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INVESTIGATING THE ROLE OF STATE CAPACITY IN PROMOTING TECHNOLOGICAL INNOVATION AND ENVIRONMENTAL SUSTAINABILITY IN ASEAN STATES

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Abstract: This study examines the relationship between state capacity, technological innovation, and environmental sustainability in two ASEAN member states, Vietnam and Singapore, from 2000 to 2020. The study focuses on the impact of impartial administration, rule of law, and technological innovation on achieving environmental sustainability. The Autoregressive Distributed Lag model and Granger causality analysis were used to analyze the existence and causal effect between the variables. The results indicate a negative association between impartial administration, technological innovation, and environmental sustainability in the long run. However, the Granger causality analysis demonstrates a causality effect running from impartial administration and technological innovation to environmental sustainability for Singapore. The study highlights the importance of state capacity in promoting innovation in both the public and private sectors to achieve environmental sustainability.

Keywords: state capacity, technological innovation, environmental sustainability, impartial administration, rule of law, ASEAN member states, Autoregressive Distributed Lag model, Granger causality analysis.

Introduction

State capacity is one of the key factors that can influence technological innovation and environmental sustainability. This study examines the relationship between state capacity, technological innovation, and environmental sustainability in two ASEAN member states, Vietnam and Singapore. The study focuses on examining the impact of impartial administration, rule of law, and technological innovation on achieving environmental sustainability. The study uses the Autoregressive Distributed Lag model and Granger causality analysis to examine the existence and causal effect between the variables.

The study reveals a negative association between impartial administration, technological innovation, and environmental sustainability in the long run. This indicates that impartial administration and the rule of law are crucial for achieving environmental sustainability. However, the Granger causality analysis demonstrates a causality effect running from impartial administration to environmental sustainability and between technological innovation to environmental sustainability for Singapore. Therefore, Singapore's state capacity, including impartial administration and technological innovation, has a positive effect on achieving environmental sustainability.

The study concludes by highlighting the importance of state capacity in fostering innovation in both the public and private spheres for achieving environmental sustainability. The findings have significant policy

implications that can inform the design of interventions aimed at promoting green technology and environmental sustainability.

Review of literatures

The role of the state in achieving a healthier sustainable environment is becoming obsolete if not dwindling. And by this, alternative actors, including citizens have emerged as potential stakeholders. Albeit, this shrinking of states' capacity in addressing environmental issues, the government still maintains its sparkle by interfering in the sustainability agenda either directly or through indirect processes, and, depending on this particular practice, it could either assist in improving the environment or deteriorate what was an already fragile ecosystem. Similarly, it is important to note that sustainability covers a larger scope, and the fact of an absence specific delineation mechanism provides academicians to implement the latter concept in different environmental fields, from energy, C02 emissions, and waste management, to public health. *2.1. State Capacity and Environmental Sustainability*

Several authors accentuate the negative impact of administrative biases when civil servants stray away from impartiality. Welsch (2004) and Cole et al. (2006), stress the relationship between the lack of impartiality and environmental pollution. Their study reveals how, poor impartiality reduces the efficiency of environmental policies, then, retroactively affects quality deliverance. In fact, better regulatory quality upgrades sustainability within the state, however, ironically, stringent environmental regulation aimed at improving sustainability would hamper the state's economy by further introducing shadow economics. Chen et al. (2018) demonstrate how stricter control of environmental regulations would reduce pollution and ameliorate ecological qualities but at the expense of providing opportunities for shadow economy activities to expand. Elgin and Mazhar (2013), build a double-sector model between the official economy and the shadow economy, they discover that depending on how severe environmental regulations were implemented, certain shadow economy sectors may eventually end up becoming a major cause of environmental pollution leakage, as a result, impeding state's sustainability effort. More formally, this excessive execution of eco-friendly policies, without practical reappraisal of its aftermath effect would certainly increment the scale of the shadow economy. Certainly, without repercussion motives, these authors are genuinely warning of the negative effect of greater propensity toward sustainability policies when the collective posterior impact hasn't been fully taken into consideration.

In a similar scenario, Kuehn (2015) argues that due to the high economic and political stakes involved in many controversies, accusations of bias in administrative sustainability judgments are becoming more frequent recently, and, indeed, appear to be growing. To exemplify this, parties in environmental proceedings allege ethical violations, discrimination in forms of favoritism, prejudging of outcomes, complaining of irregular prosecutorial and judicial functions, and illegal political influence, particularly, in legal cases that require higher impartiality and integrity by the competent organs. Interestingly such as scenario transpires in every corner of the globe from high-profile oil conglomerates to C02 emission effect on locals' well-being. Only recently, opponents of a 1,700mile Keystone XL oil pipeline have alleged that the environmental decisionmaking process has been sullied by State Department cronyism of the pipeline's construction company, further reinforcing the blatant bias and favoritism among civil servants. see (Rosenthal and Frosch, 2011).

While the point (Kuehn, 2015) should be treated as a particular case, Romano et al. (2021), also applies the lack of impartiality and ineffectiveness in Italy by considering waste management performance as a point of illuminating the state's maladministration. The outcome of the causality framework demonstrates that urban disposal production per capita is higher in municipalities with relatively high amounts of corruption and poor governance. Reasonably, the following outcome is justified by the author as the presence of possible, biased activities, while simultaneously pursuing personal interest at the expanse of the conferred mission to them by

abusing their titles which are mostly defined by their professional positions, thus. Ironically, providing irrational immunity. The significance of the link between waste management and unlawful actions and the absence of impartiality has also been emphasized by (Gumisiriza and Kugonza, 2020; Cesi et al., 2019; Agovino et al., 2018), according to their theory, Corrupt businesses entities, local governments, and oversight agencies frequently collaborate in the context of environmental violations to create illicit networks that jeopardize effective waste disposal and the flow of sustainable management. For instance, these networks, have a significant impact on contractors and subcontracts who handles garbage collection, transportation, and disposal, by exerting substantial control, thus carrying out their well-orchestrated extortion activities, in turn undermining the public health. Generally, ineffective waste disposal produces health problem D'Alisa et al. (2010) reveals how organized crime is a key contributor to environmental offenses, including the disposal of dangerous waste. therefore, contributing to health issues including asthma, respiratory issues, tumors, and circulatory system abnormalities, notwithstanding, perpetrators continue to pursue their sustainable degradation, given, the low attention provided to environmental infractions.

Highlighting how ineffective state capacity affects sustainability (Fredriksson and Svensson, 2003), explores the effect of government stability and absence of corruption on environmental policies by collecting data from 60 countries. They conclude that the degree of corruption may have been what determines the association between political risk and the strictness of environmental regulations. In particular, political stability has a detrimental influence on the effectiveness of environmental legislation when the amount of corruption is low; yet, once the level of corruption is at its peak, political stability has a favorable influence on environmental legislation. Additionally, corruption can reduce the effectiveness of environmental regulation, but the impact will vanish with greater political stability.

Chen et al. (2019) and Pang et al. (2019), analyze a way of achieving sustainable development by reducing air pollution. Based on their conclusion; Car exhaust is one of the major sources of air pollution in China, because of the country's ongoing urbanization and rising living standards, which has led to an increase in the number of families; owning to several fuel-powered vehicles. The authors suggest that pushing electric vehicles over gasoline-powered ones will assist in tackling the problem of urban air pollution. On the other hand, some scholars support maximizing the involvement of the government in the environment by enhancing environmental protection legislation, boosting environmental rules, and tightening environmental inspection procedures in order to reduce air pollution (Song et al., 2020).

An interesting case about ecological issues can be linked to the famous case of (Oposa Minors Case, 1993). According to the Philippines Chief Justice, the petitioners filed a lawsuit on behalf of future generations. According to the court's reasoning, intergenerational standing is helpful when environmental harm is longlasting and worsens with time, posing a greater hazard to coming generations than to the current. However, in order for the rights of coming generations to be really convincing, they must be completely incorporated into constitutional and international human rights law. Following this verdict, several countries have already set agendas of integrating future-generation values into constitutional environmental rights, see (Commonwealth, Robinson Tp, 1993). Another German case has rejected to consider condemning a c02 emission industry. according to the plaintiff's argument, the c02 emitted by these industries was infringing his fundamental rights. After finding unsubstantiated human rights violations, the court decided to discard the plaintiff's appeal, however, the court shifted its verdict to proportionality scope, in which, excessive consumption of C02 from the current generation would cause future sustainability damages for the upcoming generation, while simultaneously leaving little quantities of C02 emission to experience (Winter, 2022).

Muhammad and Long (2021) highlight the critical role of institutional components like political stability, anticorruption measures, and the rule of law in reducing carbon emissions and enhancing environmental quality. Further providing support for Muhammad's institutional variation, Salman et al. (2019), contends that

the strength of a nation has a significant impact on how well the Paris Agreement and other environmental pollution-related regulations are implemented. On the other hand, industries wouldn't think twice about breaking pollution control regulations to maximize profit if there are defects and weak institutions. Welsch (2004) and Aden (2022), also argue that robust institutions have the potential to reduce pollution not only at the national level but also at an international level through a mechanism based on a spatial institutional spillover effect. On the other hand, ineffective institutions, which are viewed as the primary cause of the lowincome trap, are the main barriers to further reaching sustainable societies and adopting sophisticated energy structures generated by greener technologies (Salman et al., 2019).

Geller et al. (2006) also look at how 123 different countries' levels of governance affected the quality of their environments. The findings demonstrate that effective policies, judiciary fairness, and accountability favorably impact water quality. On the other hand, judiciary fairness, and bureaucratic efficiency have a positive effect on air quality. However, the six governance indices are adversely affected by forests, and there is no indication that governance indicators have an influence on biodiversity.

2.2 Sustainability and Innovation

An institution must purchase or create a new product, service, or platform that requires technical innovation in order to attain Sustainability; yet, specific characteristics of procurement authorities affect such activities. Although, public strategies that are innovative and sustainable can be implemented at several levels. And when deeply ingrained and widely accepted these groundbreaking technological tools, achieving sustainability through an innovation-driven agenda becomes further plausible, while, simultaneously, producing potential benefits for society (Nijboer et al., 2017). Hence, embracing these smart technological innovation policies by governments has a crucial role in fostering the adoption of environmental technologies by business entities, thus boosting sustainability levels and indirectly contributing to the major social problem of climate change through the business-government collaboration mechanism. Therefore, in order for economies to achieve a decarbonized and controllable development path that is compatible with competitiveness goals; technological innovation may be crucial, in the context of implementing and disseminating greener manufacturing technology, and lesser dependence on C02 emission.

Khan et al. (2020b) employ a fully modified ordinary least square (FMOLS) model, a dynamic ordinary least square (DOLS), a generalized least square (GLS), and chronical cointegration regression (CCR) method to show the relationship between innovation, and private and public partnership energy investment. The results yield that technological innovation (TIN) infuses higher energy consumption generated through renewables. The findings also underline the important role of reducing c02 emissions when the state embraces technological tools, subsequently contradicting the general belief of the negative effect of technological advancement on the environment. Additionally, the favorable effect of TIN on cleaner production is revealed by (Alvarez-Herranz et al., 2017), the empirical results indicate that spending on technological innovation lowers Carbon footprints and enhances the climate's overall health. The authors also point out that while the impact of innovation and technological expenditure varies among nations, these tools might be leveraged to reach salient sustainability.

Sun et al. (2008) examine the connection between greenhouse gas emissions (GHG) and patent technologies. The researchers conclude that technological progress considerably lowers CO2 emissions. Additionally, their comparative research indicates that, in contrast to other geographical regions, Eastern counties are more effective at implementing innovations and eco-friendly technology. This pivotal finding might suggest, perhaps, comparing the development status between the North and the East; developed nations had already at their peak of progress, although their mission of achieving sustainability could be easier but still growing nations possess the upper hand in transforming their economy to better match sustainability goals, with less, inconvenience vis-à-vis the northern. In a similar case, the effects of advancements in technologies,

environmental laws, and urbanization on ecological performance were investigated using the generalized method of moments GMM technique by (Yasmeen et al., 2020), The findings show that the eastern area had the greatest ranking in terms of ecological effectiveness, preceded by the middle and western regions, correspondingly. On a national scale, the urbanization index has a detrimental effect on ecological effectiveness. While the results in the western and middle areas are inconsequential as they are favorably significant in the eastern region.

Zhou et al. (2018) reveal that technological progress in green fields might encourage an increase in anticipated production. Therefore, developing green technologies is a crucial approach for China to increase its ecological efficiency. Nevertheless, these authors contend; at the current time, China's eco-friendly technological innovations are somehow lacking and indeed at some point need to be addressed. Furthermore, China's technological evolution exhibits a "U"-shaped environment Kuznets curve. Indicating, that advanced technology before 2010, somewhat decreased ecological efficiency. In a similar context, Shahbaz et al. (2016) reveal that technological innovation may lower carbon emissions and assist in addressing the difficulties associated with environmental sustainability by coping with unexpected climate damages while at the same time playing a major key in the betterment of environmental quality. Another ground-breaking study conducted by Bouzguenda et al (2019), aimed to explore the role of communications and technology on enhancing engagement among citizens toward sustainable cities. The author's main purpose is to investigate in deep the incorporation of digital citizen participation in sustainable smart cities, the result suggests that emphasizing Information and Communications Technology (ICT) will direct to better social sustainability and produce human-based interconnection than a robotic administrated platform which in most cases interferes at delivering acceptable feedbacks. Adebayo and Kirikkaleli (2021), also analyze the effect of renewable energy, globalization and technological innovation in Japan's environmental sustainability. The wavelet statical tools show an increase in the level of C02 emission when technological innovation has been embraced, further creating discrepancy between the positive impact and the negative scope when technological tools deployed in climate mitigation context. **Methods**

In this study, environmental sustainability (our dependent variable) is proxied by adjusted net savings, excluding particulate emission damage, adopting the famous work of (Ganda, 2020), whereas, technological innovation is adopted by (Rafique et al., 2020). Moreover, A period of twenty years was selected starting from 2000 to 2020. The period could have been extended, however, to avoid biases in a format of missing data the study contends to carry on within this interval period. Furthermore, the study is built by collecting several variables interlinked with the country's governments and civil servants. The collected variables are taken from the world bank development except for impartial administration which was taken from the global state of democracy indices. More formally, we are anticipating that greater states' characteristics improve, to some extent, the level of sustainability, thus, establishing a positive compromise between the host country and the quality of the environment. All the variables and their assessments including their respective sources can be seen in Table 1.

Table 1. Variables Summary

Variables	Description	Sources
Adjusted net savings, excluding particulate emission damage Adopted as environmental sustainability (ENS)		World Bank

Impartial Administration (IMP)	The government and the public administration more generally should implement official public policies in an impartial manner. Scaled to range from 0 (lowest score) to 1 (highest score).	The Global State of Democracy Indices
Regulatory Quality (RQ)	Perception of state to formulate sound policies. Ranging from -2.5 to 2.5	World Bank Governance
Rule of law (RL)	Quality of law enforcement, trust toward agents for their rule abiding. Ranging from -2.5 to 2.5	World Bank Governance
Government effectiveness (GE)	Quality of public and civil services and the credibility of commitment to their formulated policies.	World Bank Governance
Total Patent application (TIVN)	Adopted as a proxy for technological innovation	World bank

3.1. Econometric model

To explore factors enhancing environmental sustainability within Singaporean and Vietnamese territories the following model is proposed:

$$\ln ESN = \beta_1 + \beta_1 IMP + \beta_2 RL + \beta_3 RQ + \beta_4 GE + \beta_5 \ln TNVN + \epsilon_t \quad (1)$$

lnENS → higher impartiality among public officials improves environmental quality

> 0 IMP → Greater emphasis on rule of law introduces higher sustainability at the national level lnENS → Embracing favorable policies toward the environment produces salient sustainable

> 0 RL → frameworks

lnENS → An effective bureaucratic system leads to environmental improvement by turning to

> 0 RQ lnENS alternative substantial measures, that in turn, promote sustainability.

> 0 GE Technological innovation infuses higher sustainability by reducing the level of C02 emissions lnENS

First, the following techniques have been applied to the collected data in order to obtain the > 0 desired estimates. Accordingly, the unit root test was performed on the dataset (Variables) to lnTINV examine the stationarity series.

$$yt = \theta yt{-}1 + \varepsilon t$$

(2) where ε_t is the error term.

Assumingly, it is likely certain variables could be stationary at level or becomes stationary at the first difference if such as stationarity explosion can't be detected, hence the termination of the model is most probable or perhaps seeking other adequate alternatives. In doing so, we used the Dickey-fuller test to investigate the variables (Dickey and Fuller, 1979), i.e.

$$\Delta \ln ENS_t = \alpha + \beta TIME + \gamma \ln ENS_{t-1} + \delta \Delta \ln ENS_{t-1} + \cdots + \delta_{P-1} \Delta \ln ENS_{t-P} + \varepsilon_t \quad (3)$$

$$\Delta IMP_t = \alpha + \beta TIME + \gamma IMP_{t-1} + \delta \Delta IMP_{t-1} + \cdots + \delta_{P-1} \Delta IMP_{t-P} + \varepsilon_t$$

$$\Delta RL_t = \alpha + \beta TIME + \gamma RL_{t-1} + \delta \Delta RL_{t-1} + \cdots + \delta_{P-1} \Delta RL_{t-P} + \varepsilon_t$$

$$\Delta RQ_t = \alpha + \beta TIME + \gamma RQ_{t-1} + \delta \Delta RQ_{t-1} + \cdots + \delta_{P-1} \Delta RQ_{t-P} + \varepsilon_t$$

$\Delta GE_t = \alpha + \beta TIME + \gamma GE_{t-1} + \delta \Delta GE_{t-1} + \cdots + \delta_{P-1} \Delta GE_{t-P} + \varepsilon_t$
$\Delta \ln TIVN_t = \alpha + \beta TIME + \gamma \ln TIVN_{t-1} + \delta \Delta \ln TIVN_{t-1} + \cdots + \delta_{P-1} \Delta \ln TIVN_{t-P} + \varepsilon_t$ where 'α' is the constant, 'β' can be interpreted as the time trend coefficient, and 'p' displays the lag process.

Adopting the approach proposed by (Pesaran et al., 2001) for our ARDL model, in which their theories was based on employing different lag operators within the ARDL model to avoid simultaneity issue, while simultaneously carrying on with a mixed unit root intermingled variables I (0) I(1). *P I L*

$$(4)\ \ln(ENS)_t = \beta_0 + \sum \phi_{1i} \Delta \ln(ENS)_{t-i} + \sum_{i=1}^{Q} \beta_{1i} \Delta (IMP)_{t-i} + \sum_{i=1}^{G} \beta_{2i} \Delta (RL)_{t-i} + \sum_{i=1}^{T} \beta_{3i} \Delta (RQ)_{t-i} + \sum_{i=1}^{Q} \beta_{4i} \Delta (GE)_{t-i} + \sum_{i=1}^{G} \beta_{5i} \Delta \ln(TIVN)_{t-i} + \varepsilon_t$$

Where β _0 is the constant, β_1 to β_5 are the coefficients of variables. Δ shows the first difference, and ε is the white noise. After the short-run verification, the long-run cointegration was verified using Wald Fstatistics. The test assumes a null hypothesis denotes non-integration. Accordingly, by looking at the F statistics we can conclude if the model is worth for a long-run estimation. in this agenda, we only kept assuming the existence of long-run relations between the variables hence proceeding with an error correction.

$$(5)\ \ln(ENS)_t = \beta_0 + \sum \phi_{1i} \Delta \ln(ENS)_{t-i} + \sum_{i=1}^{P} \beta_{1i} \Delta (IMP)_{t-i} + \sum_{i=1}^{I} \beta_{2i} \Delta (RL)_{t-i} + \sum_{i=1}^{L} \beta_{3i} \Delta (RQ)_{t-i} + \sum_{i=1}^{Q} \beta_{4i} \Delta (GE)_{t-i} + \sum_{i=1}^{G} \beta_{5i} \Delta \ln(TIVN)_{t-i} + \lambda ECT_{t-1} + \varepsilon_t$$

i=1 where the ƛ ECT is the error correction term.

The granger causality was lastly performed to examine the existence of causal effect between the candidate factors. Hence, the F-test and the P value were used to assess if the factors are significantly affecting each other. Nevertheless, this depends on the causality direction, whether it is a one-way causality, a bidirectional relation, or a neutral relationship in spite of the strong association. Therefore, we take into account the following effect-relationship:

$$ENSt = c1 + \sum_{i=1}^{2} \beta 1\ ENS\ t{-}i + \sum_{i=1}^{2} \beta 2\ IMP\ t{-}i + \sum_{i=1}^{2} \beta 3\ RL\ t{-}i + \sum_{i=1}^{2} \beta 4\ RQ\ t{-}i + \sum_{i=1}^{2} \beta 5\ GEt{-}i + \sum_{i=1}^{2} \beta 6\ TIVN\ t{-}i + \varepsilon$$

$$IMPt = c1 + \sum_{i=1}^{2} \beta 1\ IMP\ t{-}i + \sum_{i=1}^{2} \beta 2\ ENS\ t{-}i + \sum_{i=1}^{2} \beta 3\ RL\ t{-}i + \sum_{i=1}^{2} \beta 4\ RQ\ t{-}i + \sum_{i=1}^{2} \beta 5\ GEt{-}i + \sum_{i=1}^{2} \beta 6\ TIVN\ t{-}i + \varepsilon$$

$$RLt = c1 + \sum_{i=1}^{2} \beta 1\ RL\ t{-}i + \sum_{i=1}^{2} \beta 2\ IMP\ t{-}i + \sum_{i=1}^{2} \beta 3\ ENS\ t{-}i + \sum_{i=1}^{2} \beta 4\ RQ\ t{-}i + \sum_{i=1}^{2} \beta 5\ GEt{-}i + \sum_{i=1}^{2} \beta 6\ TIVN\ t{-}i + \varepsilon$$

$$RQt = c1 + \sum_{i=1}^{2} \beta 1\ RQ\ t{-}i + \sum_{i=1}^{2} \beta 2\ RL\ t{-}i + \sum_{i=1}^{2} \beta 3\ IMP\ t{-}i + \sum_{i=1}^{2} \beta 4\ ENS\ t{-}i + \sum_{i=1}^{2} \beta 5\ GEt{-}i + \sum_{i=1}^{2} \beta 6\ TIVN\ t{-}i + \varepsilon \quad (6)$$

$$GEt = c1 + \sum_{i=1}^{2} \beta 1\ GE_{t-i} + \sum_{i=1}^{2} \beta 2\ RQ_{t-i} + \sum_{i=1}^{2} \beta 3\ RL_{t-i} + \sum_{i=1}^{2} \beta 4\ IMP_{t-i} + \sum_{i=1}^{2} \beta 5\ ENS_{t-i} + \sum_{i=1}^{2} \beta 6\ TIVN_{t-i} + \varepsilon$$

$$TIVNt = c1 + \sum_{i=1}^{2} \beta 1\ TIVN_{t-i} + \sum_{i=1}^{2} \beta 2\ GE_{t-i} + \sum_{i=1}^{2} \beta 3\ RQ_{t-i} + \sum_{i=1}^{2} \beta 4\ RL_{t-i} + \sum_{i=1}^{2} \beta 5\ IMP_{t-i} + \sum_{i=1}^{2} \beta 6\ ENS_{t-i} + \varepsilon$$

Results

The Augmented Dickey-Fuller test (ADF) is used for this study, it is worth noting that ADF determines the presence of stochastic stationery in the dataset and it is the most renowned Unit root test used by most studies (Morshed & Hossain, 2022; Pula & Elshani, 2018; Wen & Dai, 2020). Interestingly, Vietnam has a mixture of stationary series at level I(0) and at 1st level; I (1). The Rule of law (RL), regulatory quality (RQ), Technological innovation (TIVN) and environmental sustainability (ENS) are stationary at level. Meanwhile, Impartial administration (IMP)and Government effectiveness (GE) became stationary at 1st level, Table no. 2. On the other hand, Singapore's variables are stationary at the first difference, although bureaucratic effectiveness (GE), technological innovation, and regulatory quality (RQ) are stationary at level. Overall, these combinations of series provide strong convincing arguments for the parameters to proceed with an ARDL approach.

The correlation matrix tables display a positive association between environmental quality, rule of law, regulatory quality, and government effectiveness within the socialist Vietnamese context with a value of 0.52, 0.72, and 0.077, respectively Table no. 3 On the other hand, impartial administration and innovation displays a negative sign. Comparing this correlation with Singapore, effective bureaucratic systems appear to have the strongest association with environmental quality, whereas the aforementioned factor seems to be the lowest for Vietnam. The outcome of this result transpires that regimes attributive characteristics seldom play a key role in enhancing environmental quality, owing to the fact of both regimes' non-democratic standing point.

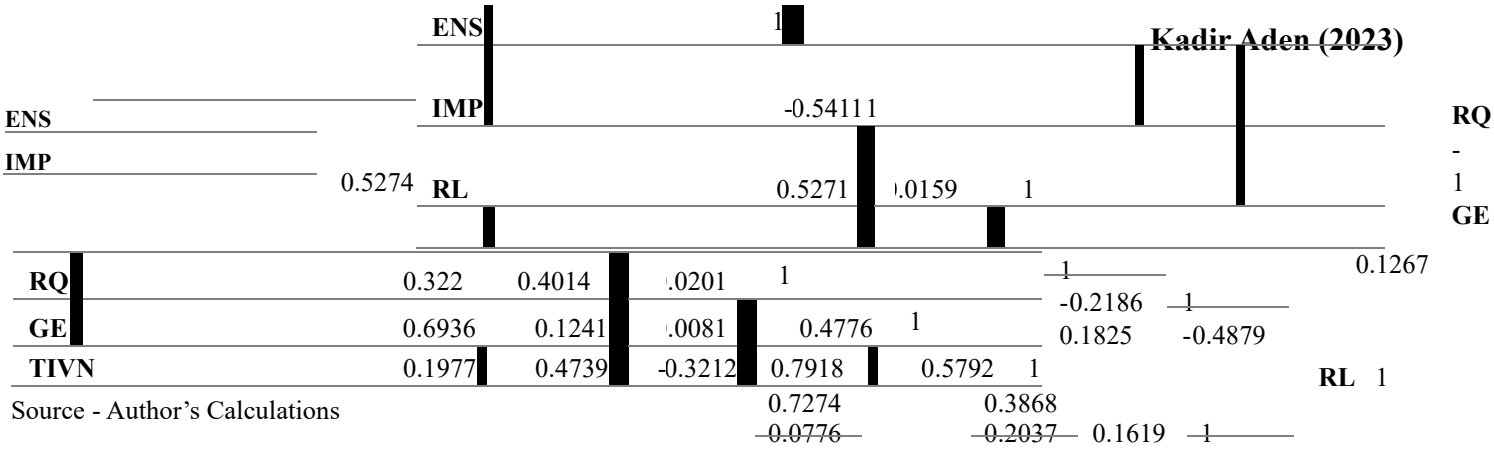
Table 3. Correlation results

	Vietnam				
ENS	IMP	RL	RQ	GE	TIVN
TIVN	-0.7915	-0.4627	-0.7352	-0.0171	1
	0.7904				

The result also indicates a unique cointegration among the selected variables. accordingly, environmental sustainability is normalized and the remained variables can be treated as a long-run forcing for the explanation of environmental quality. It can be seen from the F-statistics table no 4, all the variables are cointegrated and fail under the upper bound. likewise, we estimate the model's diagnostic. The diagnostic results can be found in table no 5.

Table 4. Bound test estimates

Singapore					
ENS	IMP	RL	RQ	GE	TIVN



Source - Author's Calculations

Vietnam		Singapore	
Test statistics	Value	Test statistics	Value
F statistics	5.867 is	F statistics	6.678
Significance level (Critical)			
Significance	I (0) Bound	(1) Bound I (0) Bound	I (1) Bound
10	2.26	3.35 2.26	3.35

Source-Author's Calculations

Further, we estimated the diagnostic of the model, all the residual shows no autocorrelation, and they are regularly distributed. Moreover, the model projects no issues of heteroskedasticity, while the outcome of the Ramsey test demonstrates that the current model does not have any misspecification errors, hence, the ARDL bounds test produces unbiased and consistent estimates. Finally, the stability of the parameters was tested, as a result, it can be drawn from the CUSUM and CUSUMQ graphs that all the statistics are in the critical bounds, meaning the coefficients of the model are stable, observe table no. 5 and figure 2,3.

Table 5. Diagnostic estimates of both models

	Test	**Results (*pvalue*)**	
Vietnam	Durbin-Watson d-statistic	3.3504	No autocorrelation
	Jarque-Bera test	0.5343	Estimated residuals are normal
	White's test	0.3918	The model is Homoskedastic
	Breusch-Pagan / Cook-Weisberg	0.8244	
	Ramsey RESET Test	0.6123	The model has no misspecification

	Breusch-Godfrey Serial LM Test:	Correlation 0.2097	No serial correlation exits

	Test	**(*pvalue*)**	**Results**
Singapore	Durbin-Watson d-statistic	3.3594	No autocorrelation
	Jarque-Bera test	0.7318	Estimated residuals are normal
	White's test	0.3799	The model is Homoskedastic
	Breusch-Pagan / Cook-Weisberg	0.9896	
	Ramsey RESET Test	0.1182	The model has no misspecification
	Breusch-Godfrey Serial Correlation LM Test:	0.8816	No serial correlation exits

Source-Author's Calculations

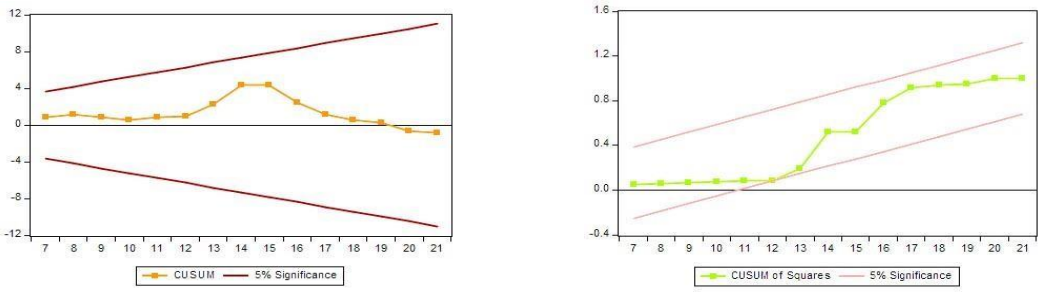


Figure 1. Cusum and Cusum Square for Vietnam

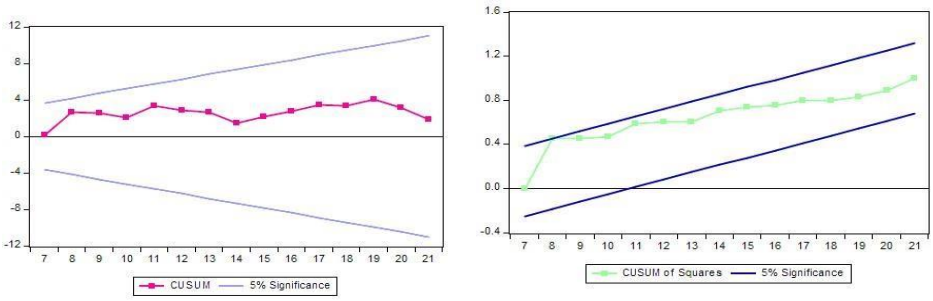


Figure 2. Cusum and Cusum Square for Singapore

The ARDL estimation for both countries can be seen in Table no. 6, Table no. 7, The shortrun and long run estimations appear to differ for both countries, for instance, impartial administration (IMP) at the national level shows a positive association in the short-run for both countries, 0.076 $p < 0.01$ and 0.012 $p < 0.05$ respectively. Nevertheless, this perfectly corresponding association lasts only in the short run for Vietnam. This sudden transformation could have been expected, considering Vietnam's late economic openness and other social aspects of life restrictions (Compared with Singapore, Vietnam adopted a state market-oriented, only, recently, which explains the country's rapid development and further attraction of foreign markets). In

addition, further administration (Private or Public) interferences in the public environment could undermine the mutual partnership between the administration and the government. Alternatively, a different explanation could be provided from an ineffective facet, in which, administrative bodies' engagement toward a more sustainable environment has been impeded, perhaps, by external factors (corruption, unfavorable environmental policies, lack of collective participation, favoring economic profits over environmental issues), and reasonably, the latter seems more plausible.

Noticeably, an effective bureaucratic system increases environmental quality in the short run for both countries 0.076 $p < 0.01$, 0.007 $p < 0.05$. Which translates; an increase of 1% in effectiveness among public officials boosts sustainability at 95% in the Vietnamese context, meanwhile it increases by 53% for Singapore. These findings are supported by the long-run estimates 0.250 $p < 0.1$ for Singapore, although a negative elasticity can be discerned for Vietnam -0.17 $p < 0.01$ (Observe both countries coefficient). Recalling, Vietnam's emphasis on strong restrictions toward fundamental rights and macroeconomic factors, which in the worst case, embodied as an ineffective government, in the sense of failing to produce a collective engagement toward the environment. Compared with Vietnam, all the variables are significant for Singapore. **Table 6.** ARDL estimates for Vietnam; Dependent variable Environmental sustainability

		VIETNAM			
		Optimal lags: (2,2,2,2,1,2)			
		Short run relationship			
	Coef.	Std.Err.	t	P>t	[95%Conf. Interval]
Δ(IMP) t	7.44753	2.214104	3.31	0.076*	-2.078991 16.97405
Δ(IMP) t-1	13.09024	3.528523	3.71	0.066*	-2.091765 28.27225
Δ(RL)t-1	-0.0013352	0.0828228	-0.02	0.989	-0.357693 0.3550227

				0.989		**Δ(RQ) t** -0.02 **Δ(RQ) t-1**
	0.2490529	0.1211267	2.06	0.176	-0.2721131	0.7702189
Δln(INVIN)T	-0.1690391	0.2196779	-0.77	0.522		
Δ ln(INVIN) t-1	- 0.6895188	0.3234377	- 2.13	0.167	- 2.081159	0.7021211
Ecm (− 1)	-4.991728	1.811627	-2.76	0.110	-12.78653	2.803073

Long Run Estimates

Variables	Coefficient	Std. Error	t-Statistic	Prob.	[95% Conf.	Interval]
		Δ(RL)t-1	0.2490529	0.1211267	2.06	0.176	-0.2721131	0.7702189
			-0.0013352	0.0828228			-0.357693	0.3550227
		0.2818846			-0.2658451	2.159858		
					-1.114237	0.7761588		**Δ(GE)**
					0.9470064			3.3
6					0.078*			
(IMP)	-0.2597011	0.2463651	-1.05	0.402	-1.319724	.8003222		
(RL)	0.1995538	0.0162665	12.27	0.007***	.1295646	.2695431		
(RQ)	0.2713976	0.0415055	6.54	0.023**	.0928139	.4499813		
(GE)	-0.1787914	0.0203297	-8.79	0.013**	-.2662629	-.0913199		
ln(TIVN)	-0.0609309	0.013631	-4.47	0.047**	-.1195803	-.0022815		
_cons	2.085394	0.5271841	3.96	0.058*	-.1828956	4.353684		

* p<0.01, ** p<0.05, ***p<0.1

Note that in the ARDL lags, the first lag (2) is for the dependent variable (ENS)

Source: Author's findings

Additionally, the long-run estimation reveals several prominent findings, according to Singapore's results; as technological innovation, and greater favorable regulation refined, the quality of the national environment improves alongside those variables. On the other side, if the rule of law (RL) improves (Vietnam) public values improves simultaneously Table no. 6, then, the tendency of creating a sustainable environment led by governmental efforts based on a greater adherence to the rule of law will increase public officials' credibility of value creation, on the other hand, a deteriorating rule of law (notice the negative value for Singapore) Table no. 7; affects both the environment and citizens, by bearing the responsibility of a fractured system. Another explanation might be, perhaps, stricter protection of the environment through national laws would reduce foreign companies' attraction, subsequently, affect the host country's foreign direct inflows (FDI), therefore tighter laws could impede Singapore's environmental sustainability in the long run, through an unprecedented macroeconomic dimension. Similarly, the positive threshold of achieving greater sustainability in the national territory, led by governmental incentives is uncommon in the Vietnamese context according to its negative (-0.17) value.

Table 7. ARDL estimates for Singapore, Dependent variable Environmental sustainability

Singapore

Optimal lags: (2,2,2,2,2,2)

Short run relationship

				P>t		
Δ(IMP) t	21.7479	0.4012416	54.20	0.012**	16.64964	26.84616
Δ(IMP) t-1	11.14372	0.2270015	49.09	0.013**	8.259389	14.02804
Δ(RL)t-1	0.4910717	0.0150468	32.64	0.020**	0.2998844	0.6822589
Δ(RL)t-1	-0.1793619	0.0050395	-35.59	0.018**	-0.2433952	-0.1153286
Δ(RQ) t	0.3553445	0.0070716	50.25	0.013**	0.2654912	0.4451978

					Coef. t [95%Conf.	Std.Err. Interval]
Δ(RQ) t-1	0.2233212	0.0030063	74.29	0.009***	0.1851229	0.2615194
Δ(GE)t	0.5349998	0.0062327	85.84	0.007**	0.4558054	0.6141941
Δ(GE) t-1	0.0314902	0.0058693	5.37	0.117	-0.0430861	0.1060666
Δln(TIVN)T	-0.6337894	0.0082869	-76.48	0.008***	-0.7390842	-0.5284946
Δln(TIVN) t-1	-1.606035	0.0157271	-102.12	0.006***	-1.805867	-1.406204
Ecm (− 1)	-1.775159	.0342853	-51.78	0.012	-2.210795	-1.339524

Long Run Estimates

Variables	Coefficient	Std. Error	t-Statistic	Prob.	[95% Conf.	Interval]
(IMP)	-24.54189	0.1688933	-145.31	0.004***	-26.68788	-22.39589
(RL)	-0.5849351	0.0038727	-151.04	0.003***	-0.6341425	-0.5357277
(RQ)	0.1848949	0.0081828	22.60	0.028**	0.0809222	0.2888675
(GE)	0.2507237	0.001129	222.07	0.003***	0.2363778	0.2650696
ln(TIVN)	-0.067511	0.0063894	-10.57	0.060*	-0.1486955	0.0136735
_cons	39.43943	0.5979719	65.96	0.010***	31.84147	47.03738

* p<0.01, ** p<0.05, ***p<0.1

Note that in the ARDL lags, the first lag (2) is for the dependent variable (ENS)

Source: Author's findings

Similarly, technological innovation (TIVN) displays a negative value for Vietnam (-0.060), therefore, a decrease in innovation, indeed, impacts negatively environmental quality, Table no. 6.

This can be explained in a more formal way, considering the fact of Vietnam's growing economy in comparison with Singapore, hence, according to this process of a so-called economic boom period, we, therefore, assume, because of the country's still technological immaturity and its slow advancement process toward higher innovative measures, will, in turn, have a long-run negative relationship, unless, Vietnam attained a threshold where the county matches sustainability agenda with their innovative measures.

Within the granger causality estimates Table no. 8, we aimed to explore if indeed either of the selected factors considerably affects each other. Table 8 shows a bidirectional causality between impartial administration and

a sustainable environment. Thus, in order to reach a sustainable environment, taking into account administration impartiality by eradicating administrative biases within the environmental context is perhaps a prerequisite step. Meanwhile, Singapore fails to project such as effect. Explaining the country's already low corruption among public officials, interestingly the following noteworthy effect can be perceived in developed and advanced societies in which factors such as state's characteristics becomes unworthy as time elapses, particularly, in providing an explanation for the socio-economic or environmental issues.

One reason for such a case, is probably the country in question has already reached a certain threshold of development, subsequently, scarcely, contributing to the overall aimed sector. On the other hand, the effect of regulatory quality on enhancing environmental performance transcends the singular impact and produces twoway causality for Singapore Table no. 8, where the formulation of friendlier environmental policies spillovers the states for higher environmental improvement, meanwhile the bidirectional effect of environmental sustainability on governmental regulatory can be viewed for Vietnam, implying the promotion of sustainable environment generates long-standing sustainability by implementing favorable roots in legislators formulation, but only this is possible if the state has achieved certain environmental performance. Similarly, both effective bureaucratic systems and technological innovation affect the environment in the Singaporean context. Putting the spotlight on the necessary requirement of reevaluating the government's efficiency in addressing environmental issues, while allocating innovative incentives toward the national environment would facilitate their sustainability mission.

Table 8. Granger Causality estimates for both Vietnam and Singapore

Vietnam Granger causality test					
Variables	Effect	Variables	F-statistics	P value	decision
IMP		→	ENS	6.178	0.036 Bidirectional
ENS	→	IMP	7.984	0.018	causality
RL	→	ENS	6.248	0.040	Unidirectional
ENS	→	RL	0.471	0.799	Non-causality
RQ	→	ENS	2.856	0.244	Non-causality
ENS	→	RQ	8.996	0.004	Unidirectional
GE	→	ENS	9.096	0.003	Unidirectional
ENS	→	GE	2.093	0.351	Non-causality
TIVN	→	ENS	0.205	0.871	Non-causality
ENS	→	TIVN	9.135	0.001	Unidirectional
	Singapore Gra	**nger Causali**	**ty test**		

Variables	effect	Variables	F-statistics	P value	decision
IMP	→	ENS	3.272	0.195	Non-causality
ENS	→	IMP	2.288	0.318	Non-causality
RL	→	ENS	4.901	0.051	Unidirectional
ENS	→	RL	3.544	0.132	Non-causality
RQ	→	ENS	7.919	0.007	Bidirectional
ENS	→	RQ	9.105	0.001	causality
GE	→	ENS	7.211	0.010	Unidirectional
ENS	→	GE	2.936	0.233	Non-causality
TIVN	→	ENS	9.180	0.000	Unidirectional
ENS	→	TIVN	1.935	0.388	Non-causality

Source-Author's findings

2. Discussion and Summary

The current paper explores the relationship between state capacity variables and environmental sustainability in the Singaporean and the Vietnamese context. In doing so, we employ an ARDL approach to catch the longrun & short-run association. The finding shows a positive association between impartial administration and environmental sustainability for both countries, nevertheless, this considerable impartiality among public & private administrations remains at this rate only in the short run for Vietnam, whereas starting to shift to insignificance in the long run. Many interpretations and conclusions can be drawn from this point. First, this estimation can be explained by the state's level of corruption, in which, Vietnam has a certain fair share of corruption in public institutions (According to the international transparency index, Vietnam scores 32%); yet, corruption might not have a direct effect on sustainability, although such an effect can impede civil servants' abilities to deliver the appropriate measures that could have addressed environmental issues. Second from a legal spectrum; courts-for-example, are similarly, affiliated to the administra- tion's scope, and have a decent portion of opinion on the environment. Albeit their independent standing ground, courts, especially tribunals dealing with environmental issues have become too political. Refereeing to the famous argument of (Breyer, 2021) in which, jurists are not different from politicians_and their allegedly impartial judicial belief is a mere disguise of their higher political affiliation, which, transpires, as time elapses, alongside their verdicts in a more form of a conservative or liberal conviction. The accuracy of this reasoning lies on the ground, for instance_a person's condition is more likely to affect the subjective choice, particularly, when administrative workers perceive available details of the interested person, hence, this undefined social status interferes in their professional judgments, as a result, reinforcing their unspoken biases. Furthermore, claimed economic victims through environmental deterioration, are typically identifiable individuals who lose their employment in the process, and, this human predisposition has prejudiced public policy and environmental law rather than appearing as ecological and environmental perseveration regulations.

However, in a country such as Vietnam, the case of matching public administration impartiality with environmental agenda in terms of establishing a compromise between two variables might take longer. In other words, the long-run relationship would not be able to manifest in a presence of high corruption and poor impartiality (Fredriksson and Svensson, 2003). Although the situation, is justifiable when looking at the state's income position, compared with Singapore, Vietnam is a middle-income country and this could have driven

the aforementioned poor performance (Treisman, 2000). Interestingly, the granger causality validates our assumption of a future effect of impartial administration in further directing to a more sustainable environment. Therefore, it is possible to raise the degree of voluntary adherence to environmental legislation by improving the perception of justice in the rulemaking process.

Furthermore, both rules of law and regulatory quality improve environmental performance, and the granger causality provides further validation for our results. The following results are in line with (Khan et al., 2020a; Ali et al., 2019). Certainly, favorable regulations toward the environment counter negative impacts that are coming from the economy which further stimulates higher environmental deterioration. Although, greater emphasis on stricter regulation might retroactively harm the pace of economic growth unless a certain threshold of economic strength has been achieved, in which the government is able to coincide environmental agendas with macroeconomic factors. On one side, further tightening environmental legislation such as imposing high C02 taxation, and emphasizing only renewable energy consummation, would reduce potential investors and FDI inflows, such a scenario is possible for Singapore.

Additionally, it is thought that nations that support the rule of law and embraces positive sustainable regulations will incentivize their citizens to create groups with a shared objective of addressing environmental sustainability. This is likely for Singapore, but as a rapidly developing country, it would be hard for Vietnam to reach an impressive environmental performance, while maintaining its economic flows, assumingly, later, after reaching a satisfactory economic development it might eventually become difficult for the state to formulate healthier environmental measures, due to the plausibility of an already ecological depletion.

The variable government effectiveness brings to light the famous assumption that a nation's institutional factors greatly influence its economic performance, and nations with higher-quality institutions are better able to control environmental damage. Singapore shows a positive relationship both in the short run and the long run. Providing us, that, regardless, of the country’s regimes whether the country in question leans toward democracy or authoritarian, the effectiveness of bureaucratic is indeed an internal structure embodied within the heart of the civil servants, thus, transforming the general stereotypical trend that constitutes comparative study between democratic and non-democratic countries, as a mere, ineffective metric, when the case involves environmental protection. at the same time, the negative relationship that appears in the Vietnamese context can provide us with a larger explanation of an ineffective government albeit the country’s recent economic growth.

On the other hand, investing in technological innovation displayed a negative interconnection with environmental sustainability in the long run. Many authors have shown that technological innovation could not transpire the general trend of sustainable development, through a mechanism led by technological progress (Adebayo, Kirikkaleli, 2021), unless the concept has been applied with a fundamental goal of sustainability attainment (Jaffe et al., 2005). On one side, the granger causality reveals a causality effect between technological innovation and sustainability, providing us with an alternative threshold of believing, that technological progress improves environmental sustainability, however, this is validated for the Singaporean context, whereas, a causality running for sustainability to the technological sector had been detected for Vietnam. This implies, that emphasizing on improving sustainability would have a direct effect on technological innovation, which, in turn, could stimulate the market to propose certain technological products in order to accommodate the high sustainability demand. Overall, technology and nature are interdependent within, whilst, technology is formed to provide means, equipment, and machinery for safeguarding the environment and conserving its resources from climatic changes and damage, in retrospect, the environment offers raw materials required to produce technology. Overall, matching administration bodies with environmental sustainability will offer higher opportunities for the ASEAN countries to achieve rapid sustainability. Although some Asian states would transit faster toward more environmentally sustainable

societies, others, due to their economic boom and immature technological innovation, the question of prioritizing the environment would be unlikely to be on the table. Finally, the current study has certain limitation; to begin with, we merely focused on two Association of Southeast Asian Nations (ASEAN) namely Singapore and Vietnam, therefore the generalization of this findings toward other ASEAN states should be avoided, with that in mind, upcoming researches could consider incorporating other countries within the regional framework in their studies. Additionally, it will also be an enrichment if future authors could compare Eastern Asian states with ASEAN countries, considering how some potential countries such as South Korea have been growing in the past thirty years at an unprecedented rate; in the context of adopting advanced technological innovation with sustainability deliverance, while competing with China, Japan and Singapore. It will also be interesting if future studies could examine sustainability from an infrastructure threshold. It is also worth noting, the current study only uses ARDL and granger test, therefore future scholars could employ a VAR model with impulse responses and variance decomposition and other models to further analyze future shock while providing robustness for future effect predictions.

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