation of reforms has been slow even when policymakers have agreed and introduced new laws and decrees. Like in the education sector, there has been resistance to change from within the system. A closer look at the SOE sector is therefore useful for thinking about reform prospects in universities and TVET institutes: a wealth of experience has been cumulated during the long reform period and the various stages of reform are well documented in the academic literature.

4.2 Economic Reforms in Vietnam

When the first steps towards market-oriented economic reform were taken in the early 1990s, the economy of Vietnam was dominated by some 11 million household farms (Marsh et al. 2006), a large informal sector concentrated in and around Ho Chi Minh City and about 12,000 SOEs in industry and services (Srinavasan et al. 1996). Decollectivization had led to large increases in agricultural output (Pingali and Xuan 1992; Raymond 2008) and the abolishment of the ban on private enterprise resulted in a boom in small-scale industry and commerce, mainly in the informal household sector (Freeman 1996). With the end of central planning, SOEs formally became autonomous and free to decide about inputs, products, production processes and prices (Gates 1995). Their initial response to increased autonomy was a credit-fuelled bubble where local authorities and SOEs joined hands to access investment funds from state banks and public budgets, quadrupling the number of state enterprises in only four years (1985–89), from around 3,000 to 12,000 (Pincus 2023).

However, most SOEs were small and inefficient, operated with simple or outdated machinery and technology and had no experience with free markets. Many of the older SOEs had relied on subsidies from the state budget and would not be able to break even in a market economy. Many of the newer ones

were speculative ventures without clear links to the core businesses of the SOEs that had founded them. If liberalization and deregulation were to continue, a fundamental reform of the SOE sector would be needed. The number of loss-making SOEs would have to be reduced and it was expected that many would be closed or privatized. Even relatively sound SOEs might be subject to divestment or privatization, especially those operating in sectors where the arguments for maintaining state ownership were weak. In strategically important SOEs, the state was expected to remain the majority owner but management and governance reforms would be needed to ensure that public funds were used more efficiently and profitably.

Like the schools and universities discussed above, all SOEs had designated "owners" or commanding bodies within the party and state sector, representing line ministries, other central and provincial authorities, party organizations and People's Committees at various levels (Painter 2003). When the first SOE reform programmes were introduced, it quickly became obvious that these interest groups were typically not eager to relinquish control of "their" SOEs. They had financial interests in "their" enterprises and could claim a share when there were any profits, their influence on management decisions—in particular, hiring and promotion—was valuable and soft budget constraints meant that even loss-making enterprises were seen as important assets (Kokko and Sjöholm 2000). The opposition from these vested interests has meant that the Vietnamese SOE reform process has been slower and less comprehensive than expected in the early 1990s (Kim and Tru 2019; Knutsen and Khanh 2021) and their responses to perceived threats have sometimes resulted in restructuring and reorganization aiming to ensure the continued existence of a strong SOE sector. The following sections will first look at the reforms introduced to reduce the power of commanding bodies and strengthen the management of SOEs and then discuss some of the responses from the commanding bodies and other stakeholders defending the SOEs.

4.3 Reducing the Power of Commanding Bodies

The first steps in Vietnam's early SOE reform programme seemed surprisingly successful, considering the power of vested interests in the state sector. The number of SOEs declined from about 12,000 in 1990 to 6,500 in 1992. Overall, employment in SOEs fell from around 2.7 million to 1.8 million between 1986 and 1992, with most of the reduction in provincial and local rather than centrally controlled enterprises (Srinavasan et al. 1996). The opposition to this first round of rationalization was weak because much of the seemingly large adjustment could be achieved by merging smaller SOEs with larger ones owned by the same commanding body. Many small and inefficient SOEs that were clearly unsustainable were also closed or sold to private investors, but these divestments were of marginal value and the new owners were generally former employees or managers of the SOE or in other ways linked to the commanding bodies. Moreover, most SOEs had been overstaffed before the reforms. Srinavasan et al. (1996) suggest that part of the downsizing involved the transfer of disabled and retired workers from the employment ranks to the list of welfare recipients. Hence, although the job cuts reduced payroll, they did not have much impact on production capacity and the output share of the state enterprise sector increased between 1989 and 1992, from about 25 to 27 per cent of GDP.

The second stage of reform was initiated in 1992 with a pilot programme on "equitization" of SOEs (announced in Prime Minister's Decision 202/1992/CT). The first step in the equitization process was a valuation of the SOE's assets and this was to be followed by a transformation of the enterprise into a joint-stock company. The intention was to mobilize resources from the sale of shares to employees and outside investors, but the controlling share (or even full ownership) could remain in the hands of the state—hence, equitization did not require much if any *de facto* privatization. The programme was initially designed as a bottom-up process where line ministries and People's Committees were instructed to develop plans for how the SOEs under their control would be equitized (Painter 2003). However, resistance to change was

strong and few enterprises volunteered. Only five SOEs went through the process between 1992 and 1996, with the managers of these firms rather than the commanding bodies pushing for equitization.[8]

Several interlinked reasons to resist equitization can be identified. The valuation of SOE assets was difficult and called for more transparency than what many of the managers and owning organizations were willing to provide: all assets would have to be declared, making it more difficult for managers to engage in rent-seeking and revenue generation for the commanding bodies (Painter 2003). Owners of SOEs worried that equitized firms would lose some of the privileges of being an SOE (Ngu 2003). Most importantly, despite its cautious beginning, equitization was seen as the start of a process that would force enterprises to introduce more market-oriented management practices. This would leave less room for intervention from the commanding bodies and might eventually lead to full privatization.

In 1996, the government announced that the equitization programme would be extended to cover all small and medium-sized SOEs where 100 per cent state ownership was not considered necessary (Decree 28-CP, 7 May 1996). The Decree also outlined tax incentives for participating firms and emphasized that many of the SOE preferences would still apply to equitized enterprises. Yet, progress remained slow and only twenty additional SOEs were equitized during the following two years. A new Decree issued in 1998 added instructions on the selection of SOEs for the equitization process and the incentives for participation (Decree 44/1998/ND-CP). Most importantly, to encourage equitization, Article 9 of this Decree stated that the proceeds from sales of shares could be used by the commanding bodies to support retraining of employees, provide allowances to redundant workers and fund investments in other SOEs. These incentives were more effective and the number of equitized SOEs increased to 834 by the end of 2002 (Dang et al. 2020, p. 6).

However, most SOEs did not seem interested in the reform. To accelerate the process, another Decree in 2002 therefore obliged commanding bodies to formulate equitizations schedules for their enterprises and stated that non-strategic SOEs below a certain size could be liquidated if they opposed equitization (Decree 64/2002/ND-CP). This can be seen as the beginning of a third stage of SOE reform. To avoid the threat of liquidation, nearly 1,300 SOEs were equitized between 2002 and 2004 (Wacker 2017). Another 1,900 SOEs were equitized between 2004 and 2008: by this time, even larger enterprises were going through the process. Taken together, the total number of equitizations reached 4,400 by 2015, at which time some 600 wholly state-owned enterprises remained non-equitized (Hiep 2017; Dang et al. 2020, p. 6; Knutsen and Khanh 2021, p. 149). About one thousand of the SOEs that existed in the mid-1990s had disappeared by this time because of mergers and divestments. To encourage further management reform, all equitized SOEs were instructed to list on stock exchanges. This would not only help to attract capital and new shareholders from the private sector but rules on information disclosure would also improve transparency and the market's valuation of the company's shares would contribute significantly to management incentives (Dang et al. 2020).

From the early 2000s, measures had also been prepared to reduce the direct influence of the commanding bodies on SOE management. The Private Company Law from 1990, the Enterprise Law from 1999, and the SOE Law from 1995 were replaced by a new unified Enterprise Law in 2005 which established a common legal framework for all enterprises regardless of the type of ownership and economic sector. The new law was important for SOEs, since it established new standards of corporate governance with more transparency and protection of minority owners. Another important step was the establishment of the State Capital Investment Corporation (SCIC) in 2005. The role of the SCIC was to exercise state ownership in small and medium-sized SOEs, including both strategic investment and sales of shares to non-state actors. Between 2006 and 2022, SCIC took over the management of 965 equitized SOEs from their former commanding bodies (Hoang and Oh 2023). In line with its mandate, SCIC has divested most of these SOEs over time and SCIC's portfolio had shrunk to 145 SOEs at the end of 2021 (SCIC 2022).

The large SOEs remained outside the domain of SCIC. The state-owned conglomerates and business groups and their member enterprises were still controlled by line ministries while many other large SOEs were governed by people's committees at the provincial and city level. In 2018, Government Decree 131/2018/ND-CP initiated a fourth stage of SOE reform focusing on the largest enterprises by establishing the Commission for Management of Capital in Enterprises (CMCE). CMCE represents the state's ownership interests in the largest state-owned conglomerates and SCIC. Its portfolio comprises the 19 largest state-owned business groups made up of 200 individual SOEs, representing two-thirds of the total state-owned equity capital in the economy (OECD 2022). The stated intention is that only three of these business groups (PetroVietnam, Electricity of Vietnam, and Viettel) will remain wholly owned by the state in the long run while the others will be partially privatized (Nguyen at al. 2020, p. 48).

On paper, it could be argued that the combination of equitization and other measures to establish more transparent and business-oriented corporate governance structures—in particular, new laws and institutions for exercising state ownership—has gradually succeeded in reducing the power of the former commanding bodies.

4.4 Responses from Vested Interests: Consolidating the SOE Sector

Although Vietnam's various SOE reforms have undoubtedly contributed to the introduction of more professional management practices and reduced the commanding bodies' control of SOE operations, it must be noted that the interest groups behind the SOE sector have not only been passive observers of the reform process. Instead, they have responded in various ways to what they perceived as threats to their interests. Most importantly, political and ideological arguments have continuously been used to ensure continued state dominance in the economy. Vietnam's first post-reform Constitution, adopted in 1992, declared that "The State economic sector shall be consolidated and developed, particularly in key branches and domains, and shall play the leading role in the national economy and constitute, together with the collective economic sector, the firm foundation of the national economy" (Vietnam 1992, Article 19). In other words, despite the comprehensive economic reforms initiated at the time, the ruling Communist Party had no intention of carrying out a full transition to a market economy or allowing the SOE sector to lose its dominant role in the economy. Since then, the Party has been forced to accept that the private sector will also play an important role in the economy, as stated in the revised 2013 Constitution: "The Vietnamese economy is a socialist-oriented market economy with multi-forms of ownership and multi-sectors of economic structure; the state economic sector plays the leading role" (Vietnam 2013, Article 51).

The ideological arguments supporting a strong SOE sector have justified restructuring and strategic partnerships intended to strengthen the power and resilience of the SOE sector. For example, in 1994, at the same time as the pilot equitization programme was rolled out, Prime Minister's Decision 90/1994/TTg and Decision 91/1994/TTg launched a restructuring process within the SOE sector, where some 2,000 SOEs were loosely merged into eighteen large State General Corporations (so-called SGCs 91) covering strategic industries and around eighty smaller corporations (SGCs 90) that often had a clearer geographic focus (Sjöholm 2008; Vu-Thanh 2017). The stated purpose of this restructuring was to create larger diversified enterprises modelled on the South Korean *chaebol* and the Japanese *keiretsu*; size was considered essential for competitiveness (Perkins and Vu-Thanh 2009) and for increasing the central government's control of state assets (Beeson and Pham 2012).

Some early observers, such as Painter (2003) and Thaveeporn (1996, 1997), report that the formal arguments for the restructuring reflected an ambition to reduce the ability of lower-level commanding bodies to interfere with business decisions and capture profits and rents. However, the establishment of the SGCs did not challenge the commanding body system, although the relative power of line ministries

and provincial people's committees managing the SGCs increased. With the benefit of hindsight, it is instead possible to see the restructuring process as a way of managing some of the risks related to unavoidable future challenges such as increasing competition from the private sector and the ongoing equitization process. Lower-level commanding bodies had to give up some direct management control to line ministries and provincial leaders, but they retained ownership rights. The interlinkages between the SGC members also reduced the risk than any individual company would be targeted for divestment without the consent of the SGC.

The political support to SOEs also ensured that equitization and the other reform measures did not end the various privileges that allowed SOEs to stay afloat despite increasing competition from the domestic private sector and the international economy. The SGCs in strategic sectors such as oil and gas, coal and minerals, telecommunications, transportation, electricity generation and even several less strategic industries, such as cement, coffee, rubber and textiles were allowed to hold on to strongly dominant market positions or even monopolies. These and other SOEs had access to land, credit and natural resources on favourable terms and special privileges related to public investment and government procurement. Although direct subsidies from the state budget were cut, many SOEs were supported through the write-off of non-performing loans and cash injections from state-owned banks and other public sources (Painter 2003).

Yet, SOE performance remained weak. Data for the early 2000s show that the pretax return on total assets in the SOE sector as a whole was only about two-thirds of the average for the business sector and that less than half of the SGCs 91—the flagships of the SOE sector—managed to reach the overall average, despite their resources and strong market positions (Vu-Thanh 2017). At the same time, it was known that the level of competition in the Vietnamese market would soon increase significantly. In 2001, Vietnam established a bilateral trade agreement with the US which was explicitly designed to be consistent with the standards set by the World Trade Organization (WTO). Membership in the WTO was expected within a few years. This would not only result in tougher import competition but also encourage inflows of FDI. Although foreign investors were expected to mainly use Vietnam as an export platform, some of them would also compete with SOEs. A new Enterprise Law was promulgated in 2000, resulting in the establishment of tens of thousands of new private firms during the following years, adding to domestic competition (Tran et al. 2008). In addition, new decrees were introduced at this time to accelerate the equitization programme. The SOE sector needed to perform better to remain a central force in the Vietnamese economy.

The response was a more radical SOE restructuring programme that aimed to create even stronger conglomerates, this time labelled State Economic Groups (SEGs). The first one was established in 2005 and twelve additional ones were formed by 2011. The SEGs were based on the SGCs with the state as the only (or in a few cases, the dominant) shareholder of the parent enterprise and clearer ownership (parent-subsidiary) links to the member companies. Several of the SEGs had a virtual monopoly in their main industry. They also had privileged access to land and other resources and many of their unlisted member companies did not have to pay dividends to the state until after 2016. In addition to the core business activity inherited from the SGCs, most of the SEGs chose to use state support in the form of capital, land and natural resources to diversify horizontally from the very beginning—moving into real estate, banking, finance, insurance and other unrelated industries (Knutsen and Khanh 2021). For example, all thirteen SEGs owned at least one bank in 2011.

Vu-Thanh (2017) argues that the creation of the SEGs was mainly a defensive move to protect the core of the SOE sector from increasing competition, rather than an attempt to match the efficiency of the private sector. The restructuring of the SOE sector before 2004 had been relatively cautious and experimental, the individual members of the SGCs were not tightly controlled by their headquarters and there was no consensus on how much protection the SOE sector would need. After 2004, even the more

reform-oriented party leaders who had earlier called for the establishment of a level playing field for private business had to accept that strengthening and consolidating the SOE sector was necessary even if it sustained many of the privileges of the SOEs (Vu-Thanh 2017). By increasing the coordination of decisions, pooling resources and taking control of distribution chains, it was believed that the SEGs would be better able to meet both foreign competition and any challenges from the growing private sector. Focusing on a few selected sectors and SEGs strengthened the argument that they were strategically important and able to "play the leading role in the national economy", as stated in the Constitution. Moreover, the diversification into banking and finance created opportunities to replace subsidized credits from state banks (which would gradually diminish under WTO rules) with "internalized" sources of funding. With each SEG owning its own banks, it would be easier to arrange directed lending and cross-subsidies to selected member companies (OECD 2022).

The SOEs that remained outside the SEGs were in a more exposed position but many of them found other ways to reduce the impact of equitization and related reforms. Nguyen et al. (2020) note that the most recent stage of the equitization process, covering the period 2016–20, was particularly slow because of problems with asset valuation and resistance from vested interests—less than half of the 405 SOEs targeted by the plan had completed equitization by 2020. Dang et al. (2020) report that only a minority of the equitized SOEs (perhaps only 20 per cent) had listed on Vietnam's stock markets by 2018. This delayed privatization since potential outside investors had only limited access to information about the activities and finances of unlisted SOEs. When shares of unlisted SOEs were sold, the buyers were likely to be actors with privileged access to information through links to the management or the commanding body of the enterprise. Several observers have noted the risk that this lack of transparency may have made the equitization process a source of private accumulation and generated a new business elite with close ties to the party system. (Beresford 2008; Gainsborough 2010; Malesky and London 2014; Knutsen and Khanh 2020).[9] When SOEs did list and shares were released to outside investors, the state often kept the controlling share. For example, 426 SOEs completed their initial public offerings in 2011–16 but the state held on to over 80 per cent of the aggregate share capital of these enterprises (Dang et al. 2020).

There is no evidence to show that the consolidation of SGCs into SEGs has improved their performance or financial efficiency. On the contrary, diversification outside their main business area has been costly for several of the business groups. Three of the SEGs—Vinashin (shipbuilding), VNIC (construction), and HUD (real estate and urban development)—were eventually downgraded to SGCs because of large losses from investment in finance, real estate and other non-core activities (Vu-Thanh 2017). It is also uncertain whether the partial privatization of SOEs will contribute much to performance. In fact, data for recent years show that the average return on capital in wholly and majority state-owned firms is still lower than that in the private sector (Nguyen et al. 2020). Interestingly, enterprises with minority state ownership record the highest capital return, presumably because they combine some remaining SOE privileges (e.g., easier access to credits) with the management influence of strong private owners (Nguyen et al. 2020).

4.5 Results of the SOE Reforms: Steady but Slow Change

A summary assessment of the reforms in the Vietnamese SOE sector must necessarily be somewhat mixed. Equitization has been slow, but over time most SOEs have been equitized. Equitization has often been combined with partial privatization, mainly to employees and managers but also to outsiders, while some equitized firms have been listed on stock markets. With increased transparency, management practices have become more market-oriented. The establishment of SCIC and SMCE has gradually reduced the direct influence of the old commanding bodies in enterprise management. The performance of the SOEs where the state owns minority shares has improved and compares favourably to that of the private sector

(although the remaining SOE privileges and the relative weakness of private domestic firms may explain some of the differences).

At the same time, it seems clear that the interest groups supporting the SOEs, either for ideological reasons or because of more direct reasons related to financial resources and political influence, have been able to hold on to substantial power. The board members of SCIC and SMCE-controlled companies are regularly chosen from the former commanding bodies (OECD 2022, Ch 4) and state ownership in many other SOEs is still exercised by provincial authorities and ministries. This is likely to distort competition and complicate management since these commanding bodies still act as both regulators and shareholders. Hence, there are still complaints about interference in SOE management from former commanding bodies. Although privatization has become an increasingly important part of SOE reform, Knutsen and Khanh (2021, p. 6) report that only 8 per cent of state assets had been transferred into private hands by 2015. The share of state assets sold to private investors is likely to be higher today but few of the SOEs with dominant state ownership operate on strict commercial terms with management effectiveness, profit orientation, hard budget constraints and accountability for performance (Dang et al. 2020).

Four broad insights can be distilled from the SOE reform experience. First, it seems clear that the implementation of reforms meeting internal resistance is likely to take time. The SOE reform process was initiated more than thirty years ago and is still not completed. One reason is that some of the strong interest groups that opposed the reforms were able to respond in various ways, neutralizing or at least slowing down the efforts to equitize and privatize SOEs. Since most of this resistance took place behind closed doors, there is limited evidence of how they achieved their goals. However, ideology has been an important force behind opposition to reform (although more materialistic motives related to the protection of private rent-seeking opportunities have probably also been present). Giving up state ownership of productive resources is difficult for many of the members of the Communist Party of Vietnam. Given that both state-owned and private schools and universities have been able to operate efficiently in many countries, it is possible that the ideological arguments in favour of or against state ownership of educational institutes are weaker. This suggests that the resistance to some types of change could also be weaker.

Second, competition has played a central role in the reform process, both from a macroeconomic perspective and from the perspective of individual SOEs. At the macro level, it was obvious from the beginning that reforms were required because the state did not have the resources to save inefficient SOEs that were unable to compete with the private sector. At the micro level, SOE managers and commanding bodies gradually understood that management practices and organizational structures had to change for SOEs to survive in competition with the private sector. In some cases, it is possible that these managerial and organizational changes will be effective enough to allow the SOEs to survive on a level playing field with private competitors. Hence, ownership changes are not always necessary to achieve the efficiency objectives of SOE reforms—the intended results can sometimes be reached through a combination of internal incentives and appropriate market institutions (Groves et al. 1994). An important step in this context was the establishment of the SCIC and the SMCE which formally took over the state's ownership function from the old commanding bodies. Concentrating the state ownership function in a professionally managed holding company could potentially reduce agency costs and raise corporate efficiency. This is important for the discussion about higher education reform where ownership is likely to be less important than incentives and governance structures. In fact. state-owned higher education institutions are able to operate relatively efficiently in most developed countries, even in the presence of privately-owned competitors. The establishment of a specialized agency representing the state's ownership interests in education institutes could help reduce the losses related to the commanding body system and contribute to more efficient public governance of schools and universities.

Third, the early stages of equitization depended to a great extent on experimentation and initiatives by highly engaged individuals, mainly managers of SOEs. The first equitized firms went through the process

not because their commanding bodies were enthusiastic supporters of the reform but rather because the managers saw opportunities to improve performance with new forms of governance. A contributing factor here was probably that some insiders were incentivized by or compensated with the possibility to acquire shares in the equitized enterprises. It may be more difficult to find similar ways to incentivize or compensate the insiders who stand to lose from reforms in Vietnam's education sector.

Fourth, to fully achieve the objectives of the SOE reform process, it will not be sufficient to focus on a narrow set of policies such as equitization, listing of firms on stock exchanges or privatization. Instead, the success of SOE reform will depend to a great degree on the implementation of competition policy, regulatory oversight and the improvement of corporate governance standards for transparency, incentives and accountability (Dang et al. 2020). Similarly, it is likely that the reform of Vietnam's TVET sector will not only depend on how much and which type of autonomy TVET institutes will be able to gain over time but also on how other rules and regulations that govern their operations develop. Moreover, changes in the education sector need to be supported by incentives to encourage enterprises to collaborate with TVET institutes, improvements in the quality of academic education, research and development (R&D) and other measures to strengthen entrepreneurship and the competitiveness of domestic industry. To manage the desired upgrading, Vietnam urgently needs human capital and skills, but a dynamic and responsive business environment is also a necessary component of sustainable development.

5. Conclusion: Steps to Implement Reform

The former Prime Minister of Vietnam, Nguyễn Xuân Phúc, repeatedly emphasized the need to counter vested interests in the law-making process. For example, in 2020, he declared on the Vietnamese government's official website chinhphu.vn that "anti-corruption in general is important and necessary, but fighting corruption in policy- and law-making is even more important" (GoV 2020).[10] Corruption violates the rules but powerful interest groups can also influence the rules and tailor laws to promote their own interests (Zúñiga 2020). Examples include laws designed to control part of a sector or industry and laws to remove and appoint officials. Tailormade laws can be seen as the highest form of "state capture" since they ultimately legalize the measures taken to capture the state. The complexity of the legal system, including loopholes (i.e., ambiguities in regulations and contradictions between different laws) contributes strongly to the creation of such tailormade laws.

The commanding body mechanism in TVET and higher education has been "tailored" to allow specific vested interests to control parts of the sector, for example through their power to appoint and remove administrative and academic staff. By delaying necessary reform, this mechanism also delays Vietnam's transition from a labour-intensive to a knowledge-based economy. More effective implementation of the reforms that have already been declared or promulgated requires measures to curb the power of vested interests and to maximize stakeholders' participation and representation in the management of education institutes.

How can these objectives be realized? Drawing on the experiences from Vietnam's own SOE reform programme and the advice from Vietnam's development partners, we suggest that five elements must come together to facilitate the move from the current stalemate to the implementation of substantive education reforms.

First and foremost, it is necessary that there is a strong political will among the country's top leaders to reduce the current power of vested interests and to prevent them from producing new or strengthening existing laws that preserve the commanding body mechanism in the education sector. The interest groups, which often claim to act on behalf of the state, have used the commanding body mechanism to preserve their exclusive power in the Vietnamese education sector for over sixty-five years. It is difficult to identify precisely who belongs to these interest groups. There are legitimate interest groups, such as trade

associations or environmental protection groups which operate openly as established organizations with a common interest and seek to influence government decision-making and/or public policymaking. The vested interests behind the commanding body mechanism, in contrast, have not declared the establishment of a formal organization representing their interests and they rarely admit that they are part of a particular group. They might comprise any member of the public apparatus and the individuals involved may have been drawn into the interest groups unintentionally or even reluctantly, for financial benefit or simply so that they will not be isolated or ostracized in a work environment where everyone else subscribes to the common interest. It will be difficult to dismantle these networks as long as they are led to believe that the country's top leaders are sympathetic to their cause.

Second, it is crucial to strengthen the capacity of lawmakers and decision-makers. They should have the resources and competence to close loopholes in the legal system, and to give public educational institutes substantial autonomy through comprehensive and consistent revision of legal provisions in the relevant range of legislation, including the Law on Public Employees, the Law on Government Officers, the Labor Code and other laws.

Third, the transparency and accountability of the education sector as a whole must be strengthened through the establishment of an open information system supported by modern information technology and digitalization. This will facilitate oversight and control, provide the data for more powerful analytics, disseminate results of successful reforms and experiments and make up a tool for accountability. As noted earlier, several of Vietnam's development partners, including the World Bank and ADB, have recommended the establishment of a national education database (Bodewig et al. 2014; ADB 2020).

In the Vietnamese context, IT and digitalization can contribute to the necessary reforms by helping to overcome the information market failures in vocational education—the efficiency of both the labour market and the education sector will benefit from the application of information technology in teaching and learning, the development of open educational resources and by helping workers to update and improve their skills through life-long learning. The digital transformation will make it possible to improve the flow of reliable and relevant information and it will save time and reduce information and transaction costs. At the end of 2021, there were more than 69 million internet users in Vietnam which will facilitate the digital transformation nationwide (Statista 2023).

Fourth, the role of competition as a driver of change must not be underestimated. In the education sector, the competition comes mainly from private universities and foreign investment. New actors that are more transparent, operate more efficiently and respond faster to market signals will put pressure on those that are slower to move. However, the increase in competition is not only achieved through the establishment of new education institutes but may also come from successful experiments and pilots carried out in existing institutes. The vocational schools, colleges and universities that remain passive cannot expect business as usual when more dynamic incumbents (or new entrants) start capturing increasing shares of the education market. Competitiveness can also be enhanced by more effective governance systems. Using the same arguments as in the case of SCIC and SMCE, it may be possible to gradually transfer the state's ownership role from the current commanding bodies to a new professional agency exercising the ownership role of the state. This could be a better alternative than letting MOET take over the governance of educational institutes, since it would allow MOET to focus on its role as a regulator rather than a manager.

Fifth, reforms must start somewhere, despite the resistance from vested interests. The success of the first SOE privatizations where individual managers chose risky strategies to convince political decision-makers to support the reform, often without support from their commanding bodies, shows that change is possible. The vocational colleges and schools that are willing to reform, where individual teachers and administrators are prepared to invest their time and energy to be on the frontline of reform, should be encouraged and supported by the policymakers and Vietnam's development partners. Some of the

commanding bodies will have stronger incentives to support reforms either because their payoff from the current setup is lower or because the potential benefits from reform are higher. Experiments and pilots should therefore focus on schools and universities under their command. What is needed to break the power of vested interests is probably simultaneous pressure from above, i.e., the political leadership that formulates new laws and policies, and below, the people working in the organizations and units that are to be reformed.

How will the outcome look and what type of governance system will Vietnamese TVET institutes have in the future? The most honest answer is probably that we don't know. The SOE reform process suggests that some commanding bodies may be able to respond to reform pressures by introducing new approaches (mergers rather than divestments, or equitization rather than privatization), possibly changing the nature of the desired reforms. If similar responses were to emerge in the higher education sector, they could involve the interpretation of which the available policy alternatives are (financial self-reliance in exchange for partial institutional autonomy) or the emergence of new governance structures for higher education institutes that allow commanding bodies to retain some power and influence, perhaps in collaboration with other stakeholder groups. Whatever the medium-term solutions turn out to be, they will probably not represent a linear extrapolation of the trends we can see today: reforms and the responses to these reforms will continuously create new opportunities, challenges, and reform requirements.

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Statements and Declarations

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NOTES

1. Some notable exceptions are contributions to volumes on higher education in Vietnam and TVET in the region including Tien (2014), Tuan and Cuong (2019), Nguyen et al. (2024) and Mori and Stroud (2022).
2. See, for example, Resolution No. 14/2005/NQ-CP issued by the Government in 2005 and Resolution No. 19-NQ/TW issued by the Party's Central Executive Committee in 2017 which stress the ambition to strengthen the autonomy of educational institutes, and Prime Minister's Decision No. 2448/QD-TTg on International Higher Education and Vocational Education Integration by 2020, issued in 2013, which stated that Vietnam was to "develop a number of higher education and vocational training schools to reach the advanced regional and international standards" to allow mutual recognition of diplomas, credit and occupational skills between Vietnam and other countries.
3. These are the four dimensions of autonomy included in the European University Association's Lisbon Declaration on how higher education can contribute to the challenges brought about by an increasingly globalized world (EUA 2007).
4. See https://dantri.com.vn/xa-hoi/con-duong-dai-nhat-viet-nam-la-tu-loi-noi-den-viec-lam-20160402070503097.htm
5. See https://moit.gov.vn/web/guest/co-cau-to-chuc
6. Phạm Quý Thọ (2018), "VN: 'Bảo trợ chính trị' đang gây nguy hại cho chế độ?", BBC News Tiếng Việt, 22 April 2018, see ghttps://www.bbc.com/vietnamese/forum-43857221
7. It is difficult to systematically document these problems but most people working in Vietnamese education institutes and other parts of the public sector will have observed them in practice. However, anecdotal evidence is easy to

find in Vietnamese media. See, e.g., https://vov.vn/nhan-su/dep-nan-bo-nhiem-nguoi-nha-phai-thi-tuyen-minh-bach-557264.vov; https://vov.vn/nhan-su/bo-nhiem-ong-trinh-xuan-thanh-va-nan-con-ong-chau-cha-537479.vov; and https://tienphong.vn/ky-luat-ca-nhan-vi-pham-trong-tuyen-dung-bo-nhiem-nguoi-nha-post941875.tpo

8. One of the present authors interviewed several of the managers of the SOEs in the pilot equitization programme in the mid-1990s. In most of the early cases, equitization was combined with (partial) privatization to enterprise managers and employees. The common message from these entrepreneurial managers was that getting permission to break away from full state ownership required great personal effort and persistence.
9. Rules were tightened in 2017 when Government Decision 125/2017/ND-CP mandated equitized SOEs to complete procedures for listing on the Unlisted Public Company Market (UPCoM) within ninety days after their initial public offering.
10. Our translation. Paradoxically, Nguyễn Xuân Phúc was forced to resign in January 2023, following corruption scandals linked to Vietnam's responses to the COVID-19 pandemic. *See* Bui and Malesky (2023).

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Is It Difficult to Get Out of the Coal Business?

Narrative from Coal Mining Companies in Indonesia

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The response of incumbent coal miners to the global coal phase-out significantly influences the trajectory and pace of the energy transition. This phenomenon is particularly pronounced in countries with high coal dependency where coal is deeply ingrained in societal structures, resulting in lock-ins and vested interests. This study examines the adaptation strategies of five major Indonesian coal mining business groups, characterized by robust upstream and downstream linkages. Through a co-occurrence and content analysis of prominent online newspapers and a documented survey of companies' annual reports, this research investigates their adaptation strategies. The findings reveal that all companies engage in coal business divestment, partial shifting to electric vehicle business, diversification into high-value products, and the implementation of best mining practices, albeit to varying degrees. The underlying factors influencing these strategies include the scale of the company, corporate image, affiliation with the current government and prevailing government policies on coal production.

Keywords: Coal, political economy, decarbonization, Indonesia, firms.

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1. Introduction

Indonesia faces a significant climate-energy conundrum. According to the Indonesian government's plan for net-zero emissions, coal usage in the primary energy supply mix is projected to peak between 2030

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and 2045. In 2022, approximately 67.7 per cent of Indonesia's 687.4 million tons of coal were exported. Additionally, of the 215.8 million tons of coal sold domestically, around 60 per cent were consumed for power generation (ESDM-RI 2023). Under the low-carbon scenario, aligned with the Paris Agreement (LCCP), the share of coal in power generation is expected to be approximately 38 per cent by 2050 (MFE-RI 2021). In this scenario, around 76 per cent of coal-fired power plants will be equipped with Carbon Capture and Storage (CCS) systems to achieve zero emissions.

Indonesia's new demand for coal (3,405 PJ, or Peta Joules) is relatively low compared to other Asia-Pacific countries, such as China (87,638 PJ), India (16,531 PJ) and Japan (4,757 PJ).[1] However, in terms of global carbon emissions, Indonesia ranks among the top seven countries,[2] demonstrating the highest rate of increase (Annur 2023). The Indonesian government's policy to implement the downstreaming of mineral resources also promotes the growth of coal-based captive power. Indonesia's captive power generation is expanding approximately five times faster than that of other countries (Pristiandaru 2023). Consequently, Indonesian coal plants may proliferate without restraint due to the absence of the Indonesian Long-term Strategy document for Low Carbon and Climate Resilience (Indonesia LTS-LCCR)[3] 2050 on captive power.

The emergence of coal oligarchs has been fostered since the 2000s when Indonesia increased natural resource exports to recover its economy. The China-induced coal boom spurred their rise in the 2000s, and the Domestic Market Obligation (DMO) and fast-track programmes for coal power plants in the 2010s further supported their growth (Mori 2018). More than 50 per cent of coal production in Indonesia is controlled by nine companies (Table 1). Additionally, many coal business actors are part of a circle close to President Joko Widodo, including Luhut Binsar Pandjaitan, Eric Tohir, Airlangga Hartarto, Johnny G. Plate, Pramono Anung, Wahyu Sakti Trenggono, Nadiem Makarim and Haji Isam (Gunawan 2022). The oligarchic nature of the coal industry has been widely discussed by researchers such as Wibawa and Wardana (2022), Asia Sentinel (2022), Singgih (2022) and Jong (2020). The closeness to political power may reduce transition costs and induce the government to provide more incentives to boost demand for their products such as electric vehicles.

TABLE 1
List of the Largest Coal Companies in Indonesia

No.	*Companies*	*Capacity Production per Year (in million tons)*	*Share to Total Coal Production (%)*
1.	Bumi Resources	78	12.7
2.	Adaro Energy Indonesia	52.7	8.6
3.	Bayan Resources	37.6	6.1
4.	Dian Swastatika Sentosa	33.9	5.5
5.	Indika Energy	35.7	5.8
6.	Bukit Asam (BA)	30	4.9
7.	Golden Energy Mines	29	4.7
8.	Indo Tambang Raya Megah	18.2	3.0
9.	ABM Investama	13.22	2.2
Total 9 companies		328.32	53.5
Total national production		614	100

SOURCE: Calculated from Saumi and Hafiyyan (2022) and ESDM-RI (2023).

The coal industry and its connection to political power are depicted in the film *Sexy Killer*, which exposes the involvement of numerous individuals closely associated with President Jokowi as well as various accompanying environmental issues.[4] Previous research has investigated the motivations and obstacles to achieving net-zero targets. Berger-Schmitz et al. (2023) revealed that a combination of institutional pressure and competitiveness motivates coal companies to set net-zero targets, but large transition costs render them unwilling or incapable of taking action to achieve these targets. However, previous research has insufficiently explored the techno-political dimension, such as the role of companies in influencing the provision of definitions, roadmaps or various standards that align with their interests. To address this research gap, we investigate how Indonesia, rich in coal resources, can transition towards net zero emissions. This study follows two operational questions: How do companies change strategies to encourage progress in greening the economy? Do companies choose green transformation strategically or tactically?

The remainder of this paper is organized as follows. Section 2 reviews previous studies to strengthen the context and identify gaps in the existing literature. Section 3 presents the methodology of the study. Section 4 presents the results, followed by a discussion in section 5. Finally, section 6 concludes the study.

2. Literature Review

Incumbent coal companies have adopted diverse strategies to achieve net-zero emission targets. These strategies vary based on firm-specific factors such as asset positions, perceptions of the costs and benefits of adaptation, socio-economic linkages with the local economy and politics and institutional factors (Mori 2021). These companies can influence the direction and speed of transitions through investments, technological and business model innovations and political and socio-cultural activities. Technological innovation involves research and development, experiments and pilot projects, while business model innovation includes collaborative projects (Heiskanen et al. 2018), alliances, mergers and acquisitions and organizational changes (Magnusson and Werner 2023; Niesten et al. 2024). Political activities encompass lobbying, financial contributions, information strategies and coalitions with political and government actors (Avelino 2017). Socio-cultural activities impact framing, propagation, and social norms (Mori 2019). These activities, both within and between companies, can advance energy transitions by triggering technological and policy feedback effects through alternative policy instruments and infrastructural and institutional developments (Jordan and Matt 2014) and mitigating technological and institutional lock-ins (Mori 2021). Dominant incumbents can wield significant structural power and influence decision-making processes in certain contexts (Lockwood et al. 2019).

In the context of Indonesian coal mining companies, political activities—particularly their closeness to the government and political leaders—warrant attention for three reasons. First, during the commodity boom in the mid-2000s, the coal sector became an attractive source of income that could be leveraged for political purposes at both local and national levels. Second, Indonesia relies on agricultural and extractive commodities for income, foreign exchange, growth and employment. Key business actors in these sectors possess inherent structural power and influence over the regulations governing their investments. Finally, although business access to these sectors depends on the state as the "gatekeeper" of various land and export permits, private sector actors can accumulate enormous wealth over time, especially during boom periods. This accumulation of wealth provides them with autonomy from rent-seeking political and state elites, as well as significant instrumental political power to shape regulatory decisions at the sectoral level (Warburton 2023).

Furthermore, the energy policy circle in Indonesia is closely intertwined with key players in the coal industry. Several ministers are involved in the coal sector, both directly and indirectly, as highlighted by various civil society organizations such as *Jaringan Advokasi Tambang* (mining advocacy network),

Greenpeace Indonesia and Indonesia Corruption Watch. This involvement suggests that the government may adopt more compromising approaches to achieving emission reduction targets in the energy sector. The successful implementation of climate change mitigation policies in the energy sector depends on the extent of policy pressure for coal phaseout on industry shareholders in both the private and public sectors (Ordonez et al. 2022), the credibility of climate policies as well as the policy-related incentives and coordination (Mielke and Steudle 2018). The challenges related to the economy's dependence on coal, potential impacts on employment and the need for significant investment in new technologies (Wang et al. 2023) could also affect the success of climate change mitigation.

A conceptual model concerning the relationship between the state and society in Indonesia (MacIntyre 1990) holds significant relevance within the context of this research framework. This model pertains to the dynamic interplay between bureaucratic government structures and patrimonial clusters. In the patrimonial model, actors maintain their positions by providing material rewards and opportunities to prominent elite members. The model identifies two types of elites: those who compete for patronage and those who accept the established rules. The patrimonial model features a pyramid-shaped network of patron-client relationships where politics is characterized by competition for material gain rather than conflict over substantive policy issues. The state's position is not responsive to societal interests or pressures. Political leadership relies heavily on profit-sharing among elite groups to maintain its position. For example, President Joko Widodo's support for Ridwan Kamil in the regional elections in DKI Province influenced the campaign funds for the candidate pair Ridwan Kamil and Suswono (Rosana et al 2024).

3. Methodology

This study employs a mixed-method approach, beginning with a content analysis. In this scientometric study, two methods were utilized to gain insights into the issues at hand. Firstly, a co-word analysis (Callon et al. 1986) was conducted using a dataset comprised of news articles. Co-word analysis examines the relationships between keywords across a corpus of texts and visualizes these associations graphically. Subsequently, to ensure a comprehensive understanding of the findings on the investigated phenomenon, a qualitative meta-analysis was conducted (Timulak 2014). Diverse news articles related to diversification technology in the energy sector were collected from prominent online newspaper publishers (thejakartapost.com, kompas.co.id, kontan.co.id, and bisnis.co.id) by combining keywords such as: "toba energy" OR "tbs energy"; "adaro energy" OR "ADRO energy"; "Indika energy"; "bumi energy" OR "brms energy"; and "bukit asam energy" OR "ptba energy". Thereafter, a fine-tuned search was conducted using the combined terms "coal" AND "diversification".

The keywords were extracted and analysed to determine their frequencies and co-occurrence. The frequency of a keyword refers to the number of times it appears in all the included articles while co-occurrence frequency indicates the simultaneous occurrence of a pair of keywords. Keywords that appeared more than five times were selected to identify weak signals. Keywords that appeared more than ten times, referred to as high-frequency words in this study, were selected to form the keyword co-occurrence matrix (co-word matrix). Articles on the diversification of coal miners in Indonesia—published between 2016 and May 2023—were retrieved. After filtering out duplicate articles, a total of 257 relevant news articles were included.

We then applied a document-based context analysis at the firm level. Companies were selected based on two perspectives. First, companies were identified where several individuals influencing the company were indicated as being directly and indirectly related to the current government (ICW 2020). These companies include Bumi Group, Adaro Group, Indika Group and Toba Group. These four private companies have strong upstream and downstream links in the coal industry. Additionally, several prominent individuals are responsible for the ownership of these groups, such as the Bakrie family in the

Bumi Group; Sandiago Uno, Teddy Permadi, the Surya Jaya family, the Subianto family and the Thohir family; Agus Lasmini and the Wiwoho Basuki family in the Indika Group; and Luhut Binsar Panjaitan, Fachrul Razi and Djamal Nasser Attamini in the Toba Group. Second, we included Bukit Asam (BA) Ltd., a state-owned enterprise, where the positions of main commissioner and independent directors are currently held by several retired officers from the Indonesian National Armed Forces. BA is one of the oldest coal companies in the world.

4. Results

4.1 Analysis of News from Selected Companies

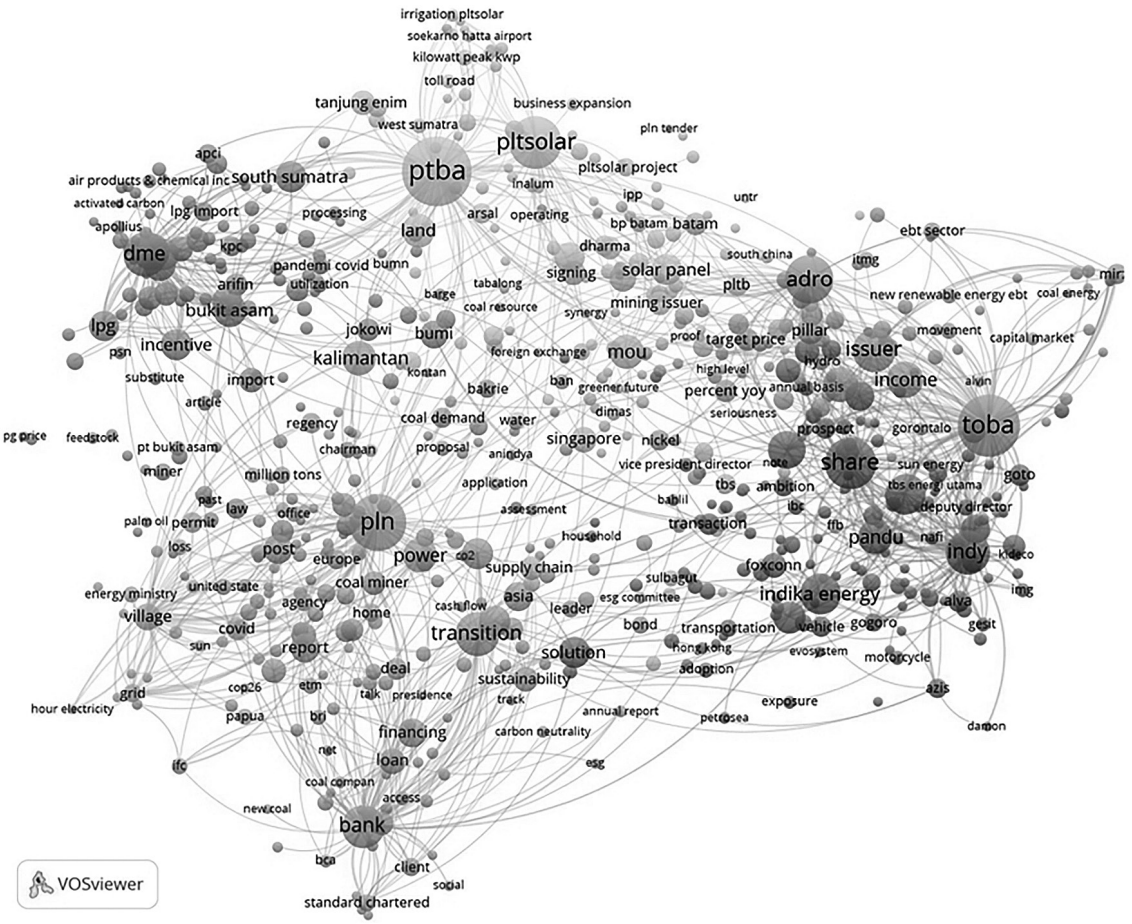
The weak-signal analysis revealed five important findings (Figure 1). First, BA's position is closely related to solar power plants and Dimethyl Ether (DME). Thus, both downstream activities from coal and the development of renewable energy are crucial for BA. Second, the positions of Adaro, Toba and Indika lie in closely connected clusters, indicating that shared values reinforce each other's strengths. For example, Indika and Toba share a common interest in electric vehicles. Solar energy and hydropower are also significant topics in renewable energy for these companies. Third, regarding Bumi, the discussion on renewable energy seems marginalized, with a focus on DME development through its subsidiary, Kaltim Prima Coal (KPC). Fourth, PLN (the state electricity company) holds a strong position among the five companies. Fifth, a connection was found between transition discussions and banks, highlighting the importance of the banking sector in energy transition discussions.

The diversification of Indonesia's coal mining sector is marked by emerging weak signals pointing towards significant transformations in response to global energy transition pressures. Companies are increasingly investing in renewable energy projects—particularly solar power—as indicated by terms like "PLTSolar" and "solar panel", reflecting efforts to leverage Indonesia's abundant sunlight. Additionally, the development of DME as a substitute for imported Liquefied Petroleum Gas (LPG) signals a strategic pivot towards utilizing coal-derived alternatives to reduce energy import dependency. Financial partnerships and international collaboration play a crucial role in this transition, as seen in references to "bank", "financing" and "Standard Chartered" emphasizing the importance of global support in funding green energy projects. Another notable weak signal is the focus on electrification and mobility, particularly through electric vehicle components and battery development, with companies like Indika Energy diversifying into this sector. Simultaneously, local energy access projects targeting rural areas, highlighted by terms like "village" and "grid", showcase the sector's potential to address socio-economic challenges. Furthermore, corporate efforts to align with sustainability goals and capitalize on climate-conscious investments are reflected in terms like "transition", "sustainability" and "solution". These weak signals underscore a strategic repositioning of Indonesia's coal miners, who are leveraging renewable energy, financial innovation and technology to adapt to a low-carbon future while addressing local and global energy needs.

Mapping based on high-frequency data showed a slightly different pattern from the previous results (Figure 2). First, Indika and Toba appeared in a cluster of electric vehicles within the ecosystem, implying potential cooperation or competition (coopetition) between the two companies. Second, Adaro organized an independent renewable energy cluster, indicating significant attention to renewable energy sources. Third, BA and Bumi are positioned in the cluster of greater value-added DME and coal gasification, although terms related to renewable energy are not clearly defined.

Figure 2 emphasizes highly frequent keywords like "PLN", "PTBA", "transition" and "electricity", which dominate the narrative of Indonesia's coal sector diversification. These terms reflect well-established priorities such as state-led energy transition efforts, PLN's central role in electricity management and

FIGURE 1
Mapping of Online News Articles About the Diversification of Coal Miners in Indonesia with Weak Signals

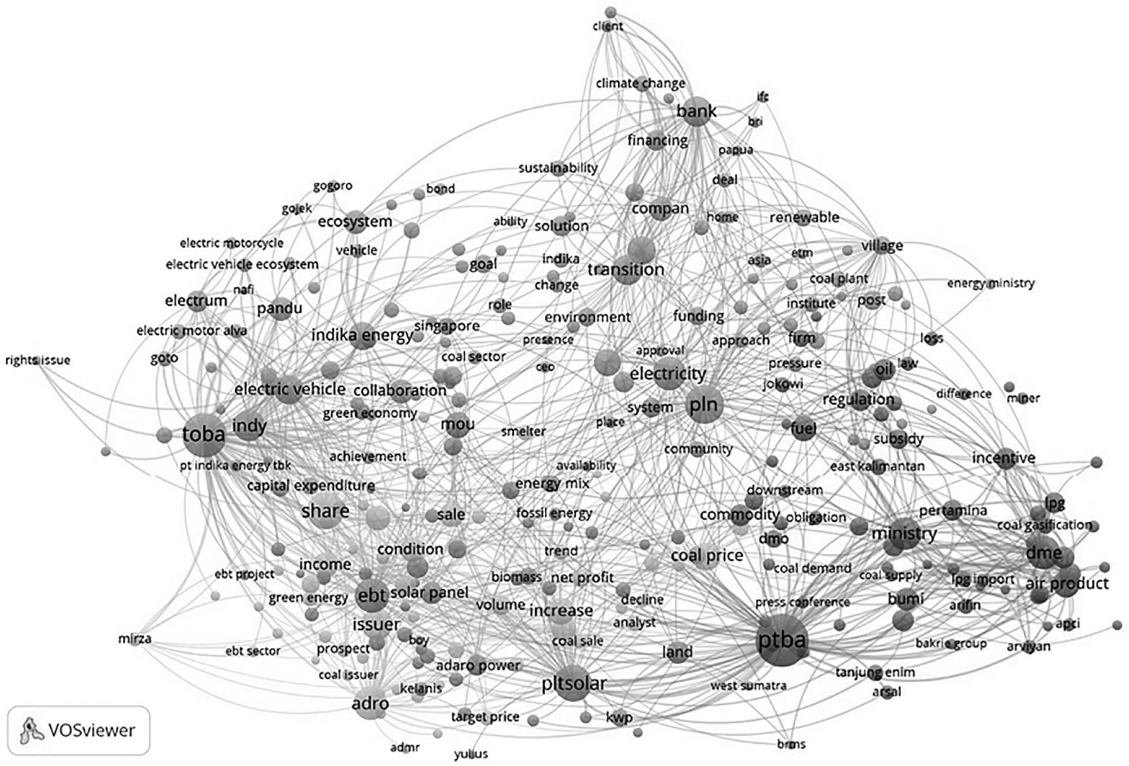


SOURCE: Authors' analysis.

the ongoing push for sustainable energy frameworks. Figure 2 provides an overarching narrative of Indonesia's coal miners' diversification—grounded in dominant, high-frequency terms that underscore established policies, institutional frameworks, and market drivers. By contrast, Figure 1 reveals a layer of weak signals pointing to emerging innovations, local opportunities and less visible shifts that could shape the future of the sector. Together, these maps present a complementary view of Indonesia's energy diversification journey, balancing the stability of dominant trends with the dynamism of early-stage developments.

From a political economy perspective, the two figures collectively show that Indonesia's coal firms are navigating a complex and uneven phaseout process. State-backed firms like BA rely on government policies and support to manage the transition, while private firms like Indika Energy and Toba Bara pursue market-driven opportunities in renewables and electric vehicles. This dual approach reflects the

FIGURE 2
Mapping of Online News Articles About the Diversification of Coal Miners in Indonesia with Highly Frequent Keywords



SOURCE: Authors' analysis.

political economy dynamics where state and private actors play distinct but interlinked roles in the coal phaseout. The weak signals suggest that private firms are positioning themselves for long-term resilience by investing in green technologies. However, these efforts are fragmented compared to the structured, state-driven initiatives highlighted in the dominant signals. Despite diversification efforts, both figures indicate that coal firms remain deeply tied to coal revenues and its political economy. Terms like "coal price" and "commodity" highlight the ongoing dependence on coal, raising questions about the pace and depth of the transition.

4.2 Context Analysis

4.2.1 The Importance of the Coal Industry in the Indonesian Economy. Indonesia's coal supply significantly contributes to the stability of its energy security. Indonesia's coal exports to eight Asia-Pacific countries increased from approximately 72 per cent in 2010 to 91 per cent in 2022 (Table 2). Indonesia's coal potential is substantial, with the latest estimate from the National Energy Council indicating that coal reserves can last up to fifty-nine years. Although Indonesia's domestic demand for

TABLE 2
Indonesia's Coal Exports to Several Asia Pacific Countries (thousand ton)

No.	*Country*	*2010*	*2022*	*Ratio 2022 to 2010*
1	China	44,056	173,323	3.93
2	India	18,640	109,843	5.89
3	Japan	25,776	26,474	1.03
4	Malaysia	11,307	25,314	2.24
5	South Korea	20,643	26,297	1.27
6	Taiwan	14,590	18,038	1.24
7	Thailand	7,175	15,533	2.16
8	Philippines	7,248	30,780	4.25
Total export share to 8 countries			0.72	0.91

SOURCE: ESDM (2023).

coal is lower compared to other Asia-Pacific countries, such as China, India and Japan (IEA 2022), it is expected to increase. In 2022, about 67.7 per cent of the 687.4 million tons of coal produced in Indonesia was exported, a decline from the proportion exported in 2019 (73.7 per cent). Furthermore, of the approximately 215.8 million tons of coal sold domestically, about 60 per cent was consumed for power generation (ESDM-RI 2023).

Additionally, the ban on nickel ore (effective 1 January 2020) significantly boosted the demand for coal in the iron, steel, and metallurgy industries. In 2023, steam coal captive power accounted for 31 per cent of the total installed PLTU (Steam Coal Power Plant) capacity or approximately 10.821 GW. Furthermore, approximately 67.21 per cent of captive power-supported nickel smelters, such as those in Sulawesi, Maluku, Nusa Tenggara and Papua, developed coal-based captive power (Pristiandaru 2023). The demand for coal increased substantially from 1.7 million tons in 2018 to about 49.3 million tons in 2022, rising from 1.5 per cent to approximately 22.87 per cent of total domestic coal sales (ESDM-RI 2023).

Coal holds strategic significance for Indonesia's economy, playing a crucial role in state revenue and exports. In 2021, coal production reached 614 million tons, slightly below the target of 625 million tons. However, the realization of non-tax state revenues (PNBP) from the mineral and coal mining sector in 2021 amounted to IDR75.16 trillion, or 192 per cent of the target set at the beginning of the year (Putri 2022). This increase was driven by soaring coal prices in the international market. Based on coal production and price data from 2021, the total value of coal was approximately IDR1.064 trillion, accounting for 6.27 per cent of Indonesia's total Gross Domestic Product (GDP) and reflecting 68.6 per cent of total government consumption expenditure. In 2021, the value of coal exports reached US$26.533 million, representing approximately 12 per cent of the value of non-oil and gas exports, which is comparable to that of 2015 at around 11 per cent.

Between 2021 and 2030, an additional 13,819 MW of coal-generating capacity will be added, representing approximately 34 per cent of the total planned installed capacity (PLN 2021). This indicates that domestic coal demand will increase in the future. PLN's contribution to construction is only 1,347 MW, or less than 10 per cent of the total PLTU to be built. The growing roles of Independent Power Producers (IPPs), captive power, and plans to optimize mine-mouth power plants indicate that efforts to reduce coal generation have not diminished. However, as stated by the Executive Director of the

Indonesian Coal Mining Association, many coal companies are diversifying into coal-derived products, investing in electric vehicles, and developing renewable energy (Newswire 2021). The transition is easier and faster for large companies, while smaller players, or those whose coal reserves will be exhausted in the next five to ten years, choose to optimize coal sales (ibid.).

4.2.2 The Size of Companies. In 2022, national coal production in Indonesia was approximately 687.45 million tons, with verified reserves amounting to 33,378 million tons (ESDM-RI 2023). The largest five companies accounted for 30 per cent of the total national production and 57 per cent of the total national coal reserves (Table 3). In terms of production, Bumi Resource and Adaro dominate, while in terms of reserves, Bumi Resource holds the highest position. Differences in the size of coal resource ownership can lead to varied responses from each company in addressing the transition to clean energy. Bara Toba Energy and Indika Energy, being relatively smaller players, can move more flexibly towards low-carbon development. This aligns with the findings in the previous section which highlight the positions of Indika and Toba as "first movers" in building an electric vehicle ecosystem compared to other coal companies.

The size of a company's mines has significant implications for its DMO contribution. The DMO is set at 25 per cent of the production plan approved by the government and is implemented to satisfy both general electrical and non-electrical needs. Companies that fail to comply with their DMO obligations are subject to sanctions, including an export ban. However, the substantial price difference between export and domestic coal prices motivates many companies to prioritize coal exports over fulfilling the DMO.

4.3 Adaptation Strategies

4.3.1 Toba Bara Sejahtera (TOBA) Ltd. Toba Bara Sejahtera (TBS) Energi Utama (TOBA) is a coal mining company with mining concessions in Kutai Kertanegara Regency, East Kalimantan. The company holds a mining concession area of 7,087 hectares, with coal reserves of approximately 147 million tons and total resources estimated at 236 million tons (TBS 2012). Luhut B. Panjaitan is the founding shareholder, holding a 99.98 per cent share ownership. In 2010, the company's total assets amounted to US$142.9 million, with a coal production volume of approximately 3.9 million tons. By 2021, the asset value had increased to US$858.1 million, with total coal sales of 2.8 million tons (TBS 2021).

TBS is a coal mining company that plans to transform its business into renewable energy (Kontan 2022a). TOBA aims to generate 80 per cent of its revenue from green energy by 2025, although 83 per

TABLE 3
Profile of Companies' Coal Production and Reserve

No.	*Companies*	*Coal Production (million tons)*	*Reserve (million tons)*	*Share in the National Production (%)*	*Share in the National Reserve (%)*
1.	Bara Toba Energy	2.6	236	0.4	0.71
2.	Bukti Asam Tbk	37.1	3.018	5.4	9.04
3.	Adaro Indonesia	62.88	3.200	9.1	9.59
4.	Bumi Resource	71.9	11.000	10.5	32.96
5.	Indika Energy	34.8	1.550	5.1	4.64
	Total	209.28	19.004	30	57

SOURCE: Annual Report of each company in 2022.

cent of its total current revenue comes from coal-related businesses. Several companies are undertaking similar resolutions. First, Batu Hitam Perkasa (BHP) acquired 100 per cent of its shares from TOBA; in August 2021, TOBA divested all shares owned by BHP in PT Paiton Energi, one of Indonesia's largest coal-generating companies. Subsequently, BHP changed its name to Karya Baru TBS (KBT) and focused on the renewable energy business as well as on electric vehicles and their ecosystem, including battery swapping stations. As a further step, TOBA conducted a joint venture with Gojek and Gogoro for the Electrum company. This new investment is in the field of electric vehicles, such as e-scooters for Gojek drivers, with rental schemes.

TBS (2021) targets carbon neutrality in two phases. The first phase, from 2021 to 2025, involves divesting coal shares and reinvesting in green businesses, with an investment value between US$500 million and US$600 million. The second phase, from 2026 to 2030, entails gradually exiting the coal business and compensating through carbon trading. In 2021, TOBA purchased shares worth US$8 million in a new renewable energy company, Solar United Network (SUN), based in Singapore. Additionally, the company has completed the Sulbagut-1 (2 x 50 MW) Steam Power Plant in North Gorontalo, Gorontalo and Sulut-3 (2 x 50 MW) in North Minahasa, North Sulawesi. The company also announced the development of a mini-hydropower plant with a capacity of 2 x 3 MW in the Way Besay River, Lampung Province and a 22 MW wind power plant in East Nusa Tenggara through its subsidiaries.

4.3.2 Indika Energy Ltd. Indika is building capabilities throughout the coal supply chain, from coal mining to power generation (INDIKA 2009). Founded in 2000, Indika's main business comprises three pillars: Kideco Jaya Agung (Kideco) and Coal Coconut Milk are engaged in energy resources; Petrosea and Tripatra are engaged in energy services; and PT Cirebon Electric Power (CEP) are engaged in energy infrastructure. Kideco's largest concession area covers 50,400 hectares in the Pasir Regency, East Kalimantan, with a total coal reserve of 579 million tons and coal resources of 1,140 million tons. Other areas include Santana Batubara in East Kalimantan and West Kalimantan. In 2009, the accumulated coal reserves were estimated to be 629 million tons. Indika also holds a 20 per cent stake in the Cirebon CEP project which has a capacity of 660 MW and utilizes ultra-supercritical technology. The plant began operating in 2011 under a thirty-year purchase contract with PLN.

Indika (2021) stated that by 2025, approximately 50 per cent of its income will come from non-coal sources and that it aims to achieve net-zero emissions by 2050. Indika aspires "to become energy for Indonesia's sustainable future". Similar to TOBA, Indika has built strong capabilities throughout the coal value chain. In the future, it is expected to transform its business towards logistics and infrastructure, minerals (gold, metals and other minerals), green business (electric vehicles and renewable energy), nature-based solutions, digital ventures and more. As part of its efforts to achieve these plans, the company divested all its shares in October 2021 into Mitrabahtera Segara Sejati (MBSS), an integrated coal logistics and transportation service company which Indika had acquired in 2010.

Indika Energy also divested its subsidiary, MBSS, to reduce exposure in the coal sector (Mahardika 2021). In October 2021, Indika signed a term sheet related to the divestment of 69.8 per cent of shares in PT Petrosea. Efforts were also made to diversify the business towards non-coal resources. PT Indika aims to rebalance its income between coal and non-coal sources. Indika plans to transition from vehicles using fossil fuels to electric vehicles. Additionally, Indika conducted a joint venture for the development of rooftop Solar Photovoltaic (PV) with Kideco Jaya Agung, targeting a development capacity of up to 500 MW by 2025. The company will develop its business in line with its Environmental, Social and Governance (ESG) commitments towards achieving carbon neutrality by 2050.

Indika Energi Tbk has initiated the process of extending the mining contract of its subsidiary, PT Kideco Jaya Agung, as the coal mining concession contract of work (PKP2B) expired on 13 March 2023 (Mudassir 2021). According to the Minerba Law, the PKP2B will be converted into a special mining

business permit (IUPK) upon expiration. Law No. 97 of 2021 stipulates that the contract extension process for the implementation of mineral and coal mining business activities must include evidence of the completion of the exploration, administrative, technical, environmental and financial stages.

4.3.3 Adaro Ltd. Adaro's 2009 Annual Report states that the company's vision is "to be the largest and most efficient integrated coal mining and energy company in Southeast Asia" (Adaro 2008). In 2008, Adaro sold approximately 41 million tons of coal and had a total asset value of approximately US$1.28 billion. Adaro titled its 2021 Annual Report "Shaping Sustainable Futures through Diversification" (Adaro 2021). The report stated that "Adaro Energy Indonesia is a vertically integrated energy company, with businesses in coal, energy, utilities and supporting infrastructure sectors".

The increase in coal prices has been highly beneficial for Adaro, providing ample room for the company to invest in renewable energy, develop the world's largest green industrial estate and strengthen its diversification into renewable energy (Fernando 2022). Through its subsidiary, Adaro Power, the company has built several 130 kWp Rooftop Solar Power Plants in the operational area/special coal terminal in the Kelanis area, Central Kalimantan. Additionally, capacity development was carried out for a 468 kWp PLTS (Solar Power Plant) with a floating system; PLTS Kelanis is claimed to be the largest floating PLTS in Indonesia (598 kWp in total) and achieved Commercial Operation Date (COD) on 27 December 2021 (Kontan 2022a). This solar PV system can produce approximately 749 MWh per year which, in turn, will reduce Adaro Indonesia's diesel consumption by approximately 200,000 litres per year, or approximately US$130,000 per year, along with a reduction in carbon emissions of approximately 500 tons per year (Kontan 2022b).

4.3.4 Bumi Resources Ltd. The company's Annual Report for 2008 stated that the company's vision was to become an international standard in the energy and mining sectors (Bumi Resources 2008). It also evaluated itself as being on track to become the largest thermal coal provider in the world with a medium-term target of reaching 10–15 per cent of global market needs. The two corporate entities at the core of the coal business are Arutmin Indonesia and Kaltim Prima Coal (KPC).

The 2021 report stated that BUMI won the Green Elite award for reducing corporate emissions and the Silver Plus award for transparency in the calculation of emissions at the 2021 Corporate Emissions event (Bumi Resources 2021). This event was organized by Berita Satu Media Holdings and Bumi Global Karbon. The report also states that the company continues to support the world's commitment to reduce carbon emissions and move towards the era of clean energy. Coal diversification should be implemented in the future, wherein BUMI will play a role. This is evident from the interest and collaboration demonstrated by the Bakrie Group to develop the electric vehicle ecosystem (*Tempo* 2022).

4.3.5 Bukit Asam Ltd. BA is a state-owned company that has been operating since 1938, during the Dutch colonial era. In 1950, the Indonesian government nationalized BA. The company appears to focus on increasing the added value of coal through processes such as gasification, coal liquefaction, coal bed methane and biodiesel. BA launched a partnership project to exploit biomass during the cofiring of a mine-mouth PLTU in Tanjung Enim, South Sumatra (Nabila 2022). This effort is part of the company's strategy to accelerate the energy transition toward net-zero emissions by 2060. However, given the large number of new coal reserves owned by BA, the company continues to increase its production capacity (Daelami 2022).

Furthermore, the company is building PLTS on post-mining lands with a potential capacity of approximately 430 MW. The company is currently developing a mine-mouth power plant. Efforts to convert coal to DME have also been initiated to reduce dependence on imported LPG. The company is considering employing Carbon Capture and Utilization Storage (CCUS) technology. As part of its carbon

offset removal strategy, it is reclaiming ex-mining land with an area of approximately 2,144 hectares and revegetating a total of 1.33 million trees (Kontan 2022c).

In summary, Toba, Indika, and Adaro have adopted similar strategies of divestment, diversification and green investment in their coal businesses (Table 4). However, BUMI has not yet clearly demonstrated the steps required to strengthen its position in the green economy while the Bakrie subsidiary has committed to participating in the electric vehicle and battery business (Hadi 2023).

5. Discussion

At varying intensities, it appears that the five companies have begun to explore new business platforms such as electric vehicles and renewable energy. The impetus for diversification is driven by government policy. For instance, Presidential Regulation No. 55 Year 2019 concerning the Acceleration of the Battery-Based Electric Motor Vehicle Program for road transportation. This regulation could only be technically followed up after the issuance of Minister of Finance Regulation (PMK) No. 38 Year 2023 concerning Value Added Tax on the Delivery of Certain Four-Wheeled Electric Motorized Vehicles and Certain Bus Battery-Based Electric Motorized Vehicles Borne by the Government. Additionally, Coordinating Minister for Maritime Affairs and Investment Luhut Binsar Pandjaitan announced that the Battery-Based Electric Motorized Vehicles (KBLBB) subsidy assistance would come into effect on 20 March 2023. Furthermore, Minister of Industry Agus Gumiwang Kartasasmita stated that the subsidy assistance for the purchase of two-wheeled electric motorbikes would be IDR7 million per unit, with a target of 200,000 motorbikes by December 2023 (Kementerian Pendayagunaan Aparatur Negara dan Reformasi Birokrasi 2023). Meanwhile, subsidies for four-wheeled electric cars will be provided to 35,900 vehicles. The two brands confirmed to receive subsidies are the Hyundai Ioniq 5—with a discount of IDR70–80 million—and the Wuling Air EV (Electric Vehicle) with a price reduction of IDR25–35 million (Taufani 2024). This policy is essential for business actors to achieve economies of scale and profitability. However, in providing tax incentives, the government sets requirements for domestic content levels.

TABLE 4
Summary of Strategies Towards Decarbonization

PT Toba Bara Sejahtera (TOBA)	*PT Indika Energy*	*PT Adaro*	*PT BA*	*PT BUMI*
• Share divestment • Diversification of business focus to EV • Joint venture • Carbon trading • Developing renewable energy power plant	• Diversification of business focus to EV • Share divestment • Utilization of electric vehicles in the company • Joint venture in developing renewable energy for power plant	• Green company certificate • Developing green industrial zone • Diversification to renewable energy	• Limited investment in renewable energy • Mixed coal with biomass • Diversification to high-value coal	• Pursuing environmental standards such as Green Elite Award • Developing EV and Battery

SOURCE: Authors' summary.

However, many people disapprove the electric vehicle subsidy policy, considering it to be wrongly targeted as it primarily benefits those who can afford to buy private vehicles (Primantoro 2023). Despite this, the government increased assistance for motorbike conversions from the previous IDR7 million to IDR10 million (Mineral 2023). This indirectly supports the argument of Garcia-Estevez et al. (2024) which states that social pressure on the government is weak when the government is overwhelmed by the support of large investors' requests.

The patrimonial model discussed by MacIntyre (1990) is evident in the relationship between Luhut Pandjaitan, Coordinating Minister for Maritime Affairs and Investment and PT Toba which is involved in developing electric vehicles (Triyoga and Lestari 2023). The involvement of other companies in the electric vehicle business can encourage competition, as stated by Berger-Schmitz et al. (2023). However, this depends on the power structure and its influence on policy formulation, as noted by Warburton (2023). At the time of writing, Luhut Pandjaitan's position remains strong due to the various roles assigned by President Joko Widodo. It appears that Erik Tohir's position as Minister of State-Owned Enterprises will become strategic after he replaced Luhut Pandjaitan during his illness (Deny 2023).

However, it is unclear whether the policy at the corporate level will be a strategic step to accelerate the energy transition or whether the necessary, important efforts made have been sufficient. From the narrative in the previous section, it appears that there is a significant opportunity for "small coal mining" companies to utilize profits from the coal business to "top up" investments in renewable energy. However, this will be challenging for "large coal mining" companies because they are more focused on optimizing mining land concessions to maximize profits. Thus, the energy transition in "small mining" companies can progress faster than in relatively large mining companies.

In the coal utilization context, at least three factors will influence the transition phase. First, the Job Creation Law has further eased the extension of coal mining permits. Among the incentives provided are the guaranteed automatic renewal of a Special Mining Business License (IUPK) for up to a period of 2 × 10 years, no obligation to reduce concession land and royalty incentives of up to zero per cent for companies that build coal downstream facilities. The following companies applied for an extension permit: ADARO, Multi-Harapan Utama Berau Coal, Kedico Jaya Agung and Kendilo Coal.

Second, the roadmap for coal development from 2021 to 2045 states that the vision will be achieved by "increasing national energy security and optimizing the use of coal in the country through an integrated national coal development and/or utilization policy from upstream to downstream". The mission for the development and utilization of coal is to "optimize the use of domestic coal by applying environmentally friendly technology (clean coal technology) until 2045". The continued use of coal for generating purposes is also evident in several government plans, including cofiring biomass for coal power plants and optimizing coal utilization with Integrated Gasification Combined Cycle (IGCC) as well as implementing CCS/CCUS (Carbon Capture, Utilization, and Storage) in coal development and utilization facilities (Maulia 2023). The existence of this road map also strengthens Warburton's (2023) argument that the government wants to optimize the value of coal resources through a regulatory umbrella.

Third, referring to Presidential Regulation (PP) No. 112 of 2022 concerning the Acceleration of Renewable Energy Development for the Supply of Electric Power, government will design a road map to accelerate the end of the operational period of coal-fired power plants. Back then, the regulation stated that the development of new coal plants was prohibited unless they met the following four criteria. First, the PLTU which has been determined in the Electricity Supply Business Plan before it comes into effect. Second, coal plants that are integrated with industry that are oriented towards increasing the added value of natural resources or are included in national strategic projects. Third, the generator owner is committed to reducing greenhouse gas emissions by at least 35 per cent within ten years since the PLTU operates compared to the average PLTU emissions in Indonesia in 202l through technology development, carbon offsets, and/or Renewable Energy mix. Finally, the PLTU will operate until 2050. However, after almost

two years of this regulation in place, efforts to implement early coal retirement are not easy due to financing problems. This aligns with the study conducted by Do and Burke (2024) which suggests that giving policy priority to encourage the growth of renewable energy and stopping the construction of new coal-fired power plants would be the most practical and feasible approach for Vietnam and Indonesia, compared to an initial focus that was too heavily reliant on the closure of coal-fired power plants.

6. Conclusion

Amidst the Indonesian government's commitment to reduce emissions, coal provides significant economic benefits not only for the country but also for many companies operating in the sector. Coal mining companies are strongly connected to government power. These two aspects mean that the transition to clean energy cannot be viewed solely from an economic perspective but also from its connection with power. We researched the transition patterns of five large coal mining companies in Indonesia by exploring their adaptation strategies.

We find that the scale of the mining business influences the determination of energy transition. The land area scale trap causes large-scale mining companies to focus on exploiting coal resources while small-scale coal mining companies tend to be more strategic. Although two of the five companies divested from the core coal business, they mainly adopted diversification into high-value-added coal and investments in renewable energy. Several diversification plans align with the government's direction of developing new and renewable energy sources as well as conserving energy, such as investing in solar power plants and electric vehicles.

Our findings suggest that the government should continue incentivizing the coal oligarchy to diversify its businesses to accelerate energy transitions toward net-zero emissions. Various efforts to provide funds from both within and outside the country as well as the preparation of criteria for PLTU to be retired need to be carried out immediately. Considering Prabowo Subianto's victory in the ongoing general election, which was also supported by President Joko Widodo, the position of the coal oligarchy is expected to remain significant in determining the direction and speed of energy transition in Indonesia.

NOTES

1. Data is obtained from https://www.iea.org/data-and-statistics/charts/world-coal-consumption-1978-2020
2. In 2022, the seven countries with the largest carbon dioxide emissions in succession are (in billion tons): China (11.4); United States (5.1); India (2.8); EU (2.8); Russia (1.7); Japan (1.1); Indonesia (700 million).
3. The LTS-LCCR document is an integral part of the government's commitment to achieve net zero emissions by 2060 or sooner. Regarding the transition in the energy sector, three policies will be pushed by the government, namely: increasing the role of renewable energy in the energy mix, substantially reducing coal consumption, and implementing CCS/CCUS and BECC (Bioenergy with Carbon Capture and Storage).
4. The film entitled *Sexy Killer* is a documentary film produced by Dandhy Laksono. This film was released in 2019 ahead of the 2019 presidential election. This film tells the story of the coal mining industry and its relationship with the country's political elite. This film shows that oligarchic groups in Indonesia have an interest in maintaining coal as the country's main energy source. This also shows that many politicians and political parties are financially supported by the coal industry.

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The Relationship between Air Freight and International Trade

Differences between Singapore and Vietnam

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This study examines the relationship between air freight and international trade in two different economies: Singapore, a developed country, and Vietnam, a developing country. Using monthly data from 1999 to 2022, the study examines the Granger causality test between time series and estimates their interaction using the SARIMAX/(E)GARCH model. The study results confirm a bidirectional causality relationship between air freight and international trade in both countries. International trade is a key explanatory variable for air freight demand, and air freight also promotes international trade. However, their roles are quite different and vary depending on whether they are dependent or explanatory variables as well as the level of development of the economies discussed. Since the onset of the COVID-19 pandemic, air freight has been significantly negatively affected, but it appears to have had a negligible effect on international trade. The specific estimated coefficients from the SARIMAX/(E)GARCH model form the basis for forecasting air freight demand and international trade in the two study countries.

Keywords: causal relationship, air freight, international trade, SARIMAX/(E)GARCH model, Singapore and Vietnam

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1. Introduction

Air transport and international trade are important areas in the economic development of countries, especially with today's ever-increasing international integration. They are considered key manifestations

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of economic globalization (Nguyen 2022). Air cargo service is intensively used to transport international merchandise trade, and it has become an integral part of the linkage system for supply chain management (Yamaguchi 2008). Therefore, there have been several empirical studies on the interplay between air transport and international trade; of course, they are not always the only factors considered. Most of these studies consider a one-way effect, such as the impact of international trade (total volume of imports and exports) or exports on air transport (Akinyemi 2023; Zhang et al. 2019; Pacheco and Fernandes 2017; Kupfer et al. 2017; Zhang 2015; Yao and Yang 2012); or vice versa, the impact of air transport on international trade (Brugnoli et al. 2018; Grosso and Shepherd 2011; Yamaguchi 2008). Nguyen and Tongzon (2010) stated that there has been inadequate effort to study the relationship between transport in general and international trade in depth. This is evident with air cargo transport. To the best of the authors' knowledge, to date, there have been only a few studies examining the bidirectional relationship between air transport and international trade (Van De Vijver et al. 2014; Kupfer et al. 2011; Chang and Ying 2008; Kulendran and Wilson 2000). However, half of these studies pertain to air travel or international travel, specifically the relationship between air travel or international travel and international trade (Van De Vijver et al. 2014; Kulendran and Wilson 2000). Only two studies have examined the relationship between air cargo transport and international trade (Kupfer et al. 2011; Chang and Ying 2008). Chang and Ying (2008) estimate air cargo transport by gross domestic product (GDP) and trade openness as well as trade openness by GDP and air cargo transport using an error correction model (ECM) panel for a sample of Economic Commission for Africa (ECA) countries. Kupfer et al. (2011) estimate the long-run relationship between world air freight and world merchandise exports using the dynamic ordinary least squares (DOLS) model. However, with annual data, these studies have not shown the influence of cyclicality and seasonality as well as external shocks affecting air cargo transport and international trade. In addition, up to now, there is still a lack of research examining this relationship between developed and developing countries. Therefore, studying the relationship between air transport and international trade, as well as forecasting each factor based on the other while considering cyclicality, seasonality and external shocks remains a meaningful topic.

This paper contributes to the existing literature by extending the results of the relationship between air freight and international trade in several directions. First, it provides comparative evidence between developed and developing countries on this relationship. Second, it tests causality and provides specific estimates for the role of international trade in explaining air freight and vice versa using appropriate forecasting models with monthly data to consider cyclicality and seasonality as well as the effects of external shocks. Finally, with data up to 2022, this study allows us to examine the impact of the COVID-19 pandemic on air freight and international trade. When the COVID-19 pandemic first emerged, governments adopted public health measures that affected manufacturing and circulation, prompting a lack of air cargo demand due to restrictions on routine cargo-carrying passenger flights.

To examine this relationship between developed and developing countries, this study chooses two countries in the Southeast Asia region: Singapore and Vietnam. These two countries have starkly different geographical, economic and social conditions. Singapore is a small island nation which in 2022 had a population of only 5.64 million people. However, it belongs to the "high-income" group of countries while Vietnam belongs to the "lower middle-income" group. Vietnam has a land area more than 455 times that of Singapore, and its population ranks thirteenth in the world with 98.19 million people in 2022—17.42 times that of Singapore (World Bank 2023). Singapore's economy is mainly based on trade, services and high technology, making its international trade highly evolved. Although there is no domestic air transport, Singapore has a well-developed aviation industry and has become a major transit hub for the region with its world-class infrastructure and favourable location.

Meanwhile, as a developing country, Vietnam has made significant development strides in the past two decades. Analysis of World Bank data shows that by 2022, the economies of the two countries were

of a similar size. However, the value of Singapore's international trade is still 2.06 times that of Vietnam by value and 32.57 times by value per capita. In contrast, Singapore's air cargo transport is 5.42 times higher than Vietnam's in tonne-km and 94.41 times higher in tonne-km per capita.

Aside from differences in income, international trade value, and per capita freight ton-kilometres, Singapore and Vietnam also exhibit significant disparities in various aspects such as the competitiveness of their business environments, levels of economic development and transportation infrastructure. Specifically, Singapore leads the region in innovation and technology, renowned for its business-friendly environment, transparent legal system and highly advanced financial sector. The country is also regarded as a global multimodal transport hub, boasting modern infrastructure and flexible connectivity across various modes of transport. Meanwhile, Vietnam is still in the early stages of economic development, facing numerous challenges in its business environment such as complex administrative procedures, inconsistent policy enforcement and corruption issues. The Vietnamese economy remains heavily reliant on the industrial manufacturing sector and the growth of small and medium-sized enterprises (SMEs). Although its transportation system and logistics connectivity are improving, they remain fragmented, limiting the country's ability to connect and compete effectively in international markets.

These features suggest that studying the relationship between air freight and international trade in Vietnam and Singapore is meaningful for policymakers and airline administrators and pertinent to compare the empirical results between the two countries with quite different levels of development.

After the introduction, section 2 presents the literature review to provide the theoretical background for the study. Next, the monthly time series of air cargo volume and the international trade value of the two countries are presented in section 3. Section 4 describes the empirical models deployed to test the causal relationship between air freight and international trade and the interplay between them. Following this, section 5 reports the study's results and discusses the findings. Finally, important conclusions and implications from the research results, along with their limitations, are presented in section 6.

2. Literature Review

For a comprehensive overview, the literature review in this study is linked with three streams of research: (1) the relationship between air transport (passenger and cargo) and international trade; (2) the impact of international trade on air freight; and (3) the impact of air freight on international trade.

In the first stream of research, Brugnoli et al. (2018) argued that relatively few papers have focused on the relationship between air transport and international trade. Chang and Ying (2008) examined the relationship between trade openness, air transport freight volume and GDP per capita for the ECA Countries from 1970 to 2002. Using panel cointegration techniques, the authors have shown a cointegration relationship between these three factors and that they are bound together in long-run equilibrium. In addition, positive trade and air freight shocks contribute to real GDP per capita in these countries. Kupfer et al. (2011) examined the relationship between world air freight (by tonne-km) and world merchandise exports (by US dollar) for the period 1981–2008, with particular attention paid to air freight flows between major regions, primarily the route between Europe and Asia. This study points out a strong positive relationship between air freight and commercial cargo in both directions using the ECM and the DOLS estimator. In addition, the study also focuses on estimating the demand for air freight that is explained by the merchandise trade. This study provides insight into the relationship between air freight and merchandise trade on an aggregated and disaggregated level. Van De Vijver et al. (2014) analysed Granger causality between international trade and air passengers (measured by seat numbers) in nine countries in the Asia-Pacific region. Using a heterogeneous time series from 1980 to 2010, the authors show very different results between developed and less developed countries and countries that have adopted liberal approaches to the air transport industry.

In the second stream of research, although there have been a considerable number of studies that consider international trade or its components (exports, imports, trade openness) as one of the explanatory variables for air transport, many concentrate on air passenger transport (Zhang et al. 2019; Pacheco and Fernandes 2017; Zhang 2015) and the studies for air cargo are still rather modest in number. Yao and Yang (2012) used international trade as one of the important explanatory variables for air transport (passengers and cargo at airports) in China from 1995 to 2006. Using the ECM model and random dummy OLS technique, the study showed that economic growth, industrial structure, population density and international trade positively impacted air transport. In contrast, ground transportation has a negative effect and is an alternative mode of air transport. Kupfer et al. (2017) used world merchandise exports and other variables such as the index of airfreight yield, the manufacturing sector's share of world merchandise export volume and the oil price index to explain world air freight (in tonne-km). The authors used the ECM model and fully modified ordinary least squares (FMOLS) regression to show that the long-run elasticity of air freight by merchandise trade in the period 1980–2014 is 0.62, and this elasticity in the short run is revealed to be higher, at 0.82. This study implies that an increase in merchandise trade will lead to a higher increase in air freight in the short run rather than in the long run. Using cointegration and error-correction modelling techniques, Akinyemi (2023) recently examined the short-run and long-run factor effects on air cargo demand in four African countries (Egypt, Kenya, Nigeria and South Africa). The value of merchandise exports is considered an important explanatory variable along with GDP per capita, foreign direct investment (FDI) and real interest rate. Using data from 1980 to 2019, the authors' research shows that the long-run equilibrium relationship between the variables and their impact on the demand for air freight in countries varies. The research results imply that measures are necessary to enhance economic development and trade and improve airport infrastructure.

Several publications are relevant to the third stream of research, but the influence of air transport on international trade in this stream of research is considered in its many different aspects. Yamaguchi (2008) examined the influence of air cargo on international trade in the US through average airfare (yield). Using export data from 1998 to 2002, he found that transport costs were significantly correlated with exports rather than distance. The export elasticity to freight costs is estimated to be –0.571, indicating that air freight costs have a negative impact on international trade. Unlike Yamaguchi (2008), Grosso and Shepherd (2011) examined the influence of air cargo transport on merchandise trade in the Asia-Pacific Economic Cooperation (APEC) region through the degree of air liberalization and other factors such as bilateral tariffs and distance. Using baseline regression, the authors have shown that more liberal air service policies are positively, significantly and strongly associated with bilateral cargo trade. Taking another direction, apart from GDP per capita and some control variables, Brugnoli et al. (2018) examined the impact of air transport on international trade through total available seats and transport infrastructure. The study used an estimation method for gravity models belonging to generalized linear models (PPML) and PPML with panel fixed effects. According to the analysis of Italian data to/from thirty European countries for the period 2004–14, the authors confirmed that civil aviation has a positive impact on international trade with an elasticity of +0.003 per cent to 0.13 per cent depending on the estimation model and the sector.

The above empirical studies have added to the theoretical foundation of the relationship between transport and trade in different contexts—case in point, air freight. International trade, or its components, is a positive explanatory variable for general air transport and air freight. Conversely, the impact of air transport on international trade is displayed in many different areas. More specifically, the cost or price of air transportation is often a barrier to international trade. In contrast, the policy of air liberalization and the development of air transport often promote and have a positive impact.

Additionally, thanks to the development of statistical studies, rich estimators have been proposed to test the causal relationship and the specific impact between variables (Nguyen 2023). The cointegration

test and Granger causal framework are commonly used research tools to examine this topic (Nguyen 2023; Van De Vijver et al. 2014; Chang and Ying 2008). In addition, estimators are also selected appropriately with the data to examine the specific impact of international trade on air transport and vice versa.

The above literature review is an important theoretical basis for certain relationships between international trade and transport in general and between international trade and air transport in particular. It is the theoretical foundation for this study to examine the causal relationship between air freight and international trade and the interplay between them. In this regard, the air freight supply is likely the most appropriate proxy for air freight (tonnes available or tonnes-kilometres available). However, air cargo transport is often combined with regular passenger flights. Consequently, air cargo levels are difficult to determine precisely. Hence, air cargo data is often not available. Therefore, this study uses the tonnes of cargo transported as a proxy for air freight. Cargo transport is closely related to air freight supply through the load utilization factor.

3. Air Cargo Volume and International Trade Value

3.1 Time Series

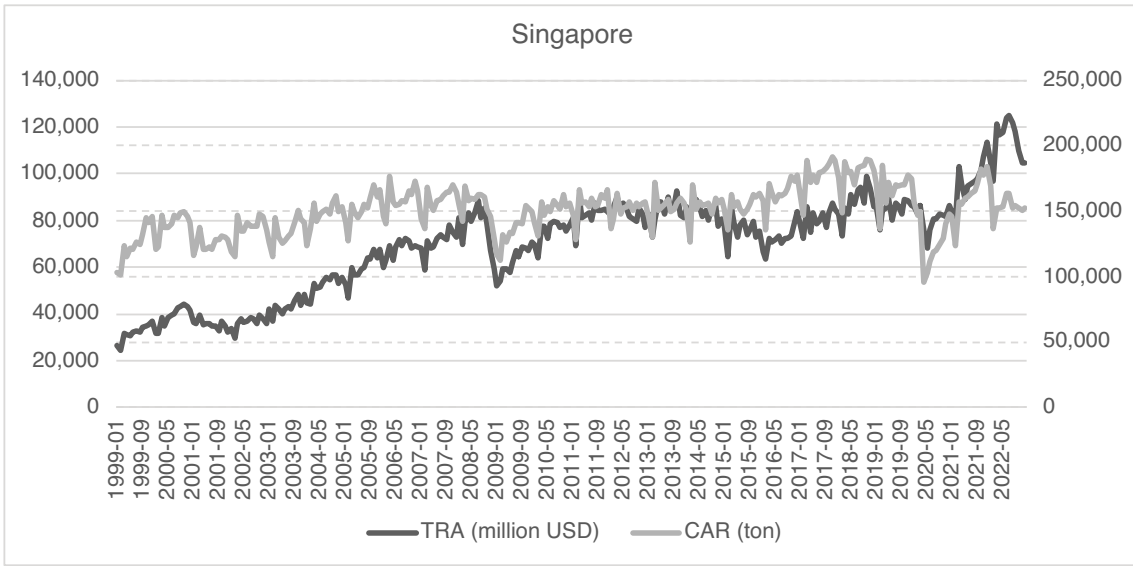
Based on the available data from Vietnam, this study analyses the monthly time series data from 1999 to the end of 2022 for both Singapore and Vietnam. This period encompasses several notable periods of instability, such as 1999 (which was the post-Asian financial and monetary crisis period) and 2022 (which marked the end of the COVID-19 pandemic that began in 2020). However, the impacts of these shocks will be addressed and controlled through the application of the GARCH (Generalized Autoregressive Conditional Heteroskedasticity) model.

According to data published by the Singapore Department of Statistics (2023) and the General Statistics Office of Vietnam (2023), air cargo traffic (CAR) and international trade value (TRA) in the period 1999–2022 tended to increase in both countries (Figures 1 and 2). The value of TRA is measured in current US dollars, as monthly data in real US dollars or purchasing power parity are unavailable, following a similar approach applied in several previous studies (Nguyen et al. 2025; Nguyen 2024; Akinyemi 2023; Nguyen 2022; Brugnoli et al. 2018; Yamaguchi 2008). However, with a low starting point and being a developing country, Vietnam has a much higher average growth rate than Singapore in both these factors. To be more specific, Vietnam has an average increase in air cargo volume and international trade value of 9.13 per cent and 16.32 per cent per year, respectively, much higher than that of Singapore, which has an average growth rate of 0.92 per cent and 5.69 per cent per year, respectively. Figures 1 and 2 present time series trends in air cargo volume and monthly international trade value for the two countries from 1999 to 2022.

The line graphs in Figure 1 show Singapore's TRA and CAR from 1999 to 2022. Starting with US$26.31 billion, TRA fluctuated in an uptrend with peaks of US$88.75, US$92.79, US$98.78, and US$125.15 billion in July 2008, October 2013, October 2018 and July 2022, respectively. The time of the deep decline of TRA was January 2009, February 2016 and February 2022, with a value of US$52.19, US$63.34, and US$96.95 billion, respectively. While the starting CAR was 103.18 thousand tons, it then fluctuated and peaked in March 2006 and October 2018 with numbers of 176.35 and 189.90 thousand tons. The CAR figures fell deeply in February 2009 and April 2020, with values of 112.14 and 95.84 thousand tons, respectively.

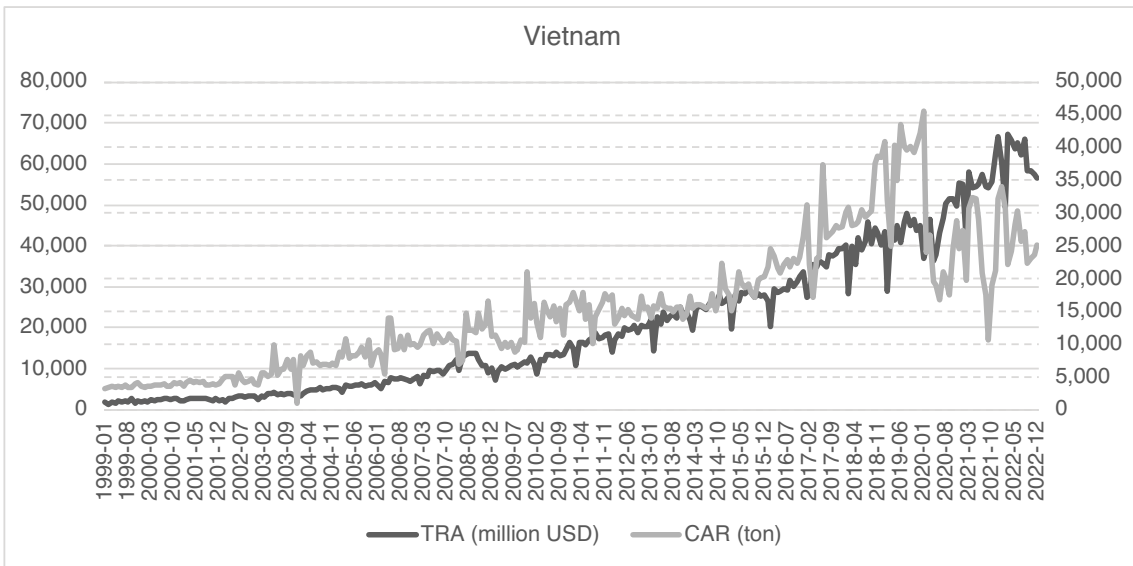
In general, TRA tends to increase quite clearly while CAR has only a slight growth in the whole study period. However, when the COVID-19 pandemic appeared, both TRA and CAR fell deeply. When the growth trend returned, CAR fell deeper and recovered more slowly than TRA. In addition, both time series were reduced at the end of 2008 due to the impact of the global economic crisis. Figure 1

FIGURE 1
Singapore's Air Cargo and International Trade, 1999–2022



NOTE: The unit of TRA is on the left; the unit of CAR is on the right.

FIGURE 2
Vietnam's Air Cargo and International Trade, 1999–2022



NOTE: The unit of TRA is on the left; the unit of CAR is on the right.

also shows similar cyclical and/or seasonal volatility between international trade and air freight in Singapore.

The line graphs in Figure 2 show Vietnam's TRA and CAR from 1999 to 2022. Starting with US$1.81 billion, TRA tends to increase quite steadily and peaks with a value of US$67.13 billion in March 2022. However, Vietnam's TRA reported a deep decline from February 2013 to 2022. While the CAR started at 3.20 thousand tons, it then increased with little volatility. Its volatility was only evident from May 2003 by rising peaks in June 2017 (37.40 thousand tons) and January 2020 (45.60) but fell sharply in June 2020 (16.78 thousand tons) and September 2021 (10.67 thousand tons).

In general, before the COVID-19 pandemic appeared, both time series reported in Vietnam had a relatively high growth trend and were quite similar. However, when the COVID-19 pandemic appeared in early 2020, CAR was deeply reduced. This was especially so with the COVID-19 outbreak in Vietnam between July and November 2021, resulting in many major cities entering lockdown. After the pandemic, CAR tended to increase again, but the output was still quite far from the pre-pandemic figures. In contrast, TRA was not greatly affected by the COVID-19 pandemic; although its value dropped significantly at first, TRA recovered and increased again to pre-pandemic levels. In addition, both the TRA and CAR in Vietnam did not decline too much during the period of the global economic crisis in 2008–9. Figure 2 shows that cyclical and/or seasonal volatilities are only apparent for CAR since 2002 and for TRA since 2008.

Table 1 reports the results of descriptive statistics for the variables, showing the difference in variables between the two countries. Although its population and area are much smaller than Vietnam's, Singapore has a much larger interested variable value. The average value of air freight volume and international trade in Singapore is 9.74 and 3.40 times larger than that of Vietnam, respectively. The standard deviation value also shows that the volatility of the variables is quite large. The time series in Singapore is skewed to the left (evident from the negative skewness value), while the time series in Vietnam is skewed to the right (evident from the positive skewness value). In terms of kurtosis, the time series of air freight has a positive excess kurtosis (evident from a kurtosis value greater than 3), while the time series of international trade has a negative excess kurtosis (evident from a kurtosis value less than 3). In general, the kurtosis and

TABLE 1
Descriptive Statistics of Variables

Statistics	*Singapore*		*Vietnam*	
	CAR	*TRA*	*CAR*	*TRA*
Mean	151,024	70,062	15,499	20,628
Maximum	191,676	125,154	45,600	67,132
Minimum	95,838	24,495	1,000	1,171
Standard deviation	17,973	21,282	9,768	17,783
Skewness	–0.2835	–0.2147	0.8339	0.8623
Kurtosis	3.0440	2.5982	3.1596	2.6811
Jarque-Bera	3.8804	4.1504	33.6819	36.9152
Probability	0.1437	0.1255	0.0000	0.0000
Observations	288	288	288	288
CAGR*	0.92%	5.69%	9.13%	16.32%

NOTE: *CAGR is Compound Annual Growth Rate.

skewness of all the time series are moderate. In addition, the Jarque-Bera test also confirms that the time series in Singapore has a normal distribution, whereas the time series in Vietnam does not confirm this.

3.2 Seasonality and Volatility

Figure 3 shows the seasonality of the time series and the monthly trend of the time series in Singapore and Vietnam, which generally exhibit a certain seasonality.

The line graphs in Figure 3 show the monthly values of TRA and CAR as well as their mean values for the two countries from 1999 to 2022. Although their shapes are different from each other, the shape of the graphs for individual months in each time series is quite similar. Among them, the simplest shape is that of TRA in Vietnam which shows a fairly steady uptrend. Singapore's TRA also shows relatively stable growth except for the period between 2008 to 2020. CAR in Vietnam also had quite stable growth before the COVID-19 pandemic. The most complex shape is that of CAR in Singapore. Although it has the same general upward trend as CAR in Vietnam, its volatilities are more complicated.

The mean values of each month in the time series are somewhat different and show that the studied time series in the two countries exhibit certain seasonality. To be more specific, in Singapore, February is usually the low month for air freight and international while March is the peak month; during the remaining months, demand tends to increase slightly over time. In particular, the seasonality is more evident in air freight. Freight demand is usually low in February and March with February being the low month for international trade. February is often a slack period in air freight volume and international trade value because it often coincides with the Lunar New Year holidays in Singapore and Vietnam when people are on holiday and business activities are suspended. Following that temporary downturn, international trade activities and air freight are usually offset in March.

However, the trajectories in Figures 1 and 2 show that in addition to seasonality, time series also have instances of great volatility. Therefore, in addition to considering the seasonality, it is essential to explore the factors that influence the volatility models of air cargo demand and international trade. Figure 4 shows the volatility of time series in two study countries.

The volatility of the time series in Figure 4 is expressed by the first difference of the variables. Their diverse trajectories indicate very different volatilities. Specifically, the trend of increasing volatility over time is stronger in Vietnam than in Singapore for both time series. The volatility over time is the least for CAR in Singapore and the most for TRA in Vietnam. Among them, there was a large decline in CAR in both Singapore and Vietnam during the early stages of the COVID-19 pandemic.

Figures 1, 2 and 4 indicate that air freight in both countries suffered from a large negative shock and high volatility during the early stages of the COVID-19 pandemic. In addition, both air freight and international trade in Singapore, as well as air freight in Vietnam, suffered a slight shock during the late 2008 to early 2009 period due to the global economic crisis.

4. Empirical Model

Singapore and Vietnam share a relationship in trade and air cargo transport as clearly reflected in the export-import turnover and air cargo volumes between the two countries. During the study period, bilateral trade accounted for 1.8 per cent of Singapore's total international trade value and 6.1 per cent of Vietnam's. In terms of air cargo volumes, this represented 1.7 per cent of Singapore's total air cargo traffic and 16.9 per cent of Vietnam's. However, to analyse the differences between the two countries in the relationship between air cargo transport and international trade, the study opts to use two separate estimation models for each country. This approach aligns with the context of significant differences between the two nations in terms of economic scale, trade policies, the composition of export-import goods and the role of trade

FIGURE 3
Seasonality of Time Series in Two Study Countries

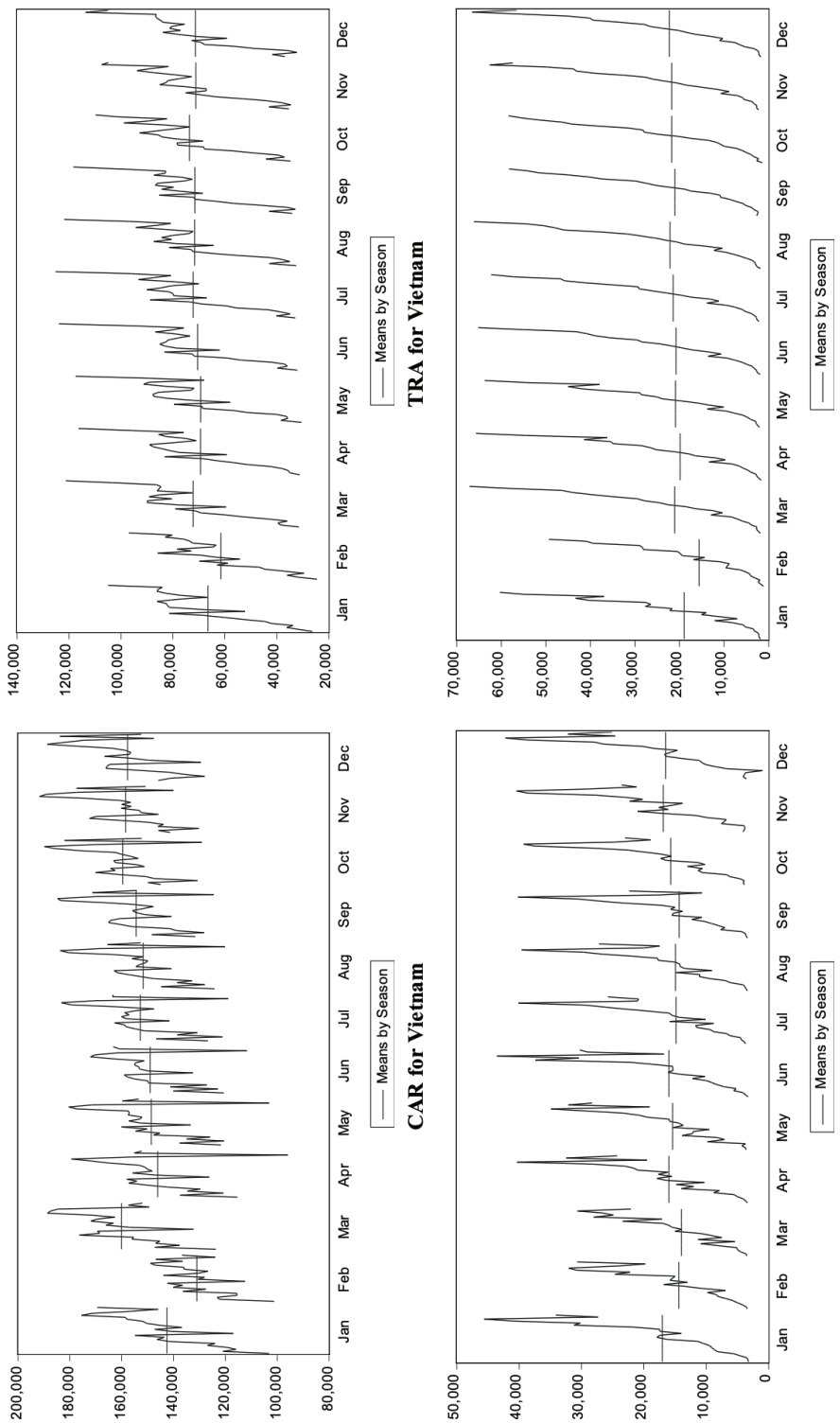
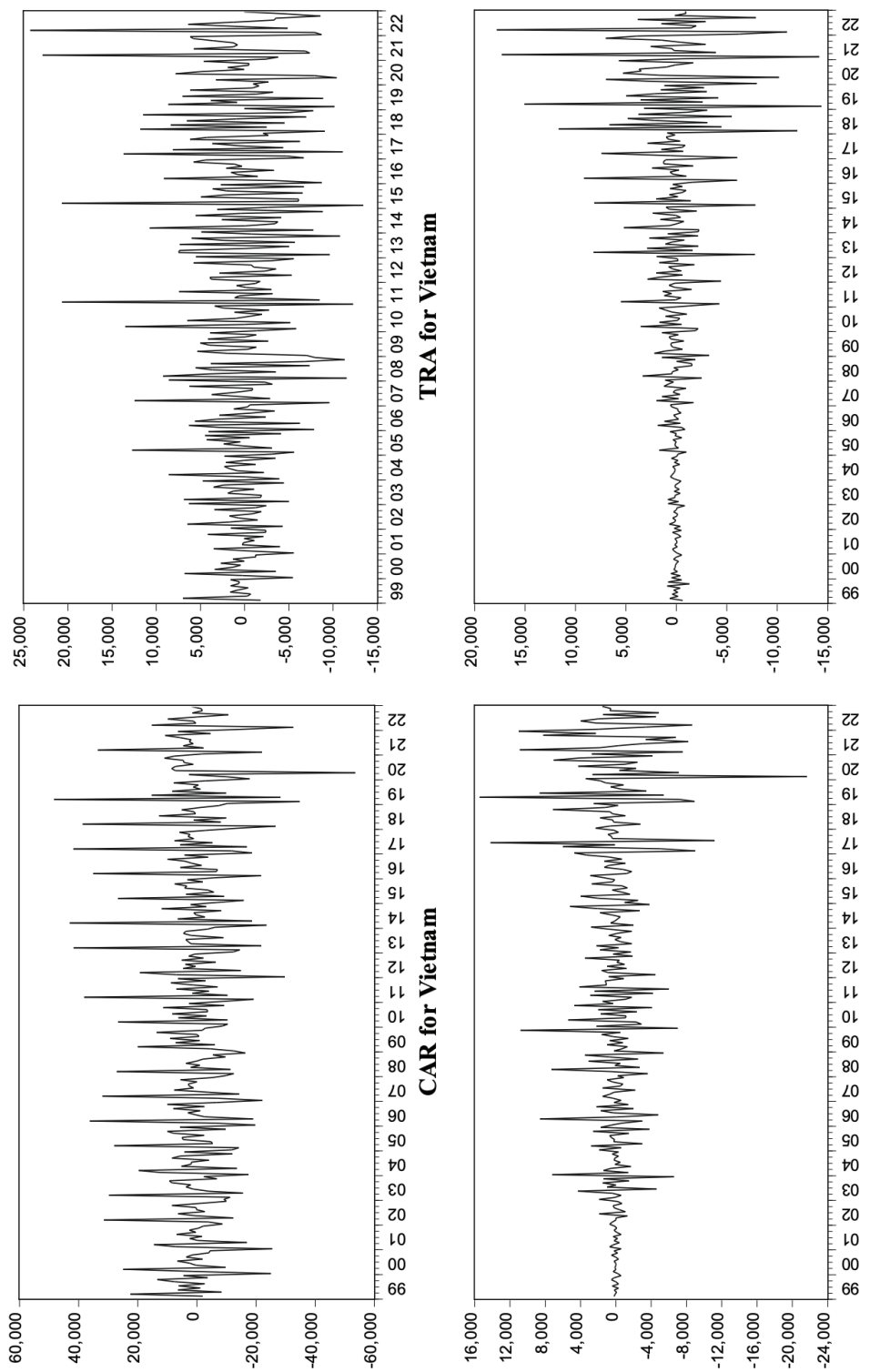


FIGURE 4
Volatility of Time Series in Two Study Countries



in their economies. Additionally, the relatively small share of bilateral trade turnover and air cargo traffic in each country's total ensures independence and minimizes mutual influence when applying separate models.

This study uses a range of econometric techniques to examine the causal relationship between air freight and international trade. First, stationary tests of variables and cointegration tests between variables are performed to select an appropriate causal estimator. Depending on the results of the cointegration test and the appropriate model specification tests, either a vector autoregressions (VAR) model or a vector error correction (VEC) model is performed to test the causal relationship between the variables within the Granger causal framework. This approach investigates whether air cargo transport serves as a cause that enhances the predictability of international trade and vice versa. When a causal relationship exists between the variables, appropriate estimators for monthly time series data are used to consider the interplay of air freight and international trade. In addition, dummy variables were included to examine the impact of the COVID-19 pandemic on air freight and international trade. During the peak periods of the pandemic, governments applied public health measures, resulting in manufacturing delays and a lack of air cargo demand due to restrictions on regular passenger flights. Therefore, the impact of air freight on international trade and vice versa in this study is proposed according to equations (1) and (2) below:

$$CAR_{j,t} = f\,(TRA_{j,t}, Dum_{j,t}) + \varepsilon_{j,t} \quad \text{(Equation 1)}$$

$$TRA_{j,t} = f\,(CAR_{j,t}, Dum_{j,t}) + \varepsilon_{j,t} \quad \text{(Equation 2)}$$

where $CAR_{j,t}$ is the volume of air cargo transported by country j in time t; $TRA_{j,t}$ is the international trade value (exports and imports) of country j in time t; $Dum_{j,t}$ is the dummy variable of country j at time t; $\varepsilon_{j,t}$ is the residual in the model of country j at time t.

Table 1 above shows that the CAR and TRA series in Vietnam are not normally distributed. To ensure stability of the data, the main variables in the models are converted to logarithmic form, except for the dummy variable (*Dum*). This also allows the coefficients of the explanatory variables to be understood as elasticity coefficients.

Although there are several tests for time series, this study uses the augmented Dickey-Fuller (ADF) test because it is commonly used for empirical estimation (Kurihara 2012). The ADF is an augmented version of the Dickey-Fuller test for a larger, more complicated set of time series models. ADF tests the null hypothesis that a unit root is present in a time series sample, implying that the data series is not stationary. The alternative hypothesis is usually stationary or trend-stationary. Table 2 reports the results of the Augmented Dickey-Fuller (ADF) stationary test for the key variables of each country. It is implemented for two patterns, "Intercept" and "Intercept and Trend".

According to Table 2, Ln(CAR) in Singapore is stationary at a level for both patterns "Intercept" and "Intercept and Trend", and Ln(CAR) in Vietnam is stationary at a level for the "Intercept and Trend" pattern. Ln(TRA) in both countries is not stationary at the level in both patterns "Intercept" and "Intercept and Trend". However, after converting to the first difference, all the time series are stationary at a significance level of 0.01 for both patterns. In other words, the countries' data series lnCAR and lnTRA are stationary at the first difference. This result allows us to check the cointegration at the first difference. In accordance with the data, the Johansen Cointegration test is selected and the cointegration test results are presented in Table 3.

According to Table 3, both the Trace test and the Max-eigenvalue test indicate 1 cointegrating equation at a significance level of 0.05 for Singapore. In contrast, the trace and max-eigenvalue tests for Vietnam indicate no cointegration at the same significance level. This means a long-run relationship exists between air freight and international trade in Singapore but not Vietnam. Therefore, to test the causal relationship

TABLE 2
ADF Unit Root Test Results

	Pattern	*Singapore*		*Vietnam*	
		Ln(CAR)	*Ln(TRA)*	*Ln(CAR)*	*Ln(TRA)*
At level	Constant only	–3.3827**	–1.8107	–1.6615	–1.6180
	Constant and trend	–3.8618**	–2.3696	–5.7660***	–1.6068
At 1st difference	Constant only	–4.8206***	–4.7642***	–11.958***	–5.0788***
	Constant and trend	–4.8446***	–4.8174***	–11.9807***	–5.2748***

NOTE: ***, ** and * for significant at the 1 per cent, 5 per cent and 10 per cent levels, respectively.

TABLE 3
Cointegration Test Results

	Singapore		*Vietnam*	
	Trace Test	*Max-Eigenvalue Test*	*Trace Test*	*Max-Eigenvalue Test*
None	22.3048 (0.0040)	18.9012 (0.0086)	24.8900 (0.0659)	19.3859 (0.0500)
At most 1	3.4036 (0.0651)	3.4036 (0.0651)	5.5040 (0.5257)	5.5040 (0.5257)

NOTE: Trend assumption: Linear deterministic trend; Lags interval (in first differences): 1 to 6.

between variables, the VEC model is applied to Singapore and the VAR model is applied to Vietnam. When there is a causal relationship between the variables, the Box-Jenkins Seasonal AutoRegressive Integrated Moving Average with Exogenous Regressors (SARIMAX) and Exponential Generalized AutoRegressive Conditional Heteroskedasticity ((E)GARCH) methods are applied to examine the specific impact of international trade on air freight and vice versa. This method is chosen for the following two main reasons.

Firstly, the SARIMAX model was chosen because it is often applied to time series for analysis of air transport demand (Gudmundsson et al. 2021; Madhavan et al. 2020; Xu et al. 2019) and international trade (Dave et al. 2011). The SARIMAX model is based on the ARIMA model with the addition of explanatory variables (X) and seasonal factors (S). The explanatory variable X in this study includes lnCAR or lnTRA and a dummy variable (DUM). The payment for export and import goods is not always completely concurrent with the delivery process. Therefore, the impact of international trade on air freight and vice versa can have a certain delay which is necessary to include in the models. Furthermore, seasonality is also included in the models because the information in Figures 1, 2 and 3 shows some strong seasonal patterns in the time series. The ARIMA model requires all the time series to be stationary.

As a result from Table 2, lnCAR in Vietnam is stationary at a level for the key pattern "constant and trend", but it is non-stationary for the pattern "constant". However, the trend estimation shows that it has both a constant and a trend (constant coefficient = 8.2871, p = 0.0000; trend coefficient = 0.0079, p = 0.000). Therefore, the pattern "constant and trend" is chosen to examine the stationary of lnCAR in Vietnam. It is convincing evidence that stationary is at a level similar to lnCAR in Singapore. In comparison, lnTRAs in both countries are only stationary at the first difference. Therefore, "Integration" is chosen for lnCAR as 0 and lnTRA as 1 in both countries, and the estimation equation for the SARIMAX model in this study consists of the following equations (3) and (4).

$$\ln CAR = \gamma_0 + \sum_{i=0}^{n} \gamma_1 \ln TRA_i + \delta_0 DUM + \delta_1 AR(k) + \delta_2 MA(1) + \delta_3 SAR(12) + \delta_4 SMA(12) + \varepsilon \quad \text{(Equation 3)}$$

$$\ln TRA = \gamma_0 + \sum_{i=0}^{n} yi\Delta \ln CAR_i + \delta_0 DUM + \delta_1 AR(k) + \delta_2 MA(1) + \delta_3 SAR(12) + \delta_4 SMA(12) + \varepsilon \quad \text{(Equation 4)}$$

where, Δ is the first difference; γ_0 is constant; γ_1 is the coefficient of lnTRA at lag i; δ_0, δ_1, δ_2, δ_3, and δ_4 are the coefficients of DUM , AR(k), MA(l), SAR (12), and SMA(12) respectively; is the residual; k and l are the lags of AR and MA.

Based on the correlation graphs of lnCAR and lnTRA in the first difference, the important lags of AR and MA were determined as seen in Table 4. Accordingly, the partial autocorrelation function (PACF) column indicates the lag for AR while the autocorrelation function (ACF) column indicates the lag for MA. The lag is selected when the values of PACF or ACF exceed the confidence range. The final model selection between the lags of AR and MA is based on the order of criteria: first, the model has the most significant explanatory variables; next, the model with the highest adjusted R^2; finally, the model has the lowest Akaike Information Criterion (AIC) or Schwarz Information Criterion (SIC) value.

Second, the (E)GARCH model was chosen because of its many advantages in empirical application to model the volatility of time series. This model can simulate changes in variance (volatility) over time and explain the differing impacts of positive and negative shocks, thereby improving the accuracy of volatility forecasting. The (E)GARCH model has been successfully applied in studies within the fields of aviation and tourism (Nguyen et al. 2025; Nguyen 2024; Balli et al. 2019; Tsui and Balli 2017; Divino and McAleer 2010). The curves in Figures 1, 2 and 4 indicate that the time series has unusual volatility, especially in the early stages of the COVID-19 pandemic. Moreover, Table 5 reports that all the time series at first difference have significant autocorrelation coefficients, indicating serial correlation up to the 12th lag. The autocorrelation statistics of the squared residuals are also significant up to the 12th lag, indicating strong second-moment dependencies (conditional heteroscedasticity) in the distribution of time series data. These characteristics provide compelling evidence for the existence of autoregression and conditional heteroscedasticity, supporting the selection of the (E)GARCH model. This model facilitates the analysis and forecasting of variance changes in time series, especially when the series exhibit instability or are influenced by shocks, thereby offering deeper insights into how various factors affect data volatility.

The GARCH(1,1) model was chosen in this study because it is generally considered suitable for capturing volatility in time series data (Balli et al. 2019; Tsui and Balli 2017; Divino and McAleer 2010). The specification equation of the GARCH volatility model includes two equations: the mean equation and

TABLE 4
Important Lags of AR and MA

	Singapore		*Vietnam*	
	AR (k)	*MA (l)*	*AR (k)*	*MA (l)*
LnCAR	1, 12	1, 12	1	1
LnTRA	1, 12	1, 12	1	1, 12

TABLE 5
Autocorrelations

	Singapore		*Vietnam*	
	CAR	*DTRA*	*CAR*	*DTRA*
Autocorrelations				
Q(1)	154.00***	45.01***	253.07***	71.38***
Q(2)	278.18***	46.73***	491.55***	71.61***
Q(3)	387.23***	66.23***	711.82***	71.61***
Q(4)	478.54***	78.68***	925.74***	71.61***
Q(5)	555.37***	78.78***	1138.20***	76.20***
Q(6)	617.66***	80.29***	1347.20***	93.04***
Q(7)	670.52***	81.92***	1551.50***	98.92***
Q(8)	712.83***	83.18***	1744.50***	99.41***
Q(9)	747.55***	93.30***	1932.60***	99.48***
Q(10)	775.58***	102.26***	2116.10***	99.88***
Q(11)	804.26***	112.80***	2299.70***	120.48***
Q(12)	874.56***	184.37***	2485.30***	194.81***
Autocorrelations of the Squared Residuals of an AR(1) model				
$Q^2(1)$	9.15***	10.83***	5.32**	56.24***
$Q^2(2)$	9.22**	11.63***	12.36***	66.58***
$Q^2(3)$	11.65***	11.85***	12.72***	70.22***
$Q^2(4)$	16.38***	11.91**	13.24**	70.51***
$Q^2(5)$	21.27***	13.76**	14.37**	70.80***
$Q^2(6)$	27.63***	15.80**	14.42**	73.37***
$Q^2(7)$	32.00***	15.90**	14.42**	75.20***
$Q^2(8)$	36.94***	17.01**	19.75**	76.26***
$Q^2(9)$	41.62***	17.05**	20.53**	79.54***
$Q^2(10)$	41.82***	22.45**	41.14***	85.73***
$Q^2(11)$	55.56***	30.59***	41.55***	123.61***
$Q^2(12)$	145.56***	67.65***	47.63***	199.30***

NOTE: The value in parentheses is the order of lag; ** and *** are the 5 per cent and 1 per cent significance levels, respectively.

the variance equation. Based on the approach by Bollerslev (1986), the variance equation GARCH (1,1) is written into equation (5).

$$\sigma_t^2 = \alpha_0 + \alpha_1 e^2_{t-1} + \beta_1 \sigma^2_{t-1} \quad \text{(Equation 5)}$$

where σ_t^2 is the time-varying conditional variance, α_0 is the mean of the volatility equation, α_1 and β_1 are the coefficients of the ARCH and GARCH effects, e_t is the error term from the mean equation, and t is the time.

According to Divino and McAleer (2010), two important limitations need to be fulfilled when applying the GARCH empirical model: first, all ARCH and GARCH coefficients must be greater than zero; second, the summation of the ARCH and GARCH coefficients should be less than or equal to

1. If these two conditions cannot be met, the EGARCH model can be used as a possible 'asymmetric' volatility model (Balli et al. 2019; Tsui and Balli 2017; Divino and McAleer 2010). In the EGARCH model, conditional variance is an exponential function to ensure its coefficient is always positive. Based on the approach by Coshall (2009), the equation of variance EGARCH (1,1) is written into equation (6).

$$\log\sigma_t^2 = \alpha_0 + \alpha_1 \left| \frac{e_{t-1}}{\sigma_{t-1}} \right| + \phi_1 \frac{e_{t-1}}{\sigma_{t-1}} + \beta_1 \log\sigma^2_{t-1} \qquad \text{(Equation 6)}$$

where, $\log\sigma_t^2$ is the logarithm of conditional variance; α_0 is the mean of the volatility equation; α_1 is the coefficient of the size effect; ϕ_1 is the coefficient of the sign effect; β_1 is the coefficient of the degree of volatility persistence.

5. Results and Discussions

5.1 Causality Test

According to the above cointegration test results, the VEC model is applied in the case of Singapore, and the VAR model is applied in the case of Vietnam to test the standard Granger causality. Table 6 reports the results of the traditional VAR/VEC Granger causality/block homogeneity Wald tests for both countries.

The results in Table 6 report that the p-values are all less than 0.05 for all cases, indicating that there is bidirectional causality between lnCAR and lnTRA in both study countries. This result implies that international trade is useful in explaining and predicting air freight and vice versa. It is also the basis for considering the specific impact of international trade on air freight and air freight on international trade in both study countries.

5.2. Estimating the Interaction Between International Trade and Air Freight Using the SARIMAX / (E)GARCH Model

The results of determining the lag of AR and MA in Table 4 indicate that in the case of Singapore, four SARIMAX/(E)GARCH models need to be tested to select the most appropriate model. While in the case of Vietnam, there is only one model for the impact of international trade on air freight and two models must be tested to choose the impact of air freight on international trade. The delay of the dependent variable in the selected models is at most one as the dependent variables at the second delay and higher are significant. Table 7 reports the estimated results for the impact of international trade on air freight, and Table 8 reports the estimated results for the impact of air freight on international trade. Accordingly, only

TABLE 6
Granger Causality/Block Exogeneity Wald Tests

Country	*Method*	*Null hypothesis*	*Chi-sq*	*df*	*Prob.*	*Causality*
Singapore	VEC	LnTRA → LnCAR	5.3122	1	0.0212**	Yes
		LnCAR → LnTRA	9.4365	1	0.0021***	Yes
Vietnam	VAR	LnTRA → LnCAR	97.4596	1	0.0000***	Yes
		LnCAR → LnTRA	5.0012	1	0.0253**	Yes

NOTE: The lag number is selected to ensure the largest Chi-square (minimum probability).

TABLE 7
Estimating the Impact of International Trade on Air Freight

	Singapore				*Vietnam*
	(1,0,1)-EGARCH	*(1,0,12)-EGARCH*	*(12,0,1)-EGARCH*	*(12,0,12)-EGARCH*	*(1,0,1)-EGARCH*
Mean Equation					
Constant	**7.3114*** **	8.6852***	8.8334***	8.6959***	**3.0353*** **
lnTRA	**0.2733*** **	0.4065***	0.3444***	0.4887***	**0.3287*** **
lnTRA(–1)	**0.1188*** **	–0.1143***	–0.0654*	–0.1971***	**0.3531*** **
DUM	**–0.1359****	–0.2352***	–0.2897***	–0.2865***	**–0.3891*** **
AR(1)	**0.9459*** **	0.7171***			**0.5815*** **
AR(12)			–0.7591***	–0.7622***	
SAR(12)	**0.9864*** **	–0.7543***	0.7189***	0.6087***	**0.6229*** **
MA(1)	**–0.4707*** **		0.3850***		**–0.2789***
MA(12)		0.8766***		–0.1520	
SMA(12)	**–0.9339*** **	0.5088***	0.8005***	0.8677***	**–0.5201*** **
Variance Equation					
α_0	**–6.6260*** **	–4.6488***	–2.2818***	–2.9460***	**–4.5553*** **
α_1	**0.6438*** **	0.6197***	0.6716***	0.8537***	**0.8711*** **
ϕ_1	**–0.0816**	–0.1044	0.0645	0.1348	**0.1288**
β_1	**0.0653**	0.3193	0.7080	0.6177***	**–0.1269**
Statistics					
Adjusted R^2	**0.8675**	0.8072	0.7080	0.5767	**0.9048**
AIC	**–3.6476**	–3.1993	–3.0891	–2.9558	**–0.5504**
SIC	**–3.4893**	–3.0411	–2.9261	–2.7928	**–0.3922**
RMSE	**0.0416**	0.0502	0.0621	0.0748	**0.2039**
MAE	**0.0291**	0.0375	0.0431	0.050	**0.1326**
MAPE	**0.2448**	0.3144	0.3616	0.4203	**1.4257**

NOTE: LnCAR is the dependent variable; Optimization method: Eviews legacy; *, **, and *** denote significance at 10 per cent, 5 per cent, and 1 per cent, respectively.

the GARCH model that reflects the impact of air freight on international trade in Vietnam satisfies the conditions mentioned above. Therefore, in the remaining cases, the EGARCH model is selected.

As shown in Tables 7 and 8, the ARIMA model (1,0,1) was chosen for the impact of international trade on air freight in Singapore, while for the impact of air freight on international trade, the model chosen in Singapore was ARIMA (12,1,1) and that for Vietnam was ARIMA (1,1,1). These models were chosen because they have the most significant explanatory variables and the largest adjusted coefficient R^2 of the compared models. In addition, the selected models also give the lowest root mean square error (RMSE), mean absolute error (MAE) and mean absolute percentage error (MAPE) among the models to be compared. All of these indicators are very small, with the exception of MAPE in models of the impact of air freight on international trade. These statistical values are proof that the models are reliable for forecasting. The adjusted R^2 values of the selected models range from 57.02 per cent to 90.48 per cent, showing that the independent variables explain the relatively high volatility of the dependent variable.

TABLE 8
Estimating the Impact of Air Freight on International Trade

	Singapore				*Vietnam*	
	(1,1,1)-EGARCH	*(1,1,12)-EGARCH*	*(12,1,1)-EGARCH*	*(12,1,12)-EGARCH*	*(1,1,1)-GARCH*	*(1,1,12)-GARCH*
Mean Equation						
Constant	0.0017	0.0019	**0.0025**	0.0001	**0.2403**	0.0956
DlnCAR	0.5374***	0.5455***	**0.5128*** **	0.5427***	**0.0457***	0.0333
DlnCAR(–1)	0.0418	0.0203	**0.0036**	0.0363	**0.0667*** **	0.0615***
DUM	0.0089**	0.0031	**0.0073**	0.0030	**–0.0095**	–0.0092
AR(1)	–0.2185*	–0.3226***			**–0.1722**	–0.4633***
AR(12)			**–0.7995*** **	–0.8689***		
SAR(12)	–0.7224***	–0.8133***	**0.2521*** **	–0.2398***	**1.0017*** **	1.0059***
MA(1)	–0.2691**		**–0.4295*** **		**–0.4498*** **	
MA(12)		0.8841***		0.7956		0.0244
SMA(12)	0.9009***	0.3243***	**0.9102*** **	0.7958	**–0.9700*** **	–0.9761***
Variance Equation						
α_0	–0.6585***	–6.2582***	**–4.5197*** **	–5.5359***	**0.0025*** **	0.0023***
α_1	–0.1149	0.3691*	**0.3762***	0.5497***	**0.3509*** **	0.3739***
ϕ_1	–0.2137***	–0.1638	**–0.2010***	–0.2012		
β_1	0.8738***	–0.0002	**0.2959**	0.1347	**0.3011** **	0.3316**
Statistics						
Adjusted R^2	0.5625	0.5585	**0.5702**	0.5076	**0.6152**	0.5922
AIC	–3.0831	–3.0438	**–3.0736**	–2.9615	**–2.1953**	–2.1500
SIC	–2.9245	–2.8851	**–2.9101**	–2.7981	**–2.0499**	–2.0045
RMSE	0.0514	0.0516	**0.0513**	0.0549	**0.0819**	0.0965
MAE	0.0400	0.0403	**0.0399**	0.0432	**0.0592**	0.0709
MAPE	893.2104	813.8738	**791.4548**	469.4695	**NA**	NA

NOTE: LnTRA is the dependent variable; Optimization method: Eviews legacy; *, **, and *** denote significance at 10 per cent, 5 per cent, and 1 per cent, respectively.

With 288 observations, this study ignores the normal distribution test of residuals as suggested by Wooldridge (2015) on the law of large numbers. As such, the diagnostic test of residuals is only based on the problem of series correlation and the ARCH effect. The ACF histograms of the residuals in the selection models all show that no bars exceed the two boundaries indicating "the residual is white noise". The results of the series correlation test of the normalized squared residuals and the heteroskedasticity test of all selected models are reported in Table 9 and show that the p-values are all greater than 0.05, indicating that there is no evidence of series correlation of normalized squared residuals. In addition, the p-values in the ARCH effect equation are all greater than 0.05, indicating that the models have no ARCH effect or variable variance on the residuals. The results of the diagnostic test are proof of the reliability of the estimated models.

TABLE 9
Diagnostic Test Results

	LnTRA → LnCAR		*LnCAR → LnTRA*	
	Singapore	*Vietnam*	*Singapore*	*Vietnam*
Correlation Test of Standardized Residuals Square				
Q(1)	0.041 (0.839)	0.007 (0.932)	0.006 (0.941)	0.050 (0.823)
Q(2)	0.123 (0.940)	0.179 (0.914)	0.541 (0.763)	0.579 (0.749)
Q(3)	2.190 (0.534)	0.720 (0.868)	0.721 (0.868)	0.601 (0.896)
Q(4)	3.017 (0.555)	1.041 (0.904)	1.772 (0.778)	3.269 (0.514)
Q(5)	3.042 (0.693)	1.210 (0.944)	2.599 (0.762)	3.956 (0.556)
Q(6)	3.144 (0.791)	1.768 (0.940)	2.709 (0.844)	4.453 (0.616)
Q(7)	4.267 (0.749)	9.832 (0.198)	4.508 (0.720)	7.110 (0.418)
Q(8)	5.242 (0.731)	10.101 (0.258)	5.446 (0.709)	7.162 (0.519)
Q(9)	5.267 (0.810)	11.012 (0.275)	5.645 (0.775)	7.331 (0.603)
Q(10)	7.529 (0.675)	11.526 (0.318)	6.585 (0.764)	7.678 (0.660)
Q(11)	8.148 (0.700)	11.758 (0.382)	11.544 (0.399)	7.830 (0.728)
Q(12)	8.171 (0.772)	12.453 (0.410)	12.302 (0.422)	17.590 (0.129)
ARCH Effects (F-statistic in Heteroskedasticity Test)				
	0.040 (0.841)	0.007 (0.933)	0.005 (0.941)	0.049 (0.825)

NOTE: Q(1) to Q(12) are Q statistics of order 1 to 12, respectively; the value in parentheses is the p-value. All p-values are greater than 0.05, so the null hypothesis of series correlation and ARCH effect in the models are rejected.

5.3 Discussion

This study confirms a bidirectional relationship between air freight and international trade in the high-income country of Singapore and the lower middle-income country of Vietnam. These findings are consistent with and support the research results of Chang and Ying (2008). The authors have shown a relationship between trade openness, air freight volume and GDP per capita in ECA countries between 1970 and 2002. The findings are also consistent with the study by Kupfer et al. (2011) as the authors found a strong positive two-way relationship between air freight and world merchandise exports on routes between Europe and Asia. Moreover, this study also points out the different positive roles of international trade and air freight in the remaining factors: high-income and lower middle-income countries.

The estimated results in Table 7 show that international trade is a key variable in explaining air freight demand. It has a positive impact on air freight during the period and one lag month. However, the role of international trade for air freight in Vietnam is higher than in Singapore. More specifically, the total impact factor of international trade on air freight in Vietnam is 0.6818, including 0.3287 for the same period and 0.3531 for the following month while this impact in Singapore is 0.3921, 0.2733 and 0.1188, respectively. These results support previous studies, which have shown that international trade or merchandise export is one of the important factors positively affecting air freight (Akinyemi 2023; Kupfer et al. 2017; Yao and Yang 2012).

Furthermore, it is believed to be quite similar to the study by Kupfer et al. (2017); the authors found that the elasticity of air freight by the world merchandise trade for the period 1980–2014 was 0.62 in the

long run and 0.82 in the short run. The impact coefficient of international trade in Vietnam is higher than in Singapore for several reasons, one of which may be due to the air transport characteristics in Singapore. Singapore has no domestic air transport and is an air transshipment hub; air cargo to or from Singapore may be transit cargo which may be less relevant to international trade than in the case of Vietnam. However, another important reason is that these two countries have very different levels of economic development. Singapore's economy is very developed where trade and services contribute greatly to GDP. In addition, services contribute significantly to the value of imports and exports. Meanwhile, Vietnam's economy is still developing; imports and exports are mainly goods, making international trade more important in explaining the demand for air freight.

In addition, according to Table 7, the negative coefficient of the dummy variable in the case of Vietnam ($\delta_0 = -0.3891$) is higher than that of Singapore ($\delta_0 = -0.1359$), implying that the impact of the COVID-19 pandemic on air freight in Vietnam was more serious than in Singapore. In other words, since the COVID-19 pandemic, air freight in Singapore has recovered faster than in Vietnam. The coefficients of constant, AR, and SAR in the mean equation in Table 7 imply a trend and autoregression with strong cyclic (one month) and seasonal (twelve months) positive coefficients in Singapore and Vietnam. However, the negative moving averages in the SARIMAX model in Singapore (–0.4707 for the cyclic and –0.9339 for the seasonal) are higher than in Vietnam, where only the seasonal moving average is –0.5201. Finally, the trend coefficient (α_0) is reported to be negative in both Singapore and Vietnam (–6.6260 and –4.5553, respectively) indicating a negative trend in air cargo demand in both economies. While the coefficient of the ARCH effect (α_1) is reported that the positive effect parameters are significant in both Singapore (+0.6438) and Vietnam (+0.8711), indicating volatility has a positive effect on air cargo volume in both Singapore and Vietnam, in which Vietnam has the higher level of impact.

In the opposite direction, the estimated results in Table 8 show that air freight has a strong impact (elasticity coefficient is 0.5128) on international trade in Singapore. However, this positive impact coefficient is quite small (0.0667) in Vietnam, with a lag of one month. These imply that developing air cargo transport strongly promotes international trade in Singapore but plays a relatively small role in Vietnam. The countries' different geographical and economic conditions can explain this distinct role. Vietnam has land borders with mainland China, Laos and Cambodia, allowing import and export merchandise to be transported by road with these countries. In contrast, Singapore can only transport import and export merchandise by road with Malaysia. In addition, Singapore's economy is very developed (based on services and technology) while Vietnam is a developing country which exports mainly agricultural products, seafood, processed goods and garments. Therefore, export merchandise in Singapore is usually of higher value and needs to be transported quickly. Air transport has an advantage and accounts for a larger proportion of the total international freight. Although there have been some previous studies examining the causal relationship between air transport and international trade as well as examining the specific impact of air transport on international trade as discussed above, considering the specific impact of air transport on international trade is focused only on passenger transport (Brugnoli et al. 2018) or considering the effect of air freight by yield (Yamaguchi 2008) or air liberalization (Grosso and Shepherd 2011). Therefore, this study can be considered the first attempt to estimate the specific impact of air freight volume on international trade and shows the more important role of air cargo in countries with more developed economies.

The coefficients of the dummy variable in Table 8 are insignificant, implying that a significant impact of the COVID-19 pandemic on international trade has not been found in either country as of April 2020. However, the negative impact of the COVID-19 pandemic on air cargo transport has significantly changed the structural structure of the relationship between air transport and international trade in these two economies, as shown by their trend lines in Figures 1 and 2. The coefficients of AR and SAR in the mean equation in Table 8 indicate only negative cyclical autoregression (one month) in Singapore, but positive

seasonal autoregression in both Singapore and Vietnam, in which a strong trend appeared in Vietnam. The moving averages (MA) with negative cyclical values (one month) are quite similar in Singapore and Vietnam, with values of –0.4295 and –0.4498, respectively. However, the seasonal value (SMA) differs greatly between Singapore and Vietnam, with values of 0.9102 and –0.9700, respectively. Finally, the ARCH and GARCH coefficients are found only in the case of Vietnam, and they show that volatility () and continuous volatility () have a positive effect on international trade in Vietnam.

6. Conclusion, Implications and Limitations

The process of international integration and globalization has been promoting the strong development of many industries and sectors, including international trade and air transport. This study examines the causal relationship between air freight (cargo volume) and international trade (import and export value) in two Southeast Asian countries with different levels of economic development, Singapore and Vietnam, from 1989 to 2022. Empirical results using Granger causality tests in accordance with each country's data confirmed the existence of a bidirectional causality relationship between these two factors in both study countries. This suggests that these two sectors are not only important individually but also interdependent and mutually reinforcing in the development process.

The bidirectional causal relationship indicates that the development of one sector will have positive impacts on the other. Therefore, it is essential to build integrated and coordinated policies to promote the harmonious development of both international trade and air cargo transportation, creating a synergistic effect and optimizing economic benefits while leveraging the unique advantages of each country. For Singapore, the top priority is to maintain its role as a regional hub for goods and passenger transit in Southeast Asia, capitalizing on its leadership position and modern infrastructure. Meanwhile, Vietnam should focus on strengthening connectivity with major trade and air transport centres such as Singapore, thereby effectively leveraging its strategic location and economic potential to promote sustainable and comprehensive development. The governments of both countries should focus on improving the legal framework related to trade and air transport, including simplifying customs procedures, enhancing the transparency of logistics regulations and improving the licensing mechanisms for air cargo carriers. At the same time, enhancing international cooperation through bilateral and multilateral agreements related to these two sectors will help maximize the mutual benefits derived from their interrelationship.

Equally important, this study also estimates the specific impact of international trade on air freight and vice versa in both countries using the SARIMAX/(E)GARCH model. The estimated models are generally appropriate to the data and reliable. International trade is a key variable to explain the demand for air freight. Conversely, air freight also promotes the development of international trade. However, their level of impact is different and diverse which is reflected not only in their role as dependent or explanatory variables but also in different countries.

International trade has a more permanent positive impact on air freight, representing the impact in the period and the following month. The role of international trade in explaining air freight demand is higher in Vietnam than in Singapore. In the opposite direction, the impact of air freight on international trade is much higher in Singapore than in Vietnam. Since the onset of the COVID-19 pandemic, air freight has been significantly negatively affected. However, it does not appear to have greatly impacted both countries' international trade.

These results suggest the need to develop policies that are aligned with the specific characteristics of each country. Vietnam should focus more on developing international trade to promote air cargo transportation while Singapore should invest more in enhancing the quality of air cargo transportation to support international trade. Policies should emphasize the long-term impact of international trade on air transport, particularly in Vietnam, while also effectively leveraging cyclical trends and seasonality.

The SARIMAX/(E)GARCH model not only explains key variables but also provides autoregressive coefficients, moving averages, cycles, seasonality and the impact of external shocks. These factors help accurately forecast the demand for air cargo transportation and international trade in each country. Countries can apply this model to forecast demand, support strategic planning and policy decision-making, thereby optimizing resources and improving logistics efficiency, in line with the context and specific characteristics of each nation.

This study has contributed to the theoretical foundation of the relationship between air freight and international trade through empirical research in two different developed economies, Singapore and Vietnam. In addition to examining the specific impact of air cargo on international trade, the new findings in this study are reflected in the following two important aspects. First, it shows the different roles of international trade and air cargo in different developed economies. International trade plays a more important role in explaining air transport demand in less developed economies, but air cargo plays a more important role in explaining international trade in more developed economies. Second, it shows the different impacts of exogenous shocks, such as the COVID-19 pandemic on air cargo and international trade in economies with different levels of development. The COVID-19 pandemic has negatively affected air cargo but not international trade. Air cargo in a developed economy such as Singapore has adapted faster than in a less developed economy such as Vietnam. In addition, the specific impact coefficients of international trade and air freight and other coefficients in the SARIMAX/(E)GARCH model also have practical significance for the two studied economies. Specific impact factors and useful insights into the impact of shocks on air cargo demand and international trade provide a basis for policymakers and airport and airline managers to forecast demand for air freight and international trade. Accordingly, the SARIMAX/(E)GARCH model is a suitable model to forecast air cargo transport and international trade in both Singapore and Vietnam because they are both cyclical, seasonal and positively affected by other factors.

However, this study only considers the impact of air freight on international trade and vice versa. In addition to international trade, other factors affect air freight, and besides air freight, many other factors affect international trade, such as economic growth, open-door policy and transportation costs. Therefore, further studies combining other variables to model the factors that explain the demand for air freight or international trade are issues that need further attention. In addition, it is reasonable for empirical studies in different contexts to produce different results.

Declaration of Interest Statement

No potential conflict of interest was reported by the author(s).

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Labour-Use Efficiency in ASEAN Countries

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This paper investigates labour-use efficiency across the six largest Association of Southeast Asian Nations (ASEAN) economies—Singapore, Malaysia, Thailand, Vietnam, Indonesia and the Philippines—from 1990 to 2018. The study employs a flexible translog functional form to specify labour demand, defined as a function of output, average wage, capital stock, country-specific variables and time effects. We generalize the model by incorporating a variance function which accommodates marginal effects. The parameters of the demand and variance functions are estimated through a multi-step procedure using generalized least squares and a nonlinear method, respectively. The empirical results show that the average labour-use efficiency among ASEAN countries is about 96.2 per cent, implying that the six ASEAN countries are very efficient in labour use relative to the country with the best labour-use practice in our sample, Singapore. In comparison with Singapore (100 per cent efficient), the labour-use efficiency of Malaysia is 98.3, Vietnam is 96.6, the Philippines is 96.5, Thailand is 94.4, and Indonesia is 91.5 per cent. The two-sample t-test results show that the labour-use efficiency significantly differs between countries.

Keywords: labour, efficiency, ASEAN, labour requirement frontier, elasticity of labour demand, marginal risk effect

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1. Introduction

With an average annual GDP growth rate of 5.7 per cent over the past four and a half decades, the ASEAN region is one the fastest-growing economic regions in the world (Rath 2019, p. 472). The abundant labour

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force is one of the factors driving the GDP growth of this region. As of 2018, the World Bank statistics place ASEAN's labour force at 350.5 million, ranking it the third-largest labour force in the world behind China and India. However, this labour force grows at only about 1.2 per cent annually, while the average GDP grows above 5 per cent. This difference between the GDP and labour growth rate raises the question: How efficiently do ASEAN countries use labour to achieve remarkable economic growth? On the other hand, the current intensive competition at the global and regional scale is expected to motivate ASEAN countries to enhance efficiency in using resources over time, including labour resources through restructuring, reorganization and eliminating slack. In addition, under the impacts of the Fourth Industrial Revolution (4IR), structural reforms carried out by ASEAN policymakers to promote more innovative economies have accelerated the transformation of economies from the labour-intensive type towards the labour-efficient type. The above issues imply that an analysis of the labour-use efficiency of ASEAN countries is desired.

As such, the present paper is the first to investigate labour-use efficiency in the ASEAN context, particularly the six largest ASEAN economies (Singapore, Malaysia, Thailand, Vietnam, Indonesia and the Philippines) from 1990 to 2018. Labour-use efficiency is measured as the distance of the quantity of labour used from the labour demand frontier, where the labour demand frontier is defined as the minimum (optimal) quantity of labour required to produce a given output level (Heshmati 2001, p. 425; Kumbhakar and Hjalmarsson 1995, p. 35). There are two approaches to estimating the efficiency of labour use. First, labour-use efficiency is specified as the ratio of the actual amount of labour used to the optimal amount of labour required (Haouas et al. 2003, p. 201; Kumbhakar et al. 2002, p. 83; Masso and Heshmati 2004, p. 692). Second, labour-use efficiency is estimated as the mean of a stochastic labour requirement frontier function (Heshmati 2001, p. 426; Kumbhakar and Hjalmarsson 1995, p. 35). This study employs the latter approach since following Kumbhakar and Hjalmarsson (1995) where: (1) the notion of the frontier is in line with the fundamental economic theory of optimization; (2) the distance from a frontier is interpreted as a measure of an economic unit's efficiency in pursuing its behavioural or technical objectives; and (3) an understanding of the structure of the frontier and the relative efficiency of economic units provides us with many policy applications.

Using the abovementioned method in balanced panel data, a flexible translog function is employed to specify the labour demand. The labour demand is a function of output (real GDP), average wage, capital stock, country-specific variables that capture the technology and production environment characteristics and time variables. The variance function, which accommodates marginal effects, enters multiplicatively with the demand function. The variance function allows for a specified form of heteroscedasticity in the labour demand function (Heshmati 2001, p. 427). This paper specifies the variance function as a function of output produced, wage, capital stock and a time effect. The parameters of the demand and variance models are estimated through a multi-step procedure using the generalized least squares (GLS) method and a nonlinear method, respectively. Besides the labour-use efficiency, we also calculate the elasticity of labour demand and marginal risk effects with respect to output, wage and capital.

Our paper differs from the literature in two ways. First, to our knowledge, all previous studies investigate the labour-use efficiency of firms or industries in a specific country. Kumbhakar and Hjalmarsson (1995) analysed the labour-use efficiency of 380 local social insurance firms in Sweden from 1974 to 1984. Heshmati (2001) focused on estimating the labour-use efficiency of fifty-five Swedish savings banks from 1990 to 1994. Kumbhakar, Heshmati and Hjalmarsson (2002) examined the labour-use efficiency of Swedish banks from 1984 to 1995. Haouas et al. (2003) measured labour-use efficiency in six manufacturing industries in Tunisia from 1971 to 1996. Masso and Heshmati (2004) studied the efficiency of labour use in Estonian manufacturing enterprises from 1995 to 1999. Kumbhakar and Zhang (2013) analysed labour-use efficiency in China's manufacturing sector from 1999 to 2008. Rashidghalam (2017) estimated the labour-use efficiency of 670 firms in Kenya's

manufacturing and service sectors in 2013. Saggay and Raies (2018) measured labour-use efficiency in seven manufacturing industries in Saudi Arabia from 2007 to 2015. Thus, this paper contributes to the existing literature on labour-use efficiency by investigating labour-use efficiency at the country level. Indeed, the analysis at the country level instead of at the firm or industry level means that the obtained labour-efficiency measures reflect the countries' ability to leverage labour resources and the countries' structural (economic, social and institutional) environment. Such an analysis helps compare the efficiency of resource usage across countries. Our country-level generalization is based on two key assumptions: (1) the aggregate production function which treats labour and capital as inputs for the entire economy's output (Douglas 1928) and allows us to generalize labour efficiency across sectors and (2) institutional theory which emphasizes the role of national institutions in shaping economic performance by influencing transaction costs and resource allocation (Hodgson 1998), justifying a macroeconomic approach. While aggregate measures provide a broader picture of a country's labour potential, they rely on the assumption that variations within sectors can be averaged out to provide meaningful insights at the national level. Therefore, the inability to account for the sectoral differences is a limitation of the present study.

Second, we employ the variance function to generalize the labour demand function to capture risks directly affecting countries' production. Since we employ the labour requirement function approach, the production risk is interpreted as labour variance (Heshmati 2001, pp. 425–26). It is labelled as variance since both the mean and variance of labour respond to different combinations of production. A non-optimal labour level with high deviation significantly affects the productivity of countries when the deviation does not correspond to demands in the event of shocks, such as the COVID-19 pandemic.

2. Literature Review

There are two approaches to estimating labour-use efficiency throughout the literature. First, labour-use efficiency is estimated as the mean of a stochastic labour requirement frontier function. Second, the efficiency of the use of labour is specified as the ratio of the actual labour usage to the optimal labour usage.

2.1 The First Approach

Kumbhakar and Hjalmarsson (1995) analysed the labour-use efficiency of Swedish local social insurance offices from 1974 to 1984. The labour requirement frontier function is specified in terms of outputs. Output is measured in the number of cases of four main types of final output services, and labour is measured in the annual number of working days. The inefficiency component is decomposed into (1) firm-specific, (2) time-varying and (3) the residual components varying across firms and over time. The study applies a three-stage estimation procedure to estimate the parameters of the labour requirement function. Empirical results show that the mean labour-use efficiency varies between 77.42 per cent and 82.85 per cent.

Kumbhakar and Hjalmarsson (1998) investigated the labour-use efficiency of public and private ownership companies to examine whether ownership systematically impacts labour productivity in Swedish electricity retail distribution from 1970 to 1990. The labour-use efficiency is derived in two ways: (1) using the average labour requirement model to capture efficiency differences across different ownership types by allowing the labour requirement function to vary according to the ownership of a firm and (2) using the stochastic labour requirement frontier model in which the basic technology is assumed to be the same for all firms irrespective of their ownership to capture the firm-specific relative labour use efficiency through a one-sided error term. The labour requirement function is expressed in terms

of hedonic outputs, capital, time variables and ownership dummy variables. Their findings suggest that privately owned firms are the most efficient ones.

Heshmati (2001) focused on the estimation of labour-use efficiency of labour in balanced panel data of fifty-three Swedish savings banks from 1990 to 1994. Although labour-use efficiency is estimated as the mean of a stochastic labour requirement frontier function, this paper generalizes the labour demand model by incorporating the variance function. The demand for labour is a function of wages, outputs (public loans, deposits and guarantees), quasi-fixed inputs (inventories) and a time variable. The variance function appears multiplicatively with the demand function. It is specified as a function of services produced, wages, quasi-fixed factors, bank characteristics and a time effect. The empirical results show that the average labour efficiency is about 96 per cent.

2.2 The Second Approach

Kumbhakar et al. (2002), Haouas et al. (2003), Kumbhakar and Zhang (2013) and Saggay and Raies (2018) define labour-use efficiency as the ratio of the actual amount of labour and desired level where the desired level of labour is represented by the labour requirement frontier.

Kumbhakar et al. (2002) examined the labour-use efficiency of Swedish banks during the period 1984–95. In their formulation, the labour requirement frontier is a function of outputs (loans to the public, guarantees and deposits), a quasi-fixed input (capital in a particular year consists of replacement value of all equipment) and firm-specific variables (bank size, bank type and number of branches). The empirical results show that the mean value of labour-use inefficiency ranges from 1.15 to 1.16, indicating an average overuse of labour of 15 per cent to 16 per cent.

Haouas et al. (2003) measured labour-use efficiency in six Tunisian manufacturing industries from 1971 to 1996. In their formulation, the labour requirement function is a function of wages, output and capital stock. The empirical results show that labour-use inefficiency ranges from 9.7 per cent to 64 per cent across industries. The sample mean is 46 per cent, implying that industries closer to the mean are (on average) overusing labour by 46 per cent compared to an industry's own best practice technology.

Kumbhakar and Zhang (2013) analysed labour-use efficiency in China's manufacturing sector from 1999 to 2008. In this case, the labour requirement frontier is specified as a function of total output, capital inventory and control variables that describe the industrial attributes of production technology and environment (whether the industry is a monopoly or capital intensive) and time trend variable. The main findings show that labour-use inefficiency ranges from 32.9 per cent to 100 per cent, with a mean value of 85.5 per cent.

Saggay and Raies (2018) measured labour-use efficiency in seven Saudi manufacturing industries from 2007 to 2015. Here, a flexible translog function of non-Saudi labour, gross domestic product, real Saudi wage and time trend approximates the labour requirement frontier. The empirical results show that the sample mean labour-use inefficiency is 1.387, indicating that industries closest to the mean overused labour by 38.7 per cent compared to an industry's own best practice technology. Among the industries, labour-use inefficiency ranged from 0.8 per cent to 255.6 per cent.

2.3 Both Approaches

Masso and Heshmati (2004) studied the efficiency of labour usage in Estonian manufacturing enterprises from 1995 to 1999. They employ both approaches to compute the labour-use efficiency. The optimal or frontier labour requirement is a function of real value-added, real wage and variables characterizing the production process and environment. The ratio approach revealed that the optimal labour level was 3.5 per

cent larger than the actual level. In contrast, the approach of the mean of a stochastic labour requirement frontier function showed the overuse of labour is 9.1 per cent on average.

In a nutshell, despite several studies on labour-use efficiency, labour efficiency has been analysed only at the firm- or industry-level. The current paper contributes to the existing literature on labour-use efficiency by investigating labour-use efficiency at the country level. As mentioned previously, this study employs the first approach where labour-use efficiency is estimated as the mean of a stochastic labour requirement frontier function.

3. Theoretical Model

3.1 Labour Demand Function

Theoretically, an economic unit is considered inefficient in two cases: (1) its output levels produced are lower than the maximum permitted by its technology or (2) its input levels used are more than the minimum required by its technology—thereby meaning that inputs are overused. In this paper, we follow the second case. We also assume that labour is the only variable input (i.e., all other inputs are quasi-fixed) Hence, a country is not efficient when it uses more labour than the optimal amount of labour required to produce a given output level (Y).

Let the desired labour level (L^*_{it}) be defined as the optimal amount of labour required to produce the given output level (Y_{it}) for country i at time t. This optimal level of labour is defined by the labour requirement frontier, which is specified as:

$$L^*_{it} = f(Y_{it}, K_{it}, W_{it}, Z_{it}, t) \quad \text{(Equation 1)}$$

where $f(.)$ represents the production technology, the subscript i represents the country i and t represents time. Y_{it} is the output, K_{it} is the capital stock, W_{it} is the wage, t indicates the exogenous rate of technical change represented by time trend or time dummy variables, Z_{it} consists of country-specific variables that capture the technology and production environment characteristics that would affect labour inefficiency and the risk (or variance) of employment. According to Layard and Nickell (1986) and Kumbhakar and Zhang (2013), Z_{it} can be GDP growth, export, money supply, exchange rate, government expenditure, saving, domestic credit to the private sector, foreign direct investment, industry value added, R&D investment and human resources quality.

Given K,W, and Z variables, if the country i at time t does not achieve the labour requirement frontier in producing Y_{it}, it is inefficient as there is excessive use of labour compared to the technically required amount. The relationship between the actual amount of labour used and the labour requirement frontier is modelled by Kumbhakar and Hjalmarsson (1995) as follows:

$$L_{it} = L^*_{it} e^{\tau_{it}} \quad \text{(Equation 2)}$$

where L_{it} is the actual quantity of labour used by country i at time t, and $\tau_{it} \geq 0$ for $\forall i$ and t. $\tau_{it} > 0$ represents technical inefficiency, measuring the percentage of labour overuse compared to the optimal level of labour required to produce the output vector Y_{it}. If $\tau_{it} = 0$, country i is technically efficient in labour use. Equation 3 below is used to capture labour-use efficiency.

$$L^*_{it}/L_{it} = e^{-\tau_{it}} \quad \text{(Equation 3)}$$

The value of this ratio varies between 0 and 1 for $\forall i$ and t. Then, given the output Y_{it}, a country's labour demand is determined by: (1) the production technology $f(.)$, (2) technical inefficiency τ_{it} and (3) external factors to a country's control, for example, global economic crisis, international conflicts and trade barriers. These external factors are captured by the random term ϑ_{it} ($-\infty < \vartheta_{it} < \infty$) which is appended in the same manner as τ_{it} in equation (2). Thus, the labour requirement function in equation (2) can be written as:

$$L_{it} = L^*_{it} e^{\tau_{it} + \vartheta_{it}} = L^*_{it} e^{\varepsilon_{it}} \quad \text{(Equation 4)}$$

where $\varepsilon_{it} = \tau_{it} + \vartheta_{it}$, is the error term. Due to the presence of ϑ_{it}, the labour requirement frontier function is stochastic.

Concerning the behaviour of τ_{it}, following Battese and Coelli (1988, p. 393) and Heshmati (2001, p. 427), we assume that τ_{it} is time-invariant, i.e. $\tau_{it} = \mu_i \ \forall \ t$. Thus, the error term in equation (4) is restructured as:

$$\varepsilon_{it} = \mu_i + \vartheta_{it} \quad \text{(Equation 5)}$$

where μ_i is the persistent country-specific labour-use inefficiency which is allowed to be correlated with the regressors. While no further assumptions are made on the distribution of μ_i, ϑ_{it} is assumed to have i.i.d $N(0, 1)$.

The model in equation (4) is specified without regard for risk. Therefore, we employ the variance function to incorporate production risk. Since the approach used is the labour requirement function, the production risk is interpreted as labour variance (Heshmati 2001, pp. 425–26) and specified as a function of all dispersion factors.

3.2 Incorporating Variance Function

To incorporate risk, we rewrite equation 4 as:

$$L_{it} = f(X_{it}; \alpha) \exp(g(X_{it}; \beta)\varepsilon_{it}) \quad \text{(Equation 6)}$$

where $X_{it} = (Y_{it}, K_{it}, W_{it}, Z_{it}, t)$, $f(X_{it}; \alpha)$, is the demand part and $g(X_{it}; \beta)\varepsilon_{it}$ is the variance component. Equation (6) can be written in a logarithmic form as:

$$lnL_{it} = lnf(X_{it}; \alpha) + g(X_{it}; \beta)\varepsilon_{it} \quad \text{(Equation 7)}$$

The expected value of L_{it}, $E(L)$, and its variance, $V(L)$, are:

$$E(L) = f(X; \alpha)\exp(g^2(.)/2) \quad \text{(Equation 8)}$$

$$V(L) = f^2(.)\exp(g^2(.))[\exp(g^2(.)/2) - 1] \quad \text{(Equation 9)}$$

Thus, if $E(L) \geq f(X; \alpha)$, marginal variance (risk) effect with respect to $X_j(Y_{it}, K_{it}, W_{it}, Z_{it}, t)$ is:

$$ME_j = \frac{\delta V(L)}{\delta X_j} = 2f(.)\exp\left(\frac{g^2(.)}{2}\right) \times \left[f_j(.)\left\{\exp\left(g^2(.)\right) - 1\right\} + f(.)g(.)g_j(.)\left\{2\exp\left(g^2(.)\right) - 1\right\}\right] \quad \text{(Equation 10)}$$

where $f_j(.)$ and $g_j(.)$ are partial derivatives of $f(.)$ and $g(.)$ with respect to $X_j(Y_{it}, K_{it}, W_{it}, Z_{it}, t)$. The ME_j can be positive or negative depending on the sign and size of the $g(.)g_j(.)$. If $g(.)g_j(.) > 0$, ME_j is positive. If $g(.)g_j(.) < 0$ and the absolute value of the second term in [.] is greater than that of the first term in [.], ME_j is negative.

4. Data

We obtain the data for our empirical analysis from the World Development Indicators Database and the International Monetary Fund Investment and Capital Stock Dataset. The panel is balanced and consists of six ASEAN countries, including Singapore, Malaysia, Thailand, Vietnam, Indonesia and the Philippines, for twenty-nine years from 1990 to 2018. The total number of observations used is 174.

In this paper, the labour-use model is defined as an input requirement function where labour (*L*) is a function of output produced (*Y*), capital stock (*K*), wage (*W*) and country-specific variables that capture the characteristics of the technology (*Y*) and production environment (*Z*). Labour (*L*) is measured in the total quantity of people aged 15 and older who participate in the country's labour force to produce goods and services. Output (*Y*) is measured as the GDP. Capital stock (*K*) is the sum of private and government capital stock collected from IMF. Wage (*W*) is measured as the average wage per labour and is proxied by the adjusted net national income per capita. Country-specific variables that capture the characteristics of the technology and production environment (*Z*) consist of net inflows of foreign direct investment (*FDI*), government expenditure (*GEX*) and research and development (*R&D*) proxied by the country's number of patent applications. The GDP, gross capital formation, adjusted net national income per capita, net inflows of FDI and government expenditure are given in current US dollars. They are transformed into fixed 2000 prices based on the consumer price index. Additionally, time dummies are used in the demand function to capture the exogenous rate of technical change while the time trend is included in the variance function to represent the shifts in labour variance over time.

The summary statistics for all variables of our interest are reported in Table 1 (see Appendix A for the summary statistics for each country).

TABLE 1
Summary Statistics of the 6 ASEAN Countries, 1990–2018

Variable	*Description*	*Mean*	*Std. Dev*	*Min*	*Max*
L	Labour (million people)	38.60	33.63	1.50	132.74
Y	GDP (US$ billion)	170.31	144.79	0.31	715.22
K	Capital Stock (US$ billion)	444.84	421.92	0.52	2,071.83
W	Average wage (US$)	5,619	9,037.57	3.61	3,4830.66
R&D	Patent applications	469.39	440.88	5	2,271
GEX	Government expenditure (US$ billion)	18.07	15.65	0.02	65.23
FDI	Foreign direct investment, net inflows (US$ billion)	7.99	11.65	–2.89	68.85
t	Time trend (years)	15	8	1	29

5. Empirical Model and Estimation

No assumption on functional form for $f(.)$ and $g(.)$ is made yet. Following the previous studies of the frontier production function (Haouas et al., 2003; Heshmati, 2001; Kumbhakar et al., 2002; Kumbhakar & Hjalmarsson 1995; Kumbhakar & Zhang 2013; Rashidghalam 2017; Saggay and Raies 2018), we approximate $f(.)$ by a translog function to place minimum restrictions on technology. Following Kumbhakar (1993) and Heshmati (2001), we adopt the linear form of $g(.)$. Using the translog function on $f(.)$ and the linear form of $g(.)$, the relationship in equation 6 becomes:

$$lnL_{it} = \alpha_0 + \alpha_y lnY_{it} + \alpha_k lnK_{it} + \alpha_w lnW_{it} + \theta_t + \frac{1}{2}\left[\alpha_{yy}(lnY_{it})^2 + \alpha_{kk}(lnK_{it})^2 + \alpha_{ww}(lnW_{it})^2\right] + \alpha_{yk} lnY_{it} lnK_{it} + \alpha_{yw} lnY_{it} lnW_{it} + \alpha_{kw} lnK_{it} lnW_{it} + \eta_1 lnGEX_{it} + \eta_2 lnFDI_{it} + \eta_3 lnR\&D_{it} + \left[\beta_y Y_{it} + \beta_k K_{it} + \beta_w W_{it} + \beta_t t\right](\mu_i + \vartheta_{it})$$

(Equation 11)

where L_{it}, Y_{it}, K_{it}, W_{it}, GEX_{it}, FDI_{it},[1] and $R\&D_{it}$ are defined above, subscripts i and t denote country and time, respectively. Here, θ_t is a vector of time dummy variables capturing the exogenous rate of technological change.[2] Due to the small sample size, we do not include any interactions between time dummies and other explanatory variables to save degrees of freedom.

Time trend, t, is used in the variance component to capture the shift in the variance over time. The shifts in the variance affect output produced, labour demand and the levels of inefficiency. The effect of technical inefficiency on labour demand is captured by $g(Y_{it}, K_{it}, W_{it}, t; \beta)\mu_i$. Hence, while μ_i is time-invariant, its effect on labour demand may vary with time. Here, μ_i and θ_t are treated as fixed, which implies that we are working with a fixed effects model.

In the labour requirement function, there might be an endogeneity problem because output Y and capital stock K are determined by labour L. To address this problem, we regress output Y and capital stock K on exogenous variables in the model and use their predicted values in equation 11. These exogenous variables are country-specific and include FDI, GEX and R&D as described in the data section.

Following Just and Pope (1978), Kumbhakar (1993), and Heshmati (2001), we estimate equation (11) through the following process:

Step 1: We use ordinary least square (OLS) to estimate equation 11 without regard to the variance function $g(.)$. μ_i is estimated from five country dummies and θ_t are estimated from 28 time dummies. Since the error term (ϑ_{it}) has a mean of zero, the OLS estimators are unbiased and consistent. However, the error term is heteroscedastic due to the omission of the variance function; thus, the OLS estimators here are inefficient.

Step 2: Using α, μ, and θ estimated in step 1, we calculate the residuals as follows:

$$E(\hat{\varepsilon}_{it}) = \ln L_{it} - \Big(\alpha_0 + \alpha_y lnY_{it} + \alpha_k lnK_{it} + \alpha_w lnW_{it} + \theta_t T + \frac{1}{2}\left[\alpha_{yy}(lnY_{it})^2 + \alpha_{kk}(lnK_{it})^2 + \alpha_{ww}(lnW_{it})^2\right] + \alpha_{yk} lnY_{it} lnK_{it} + \alpha_{yw} lnY_{it} lnW_{it} + \alpha_{kw} lnK_{it} lnW_{it} + \eta_1 lnGEX_{it} + \eta_2 lnFDI_{it} + \eta_3 lnR\&D_{it} + \mu_i\Big)$$

(Equation 12)

From equations 11 and 12, we know that:

$$\hat{\varepsilon}_{it} = \left[\beta_y Y_{it} + \beta_k K_{it} + \beta_w W_{it} + \beta_t t\right]\vartheta_{it} \quad \text{(Equation 13)}$$

In logarithmic terms, equation 13 is written as:

$$ln\hat{\varepsilon}_{it} = ln\left[\beta_y Y_{it} + \beta_k K_{it} + \beta_w W_{it} + \beta_t t\right] + ln\vartheta_{it} \quad \text{(Equation 14)}$$

Multiplying both sides of equation 14 by 2, we get:

$$2ln\hat{\varepsilon}_{it} = 2ln\left[\beta_y Y_{it} + \beta_k K_{it} + \beta_w W_{it} + \beta_t t\right] + 2ln\vartheta_{it}$$

$$ln\hat{\varepsilon}_{it}^2 = ln\left[\beta_y Y_{it} + \beta_k K_{it} + \beta_w W_{it} + \beta_t t\right]^2 + ln\vartheta_{it}^2 \quad \text{(Equation 15)}$$

Since ϑ_{it} is assumed to be i.i.d $N(0, 1)$, $ln\vartheta^2_{it}$ is the logarithm of a χ^2 variable with one degree of freedom. Following Theorem 2 of Just and Pope (1978), the estimates of $ln\vartheta^2_{it}$ have mean and variance of –1.2704 and 4.9348, respectively. These specifications were employed in estimating equation 13.

We rewrite equation 15 as:

$$ln\hat{\varepsilon}_{it}^2 = -1.2704 + ln\left[\beta_y Y_{it} + \beta_k K_{it} + \beta_w W_{it} + \beta_t t\right]^2 + ln\vartheta_{it}^2 + 1.2704 \quad \text{(Equation 16)}$$

Let $\vartheta^*_{it} = ln\vartheta^2_{it} + 1.2704 \rightarrow E(\vartheta^*_{it}) = 0 \; and \; V(\vartheta^*_{it}) = 4.9348$. Then, equation 16 becomes:

$$ln\hat{\varepsilon}_{it}^2 = -1.2704 + ln\left[\beta_y Y_{it} + \beta_k K_{it} + \beta_w W_{it} + \beta_t t\right]^2 + \vartheta^*_{it} \quad \text{(Equation 17)}$$

We estimate equation 17 using nonlinear least squares by linearization method to obtain the estimates of β.

Step 3: Using the estimates of μ_i obtained in Step 1, we re-estimate equation 11 using GLS to get asymptotically efficient estimates of α and β. It should be noted that the same results can be obtained by using OLS after dividing both sides of equation 11 by $\hat{g}(.) = \hat{\beta}_y Y_{it} + \hat{\beta}_k K_{it} + \hat{\beta}_w W_{it} + \hat{\beta}_t t)$.

Step 4: We iteratively repeat Steps 1 to 3 until convergence where changes in the estimates of α, β and the value of the labour requirement function are negligible.

Step 5: Since we estimate μ_i from country dummies, the μ for reference country cannot be estimated. Thus, labour-use inefficiency is measured relative to the most efficient country each year in our sample, assuming $\mu = 0$ (fully efficient) for the most efficient country. The country- and time-specific labour-use inefficiency is calculated as:

$$LINEFF_{it} = g\left(X_{it}; \hat{\beta}\right)(\alpha_0 + \mu_i) - \min_t\left[g\left(X_{it}; \hat{\beta}\right)(\alpha_0 + \mu_i)\right] \quad \text{(Equation 18)}$$

Conversely, the country- and time-specific labour-use efficiency can be estimated as:

$$LEFF_{it} = \exp(-LINEFF_{it}) \quad \text{(Equation 19)}$$

Next, the elasticities of labour demand with respect to output, capital stock, and wage need to be calculated at all data points for making an economic inference, where E_y represents the return to scale.

$$E_y = \frac{\partial \ln L_{it}}{\partial \ln Y_{it}} = \alpha_y + \alpha_{yy} \ln Y_{it} + \alpha_{yk} lnK_{it} + \alpha_{yw} \ln W_{it} \quad \text{(Equation 20)}$$

$$E_k = \frac{\partial \ln L_{it}}{\partial \ln K_{it}} = \alpha_k + \alpha_{kk} \ln K_{it} + \alpha_{yk} lnY_{it} + \alpha_{kw} \ln W_{it} \quad \text{(Equation 21)}$$

$$E_w = \frac{\partial \ln L_{it}}{\partial \ln W_{it}} = \alpha_w + \alpha_{ww} \ln W_{it} + \alpha_{yw} lnY_{it} + \alpha_{kw} \ln K_{it} \quad \text{(Equation 22)}$$

Since we do not allow any interactions between the time dummies and the other regressors, the exogenous rate of technical change comprises only a neutral component (i.e., varies only over time). Therefore, following Heshmati (2001), the technical change—which is a shift in labour demand function over time—is obtained as the elasticity of labour with respect to time

$$E_t = \frac{\Delta \ln L_{it}}{\Delta \ln t} = \theta_t - \theta_{t-1} \quad \text{(Equation 23)}$$

If $E_t > 0$, an upward shift in the labour requirement function implies that more labour-using technology is employed. If $E_t > 0$, a downward shift in the labour requirement function implies labour-saving technical progress.

Finally, the marginal variance (risk) effects ME_y, ME_k and ME_w based on $g(.)$ are calculated using the formula in equation 10. $ME_j > 0$ suggests that the variable j is variance increasing and vice versa. $ME_y > 0$ suggests that an expansion in output level increases the labour-use variance and vice versa.

Since the translog form is a point approximation of $f(.)$ with the unknown functional form, the data is normalized by the sample mean before estimating the model.

6. Results

Using the empirical model and estimation procedure above, we estimate the labour demand function for six ASEAN countries in twenty-nine years from 1990 to 2018. The parameter estimates of the demand function, $f(X_{it}, \alpha)$, are reported in section A of Appendix B. All country-specific effects (μ) are statistically significant at 1 per cent. Only six out of twenty-eight time-specific (θ) effects are significantly different from zero. The government expenditure (η_1) and R&D investment (η_3) are found to significantly affect the amount of labour used at 1 per cent and 5 per cent significance levels, respectively.

The parameter estimates of variance function, $g(X_{it}, \beta)$ obtained from equation 13, are reported in section B of Appendix B. The variance coefficient of output (β_y) is negative and that of capital wages (β_k and β_w) are both positive. However, all three coefficients are insignificant. The variance coefficients of average time (β_t) significantly positively differ from zero at 1 per cent significance levels.

6.1 Labour Demand Elasticity

The elasticities of labour demand to output, wage and capital were computed for each country each year. The labour demand elasticities to all dispersion factors are country- and time-specific. The mean values by country and year are reported in Table 2. The mean values of elasticities are consistent with theory: the elasticities of labour to wage and capital are negative and the elasticities of labour to output are positive. The responsiveness of labour is highest to output, followed by wage and capital.

The sample mean of labour to output elasticity is 0.72 and a standard deviation of 0.153. The estimate of 0.72 means that a 1 per cent increase in the volume of GDP is associated with a 0.72 per cent increase in labour used. This implies increasing returns to scale in ASEAN economies, i.e., increasing output by k per cent will result in less than k per cent increase in labour requirement. Moreover, the responsiveness of labour to output considerably varies across countries. Singapore has the largest output elasticity (1.012) which is almost double Indonesia's labour responsiveness to output (0.535). This finding aligns with Furceri et al. (2012) finding that the labour elasticity to output in high-income countries is about three times larger than in low-income countries.

The sample mean of labour-to-wage elasticity is –0.377, with a standard deviation of 0.113. There is an observable continuous and slow decline in the size of wage elasticity over time (from –0.399 to –0.353 for twenty-nine years); this indicates that adjustment in labour to changes in wage due to labour market conditions is a slow process. Theoretically, we may observe this decreasing pattern because the closer the quantity of labour used is to the optimal level, the smaller the change in labour to the change in wage (Heshmati 2001). From a practical perspective, this decreasing pattern can also be explained by the continuous increase in the quality of labour in ASEAN countries. The more specialized labour, the higher the cost of labour substitution, leading to the demand for labour being more inelastic to the wage rate. The increase in the skilled labour flow in ASEAN results from the policies involved in creating new training programs or enhancing existing ones in this region (Gama et al. 2019).

The sample mean of labour-to-capital elasticity is –0.113, with a standard deviation of 0.052. The negative labour-to-capital elasticity implies that capital and labour are substitutes. The capital elasticity is of the highest magnitude in Singapore (–0.186) and lowest in Thailand (–0.063). Thus, Singapore is the most effective in substituting labour with capital among ASEAN countries.

6.2 Technical Change

The values of the exogenous rate of technical change, defined as the shift in the labour demand function over time, are reported in column 4 of Table 2. The labour demand elasticity with respect to technical change is the same across the six ASEAN economies. This can be explained by the new geography theory proposed by Krugman (1991). Countries in close geographical and economic proximity, like the ASEAN economies, may experience technology diffusion through trade and investment. This is further reinforced by the free trade agreements between the ASEAN economies, such as the ASEAN Free Trade Area (AFTA). This can lead to similar rates of technological change despite differing industrial structures. The empirical results from Tu and Tan (2012) and Lee and Tan (2006) confirm this technology spillover among ASEAN countries. However, it is noteworthy that the proxy used (time) may not fully capture the nuanced differences in technological adoption between these economies. This is a key limitation here.

TABLE 2
Output, Capital, and Wage Elasticities and Marginal Effects by Country and Year

Country/ Year	Labour Demand Elasticity				Marginal Variance Effect				Efficiency
	GDP (1)	Capital (2)	Wage (3)	Time (4)	GDP (5)	Capital (6)	Wage (7)	Time (8)	(9)
Mean by country									
Indonesia	0.535	–0.071	–0.231	0.000	–0.123	–0.124	–0.098	–0.008	0.915
Malaysia	0.778	–0.122	–0.425	0.000	–0.001	–0.001	–0.036	0.000	0.983
Philippines	0.661	–0.092	–0.342	0.000	–0.009	–0.035	–0.005	–0.001	0.964
Singapore	1.012	–0.186	–0.590	0.000	0.000	–0.001	0.000	0.000	1.000
Thailand	0.645	–0.063	–0.353	0.000	–0.051	0.002	–0.021	–0.001	0.944
Vietnam	0.691	–0.145	–0.320	0.000	0.190	–0.019	–0.005	–0.001	0.966
Mean by year									
1990	0.743	–0.119	–0.399	0.000	0.003	–0.003	0.000	0.000	0.993
1991	0.750	–0.125	–0.398	–0.009	0.005	–0.003	0.000	0.000	0.991
1992	0.747	–0.123	–0.397	–0.002	0.012	–0.004	–0.001	0.000	0.989
1993	0.746	–0.123	–0.395	0.007	–0.005	–0.006	–0.001	0.000	0.987
1994	0.750	–0.127	–0.394	0.001	–0.299	0.047	–0.001	0.000	0.985
1995	0.753	–0.131	–0.391	0.000	–0.009	0.136	–0.002	0.000	0.982
1996	0.749	–0.129	–0.389	0.013	–0.007	–0.002	–0.002	–0.001	0.980
1997	0.740	–0.122	–0.389	0.007	0.014	–0.158	–0.002	–0.001	0.979
1998	0.709	–0.093	–0.391	0.036	0.015	–0.010	–0.002	–0.001	0.977
1999	0.710	–0.095	–0.388	–0.001	0.045	–0.018	–0.003	–0.001	0.974
2000	0.621	–0.035	–0.397	0.254	0.005	–0.009	–0.001	–0.001	0.983
2001	0.704	–0.095	–0.383	–0.249	0.084	–0.019	–0.003	–0.001	0.972
2002	0.707	–0.099	–0.382	–0.004	–0.063	–0.065	–0.004	–0.001	0.971
2003	0.708	–0.100	–0.380	–0.005	–0.018	–0.009	–0.005	–0.001	0.968
2004	0.710	–0.105	–0.376	–0.016	0.001	–0.014	–0.006	–0.001	0.966
2005	0.710	–0.107	–0.373	–0.019	0.126	–0.016	–0.007	–0.001	0.964
2006	0.714	–0.111	–0.372	0.001	–0.041	–0.022	–0.010	–0.002	0.960
2007	0.720	–0.118	–0.369	0.001	–0.019	–0.026	–0.013	–0.002	0.957
2008	0.717	–0.117	–0.367	–0.001	–0.019	–0.033	–0.018	–0.002	0.953
2009	0.704	–0.104	–0.367	0.027	–0.024	–0.039	–0.024	–0.003	0.948
2010	0.719	–0.119	–0.366	–0.011	0.027	–0.043	–0.041	–0.003	0.944
2011	0.721	–0.121	–0.363	0.001	–0.100	–0.052	–0.045	–0.003	0.940
2012	0.721	–0.123	–0.361	0.001	–0.062	–0.055	–0.051	–0.003	0.938
2013	0.720	–0.123	–0.360	0.001	–0.052	–0.065	–0.050	–0.003	0.937
2014	0.718	–0.122	–0.360	0.003	–0.050	–0.074	–0.052	–0.004	0.935
2015	0.716	–0.121	–0.358	0.001	–0.047	–0.068	–0.064	–0.004	0.934
2016	0.720	–0.126	–0.358	–0.008	–0.035	–0.068	–0.073	–0.004	0.932
2017	0.722	–0.129	–0.355	–0.021	0.014	–0.071	–0.084	–0.004	0.930
2018	0.720	–0.129	–0.353	–0.013	0.522	–0.095	–0.234	–0.004	0.928
Mean	0.720	–0.113	–0.377	0.000	0.001	–0.030	–0.028	–0.002	0.962
Std. Dev	0.153	0.052	0.113	0.067	0.339	0.117	0.093	0.004	0.039

6.3 Labour-Use Variance

The parameter estimates of variance function, $g(X_{it}, \beta)$ are reported in Appendix B. The variance coefficient of output (β_y) is negative and that of capital wages (β_k and β_w) are both positive. However, all three coefficients are insignificant. $\beta_w = 0.002$ suggests that each dollar wage increase is accompanied by about a 0.2 per cent increase in the residual variance of labour used. β_t is significantly different from zero, implying that the time trend used in the variance function can capture a neutral shift in the labour variance over time. The estimate of the variance, σ^2_v, is 7.9806.

The labour variance elasticities or marginal variance (risk) effects with respect to the output, capital, wage and time in equation 10 were computed for each country in each year. Columns 5–8 of Table 2 report the mean values by country and year together with the overall sample mean of marginal effect.

The sample mean of marginal effects with respect to capital, wage and time are negative. However, the marginal effects of time and capital are positive for Malaysia and Thailand, respectively, albeit these effects are very small. The marginal effect for Singapore is also positive for all except capital, however, its magnitude is also negligible (zero up to 3 decimals). Thus, overall, with production levels closer to the sample mean, the variance of labour used decreases with the increase in capital and wage. There are some potential implications for these negative variances. First, the negative marginal variance with respect to capital could suggest that investments in capital reduce variance in the use of labour. Investing in capital such as machinery and technology can substitute for human labour in certain tasks. This substitution often results in more predictable and consistent production processes, thereby stabilizing workforce requirements (Alvarez-Cuadrado et al. 2017; Hirakata and Koike 2023). Second, a negative marginal variance with respect to wages may suggest that higher wages encourage optimized labour use due to cost pressure, leading to a more stable labour force. This point can be supported by the efficiency wage theory that higher wages incentivize employees to work harder, reduce shirking and decrease turnover rates, leading to a more stable and motivated workforce (Katz 1986). Third, the negative marginal variance with respect to time implies that technological improvements reduce the variability in workforce requirements, perhaps by automating repetitive tasks and streamlining operations to ensure consistent labour allocation (Acemoglu and Restrepo 2018).

The mean marginal effect with respect to output is negative for all countries except for Vietnam where the variance of labour used increases with an increase in output. Vietnam's labour variance increasing with output can be attributed to the dominance of state-owned enterprises (SOEs), which often prioritize social objectives over efficiency, leading to rigid labour allocation and mismatches between labour input and output (Taussig et al. 2015; Nguyen Thi et al. 2023). This issue is exacerbated by Vietnam's ongoing transition from a centrally planned to a market-oriented economy where outdated practices and limited adaptability hinder efficient labour use (Taussig et al. 2015).

Concerning the size of the marginal effects, Indonesia shows the highest responsiveness of labour variance to capital and wage while Vietnam shows the highest responsiveness of labour to output.

The marginal effects estimated show a higher variance over time than across countries. The marginal effect with respect to wages (except in 1990 and 1991) and capital (except in 1994 and 1995) remains negative over time. The marginal effect with respect to output does not show any systematic patterns in its sign. We also do not observe any systematic patterns in the size of marginal effects with respect to output and capital over time. However, the marginal effect with respect to wage is increasing in magnitude over time.

6.4 Labour-Use Efficiency

Column 9 of Table 2 reports the mean values by country and by year of estimates of labour-use efficiency. The sample mean of labour efficiency is 96.2 per cent, implying that for a given output level, on average,

the labour use can potentially be reduced by 3.8 per cent across these ASEAN economies. The sample means suggests that these countries, in general, are very technically efficient in labour use, i.e., they are close in their labour-use efficiency. Table 3 reports the country- and time-specific estimates of labour efficiency.

In this paper, the labour-use efficiency is measured relative to the country with the best labour-use practice in our sample of six ASEAN nations, which is assumed to be 100 per cent efficient. We cannot obtain absolute efficiency since the intercept, α_0, also contains the omitted country and time effects. Therefore, with the assumption that our sample contains the most efficient country, Singapore is seen to have the best labour-use practice each year in our sample.

TABLE 3
Country- and Time-Specific Labour-Use Efficiency

Year	*Singapore*	*Thailand*	*Malaysia*	*Philippines*	*Vietnam*	*Indonesia*
1990	1	0.987	0.997	0.991	0.998	0.985
1991	1	0.983	0.996	0.988	0.996	0.984
1992	1	0.980	0.995	0.985	0.994	0.980
1993	1	0.977	0.994	0.982	0.992	0.977
1994	1	0.973	0.993	0.980	0.989	0.973
1995	1	0.969	0.992	0.978	0.987	0.969
1996	1	0.964	0.990	0.976	0.985	0.965
1997	1	0.961	0.989	0.975	0.983	0.965
1998	1	0.959	0.989	0.976	0.981	0.961
1999	1	0.956	0.988	0.973	0.978	0.951
2000	1	0.978	0.991	0.980	0.977	0.970
2001	1	0.953	0.986	0.971	0.973	0.951
2002	1	0.951	0.985	0.969	0.971	0.947
2003	1	0.949	0.985	0.968	0.968	0.939
2004	1	0.947	0.984	0.966	0.966	0.933
2005	1	0.943	0.982	0.964	0.964	0.929
2006	1	0.939	0.981	0.961	0.961	0.918
2007	1	0.935	0.980	0.959	0.959	0.910
2008	1	0.928	0.979	0.956	0.956	0.898
2009	1	0.928	0.978	0.954	0.953	0.878
2010	1	0.923	0.976	0.953	0.951	0.861
2011	1	0.916	0.975	0.951	0.949	0.851
2012	1	0.914	0.974	0.949	0.947	0.845
2013	1	0.911	0.972	0.947	0.944	0.846
2014	1	0.910	0.972	0.946	0.942	0.842
2015	1	0.910	0.972	0.945	0.939	0.840
2016	1	0.910	0.971	0.945	0.938	0.831
2017	1	0.906	0.970	0.943	0.936	0.826
2018	1	0.903	0.968	0.940	0.934	0.825
Mean	1	0.944	0.983	0.965	0.966	0.916
Std. Dev	0	0.026	0.009	0.015	0.020	0.056

The mean labour-use efficiency over time is declining. During the twenty-nine years, there is an observable decrease of about 6 per cent in the mean labour efficiency of ASEAN countries from 99.3 per cent in 1990 to 92.8 per cent in 2018 (Table 2). Since these are relative labour-use efficiency estimates, this decreasing pattern indicates that Singapore has become more efficient in labour use than the other five ASEAN countries over time. Moreover, large variations can be observed across countries. The country with the highest labour-use efficiency is Singapore (100 per cent), followed by Malaysia (98.3 per cent), Vietnam (96.6 per cent), the Philippines (96.4 per cent), Thailand (94.4 per cent) and Indonesia (91.5 per cent) with the lowest labour efficiency. The results indicate that compared to Singapore, the Philippines, Vietnam and Thailand have a potential for improvement of about 4.5 per cent in their labour use, while Indonesia can potentially improve its labour-use efficiency by up to 8.4 per cent.

Singapore's superior performance in ASEAN is driven by its economic structure, labour market policies and technological adoption. First, Singapore's diversified and services-driven economy, strategic location, and highly appraised business-friendly environment make it a global hub for trade and investment (Holtze-Jen et al. 2024, pp. 1, 3; Madu and Tanimu 2024, p. 2). Second, Singapore's labour market policies emphasize workforce expansion and human capital development. This is evidenced by a 104 per cent domestic workforce growth from 1994 to 2019 (MAS 2023, p. 1) and a "whole-of-government" approach as highlighted by the Human Capital Project which emphasizes continuity, coordination and evidence-based policymaking to address challenges in human capital development (GDI 2020, p. 1). Third, Singapore is leading the ASEAN economies in technology development captured by basic technology structure, information technology, technology management and technology environment (Wang and Chien 2007).

Table 3 reports the labour-use efficiency across countries over time.

To check if the labour-use efficiency is significantly different between countries, we use the two-sample *t*-test.[3] The two-sample *t*-test reported in Table 4 shows that the efficiency significantly differs between the ASEAN countries except for Vietnam and the Philippines.

Table 5 shows the frequency distribution of labour-use efficiency. The lowest levels of labour-use efficiency are recorded for Indonesia from 2008 to 2018, i.e., below 90 per cent (Table 3).

7. Robustness

Including Singapore skews the analysis, as it will always dominate the efficiency scale, leaving little room to observe meaningful shifts in the relative efficiency of the other countries. Furthermore, since Singapore has a very high level of development compared to the five remaining ASEAN countries (Jetin and Petit 2018), its labour-use efficiency reflects advanced technology, infrastructure and governance. These are unattainable for other ASEAN countries at their current development levels which places it as an outlier. Therefore, we excluded Singapore from our sample and re-estimated the model to study the shift in the level of efficiency among the remaining five ASEAN countries (Table 6). In our re-estimation, we make two observations. First, the gap in the efficiency levels between the remaining five ASEAN countries is smaller which can be explained by the fact that these five countries are less different in their development status. Second, the order from most to least efficient country remains the same as our complete model (ASEAN 6, including Singapore), with the exception of Vietnam which went from the most efficient after Malaysia to being the second least efficient before Indonesia. However, it is noteworthy that in this model, the efficiency estimates for Vietnam (0.954), the Philippines (0.96) and Thailand (0.956) are very small with a difference of less than 0.006. It should be emphasized that the efficiency level is relative to the most efficient country in the sample.

To further test for robustness, we substitute total government expenditure with government expenditure in education (Table 7). The results are consistent with the baseline where Singapore is still the most

TABLE 4
Two-Sample *t*-Test on the Difference in Labor-Use Efficiency

Countries		*Difference in Means*
Singapore	Thailand	0.056***
		(0.005)
Singapore	Malaysia	0.017***
		(0.002)
Singapore	Philippines	0.035***
		(0.003)
Singapore	Vietnam	0.034***
		(0.004)
Singapore	Indonesia	0.084***
		(0.01)
Thailand	Malaysia	–0.039***
		(0.005)
Thailand	Philippines	–0.021***
		(0.006)
Thailand	Vietnam	–0.022***
		(0.006)
Thailand	Indonesia	0.028**
		(0.012)
Malaysia	Philippines	0.018***
		(0.003)
Malaysia	Vietnam	0.017***
		(0.004)
Malaysia	Indonesia	0.067***
		(0.011)
Philippines	Vietnam	–0.001
		(0.005)
Philippines	Indonesia	0.049***
		(0.011)
Vietnam	Indonesia	0.05***
		(0.011)

NOTE: *$p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

efficient country, which is followed by Malaysia, a tie between Vietnam and the Philippines and Thailand and Indonesia at 4th and 5th places, respectively.

From the two robustness tests above, it is apparent that the level of efficiency between Vietnam and the Philippines is very close in our robust models. This is consistent with our analysis of the difference in means where the difference in labour-use efficiency between the Philippines and Vietnam is not statistically significant (Table 4).

TABLE 5
Labour-Use Efficiency Frequency Distribution

Percentage Efficiency Interval	*Frequency*	*Percentage*
< 86.0	8	4.60
86.1 – 88.0	2	1.15
88.1 – 90.0	1	0.57
90.1 – 92.0	10	5.75
92.1 – 94.0	12	6.90
94.1 – 96.0	30	17.24
96.1 – 98.0	45	25.86
98.1 – 100.0	66	37.93

TABLE 6
Labour-Use Efficiency by Country and Year (After Excluding Singapore)

Year/Country	*Thailand*	*Malaysia*	*Philippines*	*Vietnam*	*Indonesia*
1990	0.979	1	0.980	0.979	0.975
1991	0.976	1	0.977	0.976	0.971
1992	0.973	1	0.974	0.972	0.967
1993	0.970	1	0.971	0.969	0.962
1994	0.968	1	0.969	0.967	0.959
1995	0.964	1	0.966	0.963	0.954
1996	0.961	1	0.963	0.960	0.951
1997	0.964	1	0.966	0.962	0.953
1998	0.975	1	0.977	0.974	0.969
1999	0.973	1	0.976	0.972	0.967
2000	0.992	1	0.993	0.990	0.986
2001	0.970	1	0.973	0.969	0.962
2002	0.968	1	0.970	0.966	0.958
2003	0.965	1	0.968	0.963	0.955
2004	0.962	1	0.965	0.960	0.952
2005	0.959	1	0.962	0.957	0.948
2006	0.955	1	0.959	0.953	0.944
2007	0.949	1	0.953	0.947	0.937
2008	0.943	1	0.947	0.940	0.931
2009	0.950	1	0.954	0.947	0.941
2010	0.941	1	0.946	0.938	0.930
2011	0.935	1	0.940	0.932	0.923
2012	0.934	1	0.939	0.930	0.922
2013	0.933	1	0.939	0.930	0.920
2014	0.932	1	0.938	0.928	0.920
2015	0.938	1	0.944	0.934	0.926
2016	0.938	1	0.944	0.934	0.926
2017	0.936	1	0.943	0.932	0.923
2018	0.934	1	0.941	0.929	0.920
Mean	0.956	1	0.960	0.954	0.947
Std. Dev	0.017	0	0.015	0.018	0.019

TABLE 7
Country- and Time-Specific Labour-Use Efficiency
(Government Expenditure Is Education Expenditure)

Year	*Singapore*	*Thailand*	*Malaysia*	*Philippines*	*Vietnam*	*Indonesia*
1990	1	0.986	0.998	0.991	0.998	0.981
1991	1	0.983	0.997	0.990	0.997	0.980
1992	1	0.981	0.996	0.988	0.995	0.978
1993	1	0.978	0.996	0.986	0.994	0.974
1994	1	0.975	0.995	0.984	0.992	0.970
1995	1	0.971	0.994	0.983	0.991	0.967
1996	1	0.968	0.994	0.981	0.989	0.963
1997	1	0.967	0.993	0.981	0.987	0.964
1998	1	0.968	0.993	0.982	0.986	0.970
1999	1	0.966	0.993	0.980	0.984	0.961
2000	1	0.987	0.996	0.989	0.985	0.983
2001	1	0.964	0.992	0.980	0.981	0.961
2002	1	0.963	0.991	0.978	0.979	0.956
2003	1	0.961	0.991	0.978	0.978	0.949
2004	1	0.959	0.991	0.976	0.976	0.945
2005	1	0.957	0.989	0.975	0.974	0.941
2006	1	0.953	0.989	0.973	0.972	0.929
2007	1	0.949	0.988	0.970	0.970	0.922
2008	1	0.944	0.987	0.968	0.967	0.910
2009	1	0.944	0.987	0.967	0.965	0.895
2010	1	0.939	0.985	0.965	0.963	0.874
2011	1	0.933	0.984	0.964	0.961	0.862
2012	1	0.931	0.984	0.962	0.959	0.858
2013	1	0.930	0.983	0.960	0.957	0.860
2014	1	0.929	0.982	0.959	0.955	0.859
2015	1	0.930	0.983	0.959	0.953	0.859
2016	1	0.930	0.982	0.959	0.952	0.850
2017	1	0.927	0.982	0.958	0.950	0.845
2018	1	0.924	0.981	0.956	0.948	0.844
Mean	1	0.955	0.990	0.974	0.974	0.924
Std. Dev	0	0.020	0.005	0.011	0.015	0.050

TABLE 8
Mean Labour-Use Efficiency Robustness

Countries	*Government Expenditure (Aggregate)*		*Government Expenditure (Education)*		*Countries Excluding Singapore*	
	Mean	*Rank*	*Mean*	*Rank*	*Mean*	*Rank*
Singapore	1	**1**	1	**1**		
Malaysia	0.983	**2**	0.990	**2**	1	**1**
Vietnam	0.966	**3**	0.974	**3**	0.954	**4**
Philippines	0.964	**4**	0.974	**3**	0.960	**2**
Thailand	0.944	**5**	0.955	**4**	0.956	**3**
Indonesia	0.916	**6**	0.924	**5**	0.947	**5**

8. Conclusion

This paper investigates the labour-use efficiency of ASEAN countries by using the balanced panel data of the six largest ASEAN economies (Singapore, Malaysia, Thailand, Vietnam, Indonesia, and the Philippines) from 1990 to 2018. The labour-use efficiency is estimated as the mean of a stochastic labour requirement frontier function. We use a flexible translog function to specify the labour demand, which is defined as a function of output (GDP), average wage, capital stock and country-specific variables that capture the characteristics of the technology and production environment and time effects. The variance function, which accommodates marginal effects, enters multiplicatively with the demand function. The parameters of the demand and variance models are estimated through a multi-step procedure using GLS and a nonlinear method, respectively.

The elasticities of labour demand with respect to output, wage and capital were computed for each country each year. The output elasticity is positive, while the wage and capital elasticities are negative. The responsiveness of labour is highest to output, followed by wage and capital. The sample mean of labour-to-output elasticity is 0.72; this implies increasing returns to scale in ASEAN countries. Singapore has the largest output elasticity (1.012) which is almost double Indonesia's (0.535). The sample mean of wage elasticity is negative (–0.377) and there is a slow, continuous decline in the size of wage elasticity over time which can be explained by the continuous increase in the quality of labour in ASEAN countries. The sample mean of labour-to-capital elasticity is also negative (–0.113), indicating that capital and labour are substitutes.

The mean marginal effects with respect to most of the dispersion factors are negative for all countries except for the marginal effect with respect to the output of Vietnam which is positive and large. This implies that for ASEAN countries that produce closer to the sample mean, the variance of labour use decreases with the increase in output, capital and wage. It should be noted that this is not the case for Vietnam where the variance of labour used increases with an increase in output. Moreover, the marginal effects estimated show a higher variance over time than across countries.

In this paper, the labour-use efficiency is measured compared to the country with the best labour-use practice in our sample which is assumed to be 100 per cent efficient. Singapore is found to be the country with the best labour-use practice each year in our sample. The overall mean labour efficiency is 96.2 per cent; this means that for a given level of output, on average, the labour demand can potentially be reduced by 3.8 per cent. The sample means suggest that these countries are very technically efficient in labour use in general. The mean labour-use efficiency decreases over time; this indicates that Singapore is becoming more efficient in labour use than the other five ASEAN countries over time. Large variations are observed across countries, with Indonesia being the least efficient in labour use among the six ASEAN countries in our sample.

The findings of this paper demonstrate that policies in ASEAN countries should target further enhancing labour-use efficiency to maintain high economic growth. Narrowing the gap between Singapore and other ASEAN countries in labour-use efficiency should be a focus of policies. However, based on our empirical results, there is a likelihood that in the following decades of the twenty-first century, ASEAN countries may experience "jobless growth", where an economy is experiencing growth while its level of employment is constant or decreasing (Thomas 2013). The combination of the increasing returns to scale (an increase of k per cent in output needs an increase of less than k per cent in labour use) and high labour-use efficiency might cause a decrease in the level of employment in the region.

Therefore, the ASEAN region's policies should prioritize restructuring the economy towards an axis of creating employment, promoting domestic and foreign direct investment to facilitate job creation, and enabling the entrepreneurs in the region to exploit the Fourth Industrial Revolution (4IR) transformations in a fashion that creates more jobs. The future of employment across ASEAN countries has been influenced by: (1) 4IR Technologies with automation, AI, IoT and advanced manufacturing transforming

industries, leading to increased productivity but also the displacement of traditional jobs, (2) ASEAN's expanding digital economy driven by startups and global investments, creating new job categories and shifting labour market demands, (3) trade tensions and rising costs in China that has redirected manufacturing to ASEAN and increased immediate job opportunities, (4) cross-border services becoming more significant, demanding high-skilled labour and knowledge-intensive roles, (5) rising education levels and tech-savviness among ASEAN citizens, enabling adaptation to knowledge-based and digital service jobs and (6) climate impacts on agriculture and migration trends, affecting job availability and worker security especially in rural and vulnerable communities (TAF 2020). Some capital-intensive industries with high employment potential that ASEAN member states could prioritize for industrial development include renewable energy, advanced manufacturing, digital and knowledge economies, healthcare and biotechnology, agribusiness with technology integration, infrastructure and smart cities as well as tourism (TAF 2020).

The main limitation of our study is the way we specify the labour-use efficiency index which is not absolute but relative efficiency compared to the most efficient country in our sample. This means that the results are interpreted based on a specific sample and not generally applicable. For example, in this paper, we found that Singapore is the most efficient country which is assumed to be fully efficient, while the other ASEAN countries, such as Thailand, Vietnam and the Philippines, are mostly efficient compared to Singapore. However, these results can change if more efficient countries are included in the sample, leading to a different relative efficiency level for all the underlying countries. A more standard measure of efficiency or a more inclusive sample may be desirable features of future studies in this field.

Appendix A: Summary Statistics

TABLE A1
Summary Statics for Data of Each of the 6 ASEAN Countries

Variable	*Mean*	*Std. Dev*	*Min*	*Max*
Singapore				
Labour (thousand people)	2,483.23	662.15	1,503.59	3,497.09
GDP (US$ billion)	135.37	69.58	0.96	255.63
Capital Stock (US$ billion)	318.73	141.19	2.43	558.90
Average Wage (US$)	24,140	8,195.14	203.69	34,830.66
Patent Applications	675.17	506.46	5	1,609
Government Expenditure (US$ billion)	13.19	6.94	0.10	25.69
FDI, net inflows (US$ billion)	25.31	19.63	0.16	68.85
Thailand				
Labour (thousand people)	35,967.53	3,289.81	29,684.40	40,105.86
GDP (US$ billion)	200.08	82.51	1.26	346.93
Capital Stock (US$ billion)	636.19	262.26	5.00	1026.71
Average Wage (US$)	2,438	845.52	15.82	3,800.00
Patent Applications	695.66	411.23	67	1,572
Government Expenditure (US$ billion)	28.84	15.84	0.17	56.04
FDI, net inflows (US$ billion)	5.16	3.03	0.03	11.80
Malaysia				
Labour (thousand people)	10,858.63	2,604.07	7,060.42	15,381.54
GDP (US$ billion)	140.44	69.76	0.94	246.76
Capital Stock (US$ billion)	352.73	167.51	2.53	608.90
Average Wage (US$)	3983	1,480.87	27.63	6,154.01
Patent Applications	614.83	455.85	92	1,353
Government Expenditure (US$ billion)	17.53	9.31	0.10	32.89
FDI, net inflows (US$ billion)	5.32	2.74	0.04	11.54
Philippines				
Labour (thousand people)	33,465.38	6,859.49	22,733.20	43,864.62
GDP (US$ billion)	123.47	65.87	0.84	237.56
Capital Stock (US$ billion)	288.78	100.08	2.22	430.82
Average Wage (US$)	1,365	560.14	10.82	2,235.25
Patent Applications	205.48	90.64	125	529
Government Expenditure (US$ billion)	13.10	7.41	0.09	28.61
FDI, net inflows (US$ billion)	2.14	1.85	0.01	7.22
Vietnam				
Labour (thousand people)	45,496.81	7,826.92	32,727.74	56,915.24
GDP (US$ billion)	64.64	51.51	0.31	167.95
Capital Stock (US$ billion)	118.69	99.17	0.52	297.95
Average Wage (US$)	617	439.90	3.61	1,443.15
Patent Applications	207.72	206.68	22	646
Government Expenditure (US$ billion)	4.09	3.18	0.02	10.87
FDI, net inflows (US$ billion)	3.91	3.25	0.01	10.62

continued on next page

Appendix A: Summary Statistics — *cont'd*

Variable	*Mean*	*Std. Dev*	*Min*	*Max*
Indonesia				
Labour (thousand people)	103,317.30	17,059.22	72,957.66	132,737.41
GDP (US$ billion)	357.88	229.44	1.65	715.22
Capital Stock (US$ billion)	953.93	704.45	4.06	2071.83
Average Wage (US$)	1,170	616.30	6.32	2,118.31
Patent Applications	417.48	501.96	29	2271
Government Expenditure (US$ billion)	31.65	22.32	0.11	65.23
FDI, net inflows (US$ billion)	6.08	6.30	–2.89	18.34

Appendix B: Parameter Estimates

TABLE B1
Parameter Estimates of Labour Demand Function and Variance Function

Parameter	*Estimate*	*SE*	*Parameter*	*Estimate*	*SE*	*Parameter*	*Estimate*	*SE*
Labour Demand Function								
α_0	–2.050***	0.143	θ_5	–0.002	0.020	θ_{21}	0.030	0.073
α_y	0.795***	0.076	θ_6	–0.003	0.021	θ_{22}	0.031	0.076
α_w	–0.434***	0.073	θ_7	0.010**	0.005	θ_{23}	0.032	0.080
α_k	–0.127***	0.047	θ_8	0.018	0.025	θ_{24}	0.034	0.085
α_{yy}	0.022	0.076	θ_9	0.053*	0.032	θ_{25}	0.037	0.089
α_{ww}	–0.045***	0.009	θ_{10}	0.052	0.035	θ_{26}	0.038*	0.094
α_{kk}	0.082	0.079	θ_{11}	0.306	0.235	θ_{27}	0.031**	0.097
α_{yw}	0.123***	0.035	θ_{12}	0.057	0.044	θ_{28}	0.010**	0.102
α_{yk}	–0.147	0.153	θ_{13}	0.053	0.048	θ_{29}	–0.003***	0.106
α_{wk}	–0.031	0.031	θ_{14}	0.048	0.052	μ_2	1.457***	0.195
η_1	–0.152***	0.032	θ_{15}	0.031	0.055	μ_3	0.573***	0.134
η_2	–0.001	0.009	θ_{16}	0.012*	0.058	μ_4	1.328***	0.201
η_3	0.000	0.008	θ_{17}	0.014	0.061	μ_5	1.546***	0.209
θ_2	–0.009	0.021	θ_{18}	0.015	0.063	μ_6	2.007***	0.290
θ_3	–0.010	0.020	θ_{19}	0.014	0.066			
θ_4	–0.003	0.020	θ_{20}	0.041	0.070			
$R^2 = 0.9993$								
Variance function								
β_y	–0.012	0.016						
β_k	0.023	0.017						
β_w	0.002	0.002						
β_t	0.001***	0.000						
$\sigma^2_v = 7.9806$								

NOTES: *$p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. The dependent variable is the amount of labour used per country. The number of observations is 174.

NOTES

1. Since the data of the net flows of FDI contain negative values, we add a constant value c to the FDI of all countries for all years before taking logarithm. Therefore, the transformation is log (FDI+c).
2. As aforementioned, the exogenous rate of technical change can be captured by time trend or time dummy variables. In time trend model, however, technical change is assumed to be a smooth, continuous, and monotonous process, while in the dummy model, it is assumed to be a discontinuous and non-monotonous process (Heshmati 2001). Thus, the time dummy model is more appropriate with our panel data.
3. $T = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{s_1^2}{N_1} + \frac{S_2^2}{N_2}}}$, where N_1 and N_2 are the sample sizes, $\bar{x}_1$ and $\bar{x}_2$ are the sample means, and S^2_1 and S^2_2 are the sample standard deviation.

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BOOK REVIEWS

DOI: 10.1355/ae42-1f

***Albert Winsemius and Singapore: Here It Is Going to Happen*, by Euston Quah with Luke Nursultan Iuldashov and Zach Lee.** Singapore: World Scientific, 2022. Pp. 745.

The subject of the book, Albert Winsemius, is a Dutch economist who was an influential economic advisor to the Singaporean government between the early 1960s and the 1980s. The book documents Winsemius' contributions to the development of Singapore through his various policy recommendations across many areas. These contributions are clearly very significant, as demonstrated by the continuous policy interactions between Winsemius and the leaders of Singapore, which went beyond his official retirement as an economic advisor in 1983. The book is a fitting tribute and a comprehensive acknowledgement of Winsemius' contributions to Singapore.

The book will appeal to students and scholars specializing in development economics, public policy, economic history and the history of economic thought. For development economists and economic historians, Chapter 3 of the book provides a narrative of Winsemius' policy work embedded within Singapore's development experiences. These experiences include key challenges related to export-oriented industrialization, industrial upgrading, industrial relations, industrial upgrading, human capital development, demographic change and financial sector development. Winsemius is often characterized in the book as someone who was not theoretically oriented but more of a pragmatist relying on a common-sense approach informed by field observations and interactions with various stakeholders. Though Winsemius does not appear to have appealed to development theories in supporting his policy recommendations, Chapter 4 attempts to place these recommendations within the broader evolution of development economics literature. Scholars interested in understanding how countries such as Singapore have developed amidst the evolution of development economics will benefit from reading Chapters 3 and 4 of the book.

The book will also be very useful for students and scholars in public policy. Chapters 5 and 6 provide useful reflections and prescriptions on effective economic advisory and policy implementation. These chapters should be read together with Chapter 3 (a case study)—which contains useful discussions on political developments that have also shaped policymaking. This should also be complemented by reading some of the essays (reminiscences and interviews) in Part IV of the book. There are too many of these essays to discuss in detail, but some provide very useful additional insights. One of this reviewer's favourite paragraphs is from the interview with Mr S. Dhanabalan (p. 577): "Dr Winsemius was a very good sounding board to leaders. Sometimes the ideas came from him, sometimes the ideas came from the leaders. But he was able to basically reinforce the thinking and make it clearer." These words clearly illustrate the degree of trust and valuable interactions between Winsemius and Singapore's leaders over time.

Economic historians will be interested in reading Chapters 3, 7 and 8. Chapter 7 provides a very useful discussion of Winsemius' policy recommendations within the broader context of the evolution

of the country's wage policies since the 1960s. Chapter 8 uses five cases to discuss Winsemius' policy recommendations that are related to the environment. Obviously, other interesting cases could have been added to the book such as public housing (i.e., HDB) and infrastructure (i.e., MRT and Changi Airport). Perhaps future editions would include this wish list.

For historians of economic thought, the early chapters of the book—Chapters 1 and 2—provide useful insights into how Winsemius' earlier experiences could have influenced his approach to policy advice. In his prior incarnation as a policymaker in the Netherlands, Winsenmius was involved in the planning and implementation of industrialization in the country. Some of the subsequent key policy recommendations for Singapore—such as tripartite labour negotiations—appear to have originated from his earlier policymaking experiences in the Netherlands. Winsemius was also unique in the sense that he was a policy activist. His contributions were not confined to merely giving policy advice as he was also personally involved in persuading multinational firms to invest in Singapore. This aspect can be traced back to his experiences in the Netherlands where he was instrumental in persuading businesses to set up new factories in the country. Clearly, one important contributing factor to Winsemius' role as a policy activist is his own experience in the private sector after he retired from civil service in the Netherlands. The combination of his experiences in the public and private sectors is likely to have also shaped his understanding of the role that state intervention and market forces can play in economic development.

Overall, the book is an important contribution to the literature on the history of economic development in Singapore. Current and future generations of scholars and policymakers will benefit from reading this book.

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***Business Groups and the Thailand Economy: Escaping the Middle-Income Trap*, by Natenapha Wailerdsak.** Routledge, 2023. Pp. 280.

Natenapha Wailerdsak's *Business Groups and the Thailand Economy: Escaping the Middle-Income Trap* provides a comprehensive and incisive analysis of Thailand's industrialization journey and its persistent struggle to escape the middle-income trap. The book offers a synthesis of theoretical frameworks, policy critiques and empirical evidence, aiming to provide actionable insights for policymakers, scholars and business leaders navigating similar challenges in other emerging economies. By focusing on the pivotal role of business groups, Wailerdsak illuminates structural, governance and socio-cultural barriers that hinder Thailand's progress while proposing pathways for transformative economic growth. This interdisciplinary work stands as a valuable resource for those seeking to understand the complexities of economic development and governance reform in Thailand.

The book is structured into three sections—theoretical foundations, policy evaluation and case studies of Thai business groups—each contributing to an overarching narrative on how Thailand can transition toward a high-income economy.

The first section of the book revisits key economic theories—catch-up industrialization, dependency theory and the developmental state model—to provide a framework for understanding Thailand's development trajectory. Wailerdsak critiques these frameworks with a balanced approach, highlighting

both their contributions and limitations. For instance, she explores the concept of the "advantages of backwardness" (p. 16), showing how latecomer nations like Thailand can adopt advanced technologies to leapfrog development stages. However, she underscores that such opportunities are frequently undermined by governance challenges, structural inefficiencies and socio-cultural constraints. In her critique of dependency theory, Wailerdsak argues that it overemphasizes external dominance while insufficiently addressing domestic issues, such as limited innovation capacity within Thailand's family-owned businesses. The "family business trap" discussion is particularly insightful, illustrating how concentrated ownership and lack of professional management hinder technological advancement and economic diversification. While this theme is expanded further in the third section of the book, the first section establishes it as one of several critical factors that collectively contribute to Thailand's struggles in escaping the middle-income trap.

The second section evaluates Thailand's industrial policies, with a particular focus on the Eastern Economic Corridor (EEC). While the EEC aims to integrate Thailand into global value chains and attract significant foreign direct investment (FDI), Wailerdsak critiques its over-reliance on foreign capital and inadequate focus on fostering local innovation. She argues that monopolistic practices, low R&D investment and the dominance of family-owned business groups stifle the development of a high-tech industrial base. This section balances optimism about policy potential with realism about structural constraints. Wailerdsak's critique of the limited separation of ownership and management within Thai businesses aligns with the broader governance challenges highlighted in the book.

Moreover, the book's comparative analysis of business group governance models in countries like China and Japan adds depth to the discussion. For example, Japan's transition to managerial capitalism and China's focus on aggressive technological innovation offers valuable lessons for Thailand. These examples underscore the need for state-business collaboration and governance reform to drive sustainable economic growth.

The final section employs detailed case studies to explore how Thai business groups navigate domestic and international markets. Wailerdsak introduces the concept of the "family business trap", highlighting governance challenges such as concentrated ownership, a lack of professional management and limited innovation capacity. By analysing Thai conglomerates' strategies—including mergers, acquisitions and foreign alliances—she provides a granular understanding of their strengths and limitations. The book concludes by emphasizing that while business group governance was effective during Thailand's industrialization phase, it now hinders innovation and technological advancement. Wailerdsak advocates transitioning from family capitalism to managerial capitalism, recommending that Thai businesses adopt practices such as ownership dispersion, professional management and stronger corporate governance. These steps, she argues, are essential to escaping the middle-income trap and achieving sustainable economic development.

One of the significant strengths of the book lies in its comparative analysis of business groups in Korea and Japan. It illustrates how the separation of ownership from management, coupled with an emphasis on professional governance, has enabled these nations to overcome periods of stagnation and promote sustained growth. Wailerdsak posits that Thailand must transition from a model of family capitalism to one of managerial capitalism, advocating for governance reforms that augment innovation, competition and sustainability. Historically, Thailand's reliance on business group governance facilitated capital accumulation and industrial expansion; however, this also led to stagnation due to monopolistic practices and a lack of managerial professionalism. In contrast, Japan's post-war corporate governance reforms dissolved the *zaibatsu* conglomerates, thereby fostering a model of managerial capitalism that incentivized innovation. Thailand's ongoing dependence on family-owned business groups prevents similar advancements, which is evident in the weak protections afforded to minority shareholders and the persistent structures of cross-shareholding. By incorporating real-world case studies, Wailerdsak

effectively demonstrates how strategic alliances with multinational corporations (MNCs) influence the modernization of industries. Thai businesses are increasingly engaging in partnerships with Chinese firms, particularly in the domains of electric vehicles, biotechnology and finance. A notable example is the SAIC-CP joint venture established in 2012 between CP Group and Shanghai Automotive Industry Corporation (SAIC), which initiated domestic automobile production under the MG brand. Although these collaborations enhance industrial capabilities, Wailerdsak contends that Thailand must maintain control over the development of technology rather than remaining dependent on foreign expertise. Her policy recommendations emphasize investments in research and development, workforce training and corporate governance reforms aimed at bolstering innovation, transparency and competitiveness.

In conclusion, this book significantly enriches the discourse on economic development and industrialization by providing a nuanced analysis of Thailand's challenges and opportunities in escaping the middle-income trap. Wailerdsak adopts an interdisciplinary approach, emphasizing the critical roles of governance, innovation and the evolution from family capitalism to managerial capitalism. The book highlights how structural reforms and effective engagement with business groups can drive sustainable growth by combining theoretical rigour with practical insights. As Thailand and other emerging economies navigate globalization, technological disruptions and shifting economic paradigms, Wailerdsak's work offers a comprehensive framework for fostering transformative change. The emphasis on addressing governance deficits and enhancing innovation systems positions the book as a valuable resource for policymakers, scholars and private sector stakeholders aiming to reimagine pathways toward equitable and high-income status.

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