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The impact of Euro 4 automobile emission regulations on the development of technological capabilities in ASEAN

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ABSTRACT

This paper aims to evaluate the policies targeted at regulating automobile emissions among ASEAN countries but with specific attention to the Philippines. Technology-based regulations on motor vehicles play an important role in reducing green-house gas emissions. However, regulations differ based on the level of economic development, policies and technological base of each country. This paper uses an example of the Euro 4 automobile emission regulations to examine its implementation process and strategies of each ASEAN countries. It subsequently focuses on the Philippines to analyse the role of government, multinational automobile manufacturers and local suppliers. The findings show that the strategies of automobile manufacturers have positively affected local suppliers' technological capabilities.

KEYWORDS

ASEAN; emission regulations; Euro 4 Policy; Philippines

1. Introduction

The number of motor vehicles sold in the Association of Southeast Asian Nations (ASEAN) has grown rapidly in the past three decades and is expected to grow further over the next several decades (Rasiah 2001). As a result, motor vehicles have become a major source of pollution and the fastest-growing source of green-house gas (GHG) emissions, which cause climate change and global warming. It is for these reasons that efforts are increasingly taken to regulate motor vehicle policies from the perspective of GHG management (Ambrose et al. 2017).

There are already a number of studies using computable general equilibrium models and input–output tables to project climate change effects under different policy interventions on ASEAN countries (e.g. Rasiah et al. 2016, 2017). This paper aims to evaluate the policies targeted at regulating automobile emission among ASEAN countries. Technology-based regulations on motor vehicles play an important role in reducing GHG emissions. However, the regulations vary based on the stage of economic development, policy and economic structure of countries. This paper first examines the procedures and strategies adopted in the implementation of Euro 4 automobile emission regulations on ASEAN. The paper subsequently presents a focused study of its impact on Japanese car makers in the Philippines.

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2. Theoretical considerations

Following the annual meeting of the Conference of Parties (COP), there has been increasing attempt to decarbonize the global economy. One such initiative is the introduction of emission control to check industrial emissions in the transport sector. Apart from the initiatives of European countries, it also demonstrates that ASEAN states are attempting to balance the challenges of economic development, environmental protection and energy security. While each member state has played a major role in implementing this shift, the greening of the auto sector is challenged by major obstacles, such as the high cost of manufacturing clean vehicles and more importantly building requisite new infrastructure essential to support it, and obstacle of convincing consumers to change their fuel consumption conduct.

In light of the above arguments, we present the analytic framework of the paper in Figure 1. In environment issues for climate change, issues on transportation have to be examined both from energy and transportation sides. Environmentally sustainable transportation includes cleaner and efficient vehicles. At the same time, fuel economy is important for the immediate action to reduce GHG. This paper focuses on cleaner and efficient vehicles to achieve environmentally sustainable transport.

ASEAN can move to cleaner vehicle technology by implementing both short- and long-term policies that can reduce conventional vehicle emissions by strengthening vehicle emission standards. Hence, the purpose of this paper is to analyse the environment policies of ASEAN member states government for cleaner and efficient vehicles. Since the major automobile production countries in ASEAN are Thailand, Indonesia, Malaysia and the Philippines, these countries were selected for assessing government environment policies to promote the use of clean and efficient vehicles. We then examine the progress of the implementation of higher exhaust gas regulations to achieve cleaner air in ASEAN using the example of higher exhaust gas regulation imposed by an upgrade from Euro 2 and Euro 3 to Euro 4 with a specific focus on the government, auto makers and local suppliers in the Philippines Euro 4.

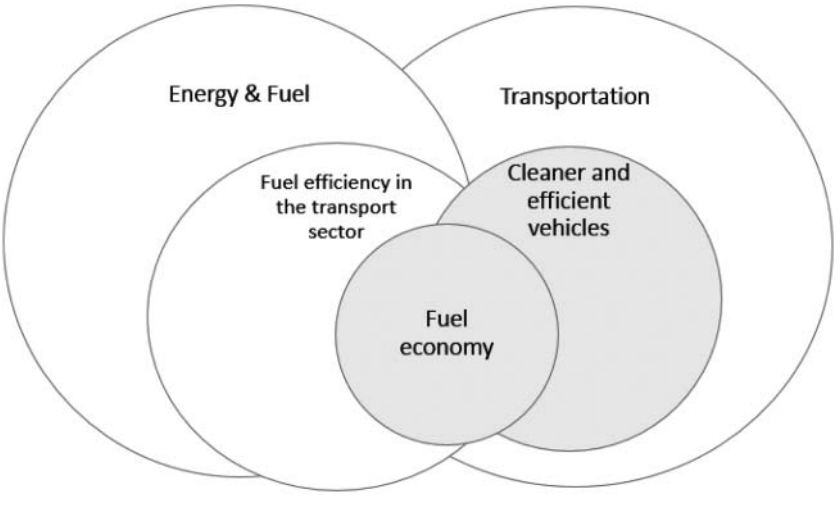

Figure 1. Analytic framework. Source: Author.

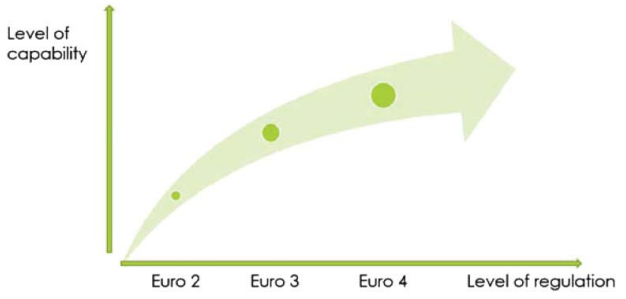

Figure 2. Research question of this paper. Source: Author.

We pursue the analysis by raising the following research questions: first, does the implementation of higher environmental regulation lead to an upgrading of local technical capabilities? And second, what impact do the regulations have on local automotive suppliers?

These research questions are presented diagrammatically in Figure 2.

The meaning of capability at the government level is explained by Kuznets (1968) that the government needs adequate personnel to establish for the specific purpose of implementing industrial and economic stabilization policies. In the early stage, Japan's Ministry of International Trade and Industry and Korea's Economic Development Board played such a role. The Economic and Social Development Board and central bank in Thailand, the National Economic Development Agency in Philippines, the Economic Planning Unit in Malaysia and the Economic Development Board in Singapore are some of the organizations that have played such a role in ASEAN. Government economic technocrats largely formulate appropriate government policies, implement them effectively and evaluate them in the light of overall policy objectives.

In addition, as shown in Table 1, it is important that government should be aware of the needs of the private sector and the citizen formulating policy. There are many intermediary bodies that mediate between government and business. The more information shared, the more sensitive will the government become to market factors and more able will it become to play the role of correcting market failures (Suehiro 2008). It is also important for a policy-maker to be independent from politics.

Enterprise capability, such as multinationals and local entrepreneurs, and workplace capability, local engineers, technicians and skilled workers are important index to examine social capability for industrialization as shown in Table 1.

Table 1. Indicators for social capability for industrialization.

Level	Actors	Index of capability
Government	Economic technocrats	• Organizational ability to formulate and implement policies • Information sharing systems • Independence from politics
Enterprise	Entrepreneurs	• Display of individual entrepreneurship • Innovative combination of managerial resources • Upgrading of corporate organization
Workplace	Engineers, technicians, skilled workers	• Individual capacity for learning technology • Organizational capacity for technology formation • Social capacity for technology formation

Source: Summarized by author based on Suehiro (2008).

Figure 3. Local supplier development process. Source: Author.

Social capability of enterprises is generally highly stimulated and promoted by government policies, regulations and incentives as Figure 3. In the case of the automobile industry, governments stimulate multinationals and auto makers by industrial policies, setting up some regulations and incentives to lead capabilities of local suppliers. For instance, local content policy for multinational auto makers showed the development of local suppliers by offering production advices and training for skilled workers (Sadoi 2003).

From absorb modern technology theory, social capability to absorb modern technology for local suppliers are human resource (Minami 1994). Absorb modern technology is the key for catch up industrialization. Especially for late comers, how effectively absorb modern technology from developed countries through multinationals are key issues.

Late comers can enjoy the advantage of backwardness (Gerschenkron 1962). The issue is how countries should go about internalizing the advantages of backwardness in the context of international comparison of modern economic growth. The differences between the average state of technologies within an industry 'backlog'. The bigger the backlog, the greater and more obvious the opportunity (Ohkawa and Rosovsky 1973). Special forms of industrial organization work by internalizing the advantages of backwardness (Minami 1994, 113–116). The remarkable economic success of East Asian countries since the 1960s seems to reconfirm the importance of social capability in reference to the Gershenkronian model (Gerschenkron 1962). Watanabe (1979) identifies the three constituent policies, corporate management capability and skilled labour.

Technology transfer largely refers to the movement of commercial technologies across, and to a lesser degree within, countries (Lall 2001). Technology (and knowledge more generally) has moved across enterprises and countries from the earliest days of productive activity. Kim (1997) refers the term technology to both collections of physical processes that transform inputs into outputs and knowledge and skills that structure the activities involved in carrying out these transformations. Technology is the practical application of knowledge and skills to the establishment, operation, improvement and expansion of facilities for such transformation and to the designing and improving of outputs therefrom.

Multinational enterprises play an important role in technology transfer across countries. Technology has moved across firms and countries through the flows from persons to persons and firms to firms. Many literatures have studied the role of multinationals from various perspectives. Teece (1977) studied it by looking at multinational firms on the resource cost of transferring technological know-how. Cantwell (1995) re-examined the hypotheses associated with earlier versions of the product cycle model (Vernon 1966), while Yap and Rasiah (2017) examined specifically how strategies of firms differ with

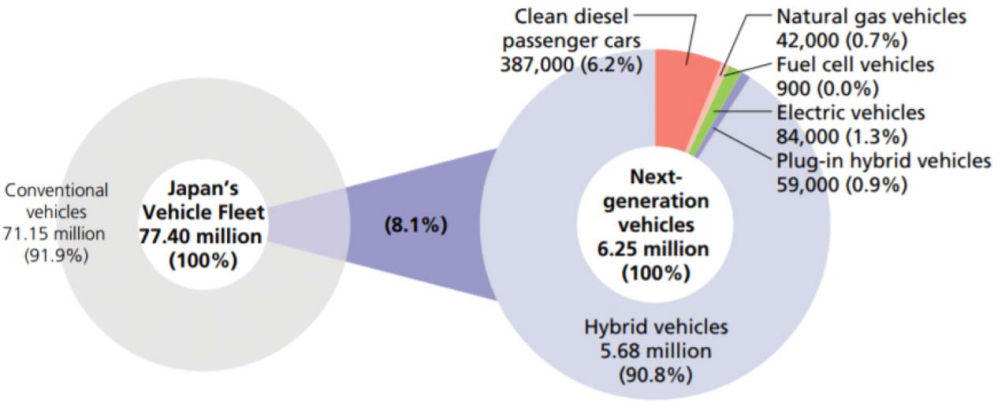

Figure 4. Composition of vehicles with breakdown of next-generation vehicle share, Japan, 2015. Source: Cited from Japan Automobile Manufacture Association (2016, p. 25).

industry and host-sites. As Rasiah et al. (2015) has argued succinctly, innovation synergies have often required host-site's institutions to stimulate the creative adaption of existing technologies.

Technology transfer of the Japanese production system was studied in various ways. Itagaki (1997) suggested the importance of human resource management through technology transfer of the Japanese production system. Especially the Japanese skill formation system is a key to successful technology transfer (Koike and Inoki 1990). Japan developed skill formation system from early years of development. In other Asian countries, as Japanese technology transferred, the importance of human resource development in industries started to be evaluated and introduced. As for the research question, higher regulation might upgrade local suppliers' technology by technology transfer through Japanese auto makers.

Regarding the environmental regulations in each ASEAN member states' current policies and future trends, there are mainly three folds: (a) introducing green energy vehicles, (b) the automotive GHG reduction by energy-saving of fuel economy regulations and (c) pollution prevention of air pollution.

(a) Introducing green energy vehicles is for the future environmental regulations and the latter (b) and (c) are current short-term issues for automobile regulations. As shown in Figure 4, the composition of Japan's vehicle shows that over 91.9% vehicles are conventional fuel engine while 8.1% are green energy next-generation vehicles as of 2015. Among the green energy next-generation vehicles, 90.8% are hybrid vehicles (HV) and only 2.3 are electric vehicles (EV) and plug in hybrid vehicle (PIHV). It means, from the total composition of vehicles, 0.2% are EV or PIHV of zero emission cars. Therefore, this paper aims the points of (b) and (c) which required fast and urgent action in automobile industries.

3. ASEAN policies on gas emission regulation

ASEAN statement at the COP22 (2016) meeting noted that ASEAN Member States have undertaken substantive actions to address climate change by submitting Intended Nationally Determined Contributions in a timely manner after signing the Paris Accord on 22

April 2016 in New York, USA. The member countries have also started implementing the ASEAN Community Roadmap 2009–2015, including ASEAN Action Plan on Joint Response to Climate Change (AAP-JRCC), the ASEAN Forging Ahead Together 2025, developing the ASEAN Post 2015 Strategic Plan on Environment (ASPEN) and ASEAN-UN Action Plan on Environment and Climate Change 2016–2020. In addition, member states have also been promoting sustainable management of forest to reduce forest degradation and deforestation, and to enhance carbon sink capacity through their own capacity, as well as through bilateral and multilateral cooperation.

ASEAN (2016) members have also urged developed countries to expedite the provision of the means of implementation of capacity building, technical assistance, technology development and transfer, and financing over the pre- and post-2020 time frame in addressing mitigation, adaptation, and loss and damage associated with the adverse effects of climate change.

South-East Asia is highly vulnerable to climate change as a large proportion of the population and economic activity is concentrated along the coastline. A study carried out by the Asian Development Bank revealed that the mean temperature in the region increased by 0.1–0.3 °C per decade between 1951 and 2000, while rainfall has trended downward from 1960 to 2000, and sea levels have risen 1–3 mm per year. Heat waves, droughts, floods and tropical cyclones have also become more intense and frequent over the years (ASEAN 2016). The same study projected a 4.8 °C rise in mean annual temperatures and a 70 cm rise in mean sea level by 2100 in Indonesia, the Philippines, Thailand and Viet Nam. A rise in sea level would result in major problems for many of ASEAN's largest coastal cities, such as Jakarta, Bangkok and Manila (2016).

Consequently, ASEAN members announced voluntary mitigation targets in 2016, including emission reduction of 26% from business-as-usual (BAU) by 2020 by Indonesia, which can be increased to 41% with enhanced international assistance, reduction of 40% in terms of energy intensity of GDP by 2020 compared to 2005 levels by Malaysia, reduction of 20% carbon emissions from BAU by the Philippines and emission reduction of 16% below the BAU levels by 2020 by Singapore (ASEAN 2016).

As for automobile regulations, many ASEAN member states decided to reduce harmful emission gas from vehicles, new fuel standards and higher emission standards. Mandatory vehicle inspection and maintenance system was implemented along with roadside pollution inspection. Recent attempts by auto industry policies of ASEAN member states show considerable shift towards cleaner emission control with cleaner vehicle technology. ASEAN emission gas regulations vary as each member state has different environment policies regarding to their level of economic development, automobile production volume and automobile market development.

As shown in Table 2 and Figure 5, automobile production volume among ASEAN countries is the highest in Thailand followed by Indonesia and Malaysia. Ownership of cars per 1000 people in the Philippines reached 23 persons, which was far below that of Malaysia (400) and Thailand (227).

ASEAN has been introduced to European emission gas regulations Euro1, 2, 3, 4, 5 and 6 with the last introduced from 2013. Each country has different levels and speeds for implementation. Thailand introduced Euro 4 in 2012, and Malaysia introduced Euro 4 in 2013. The Philippines introduced Euro 4 in 2016 with two years extension. Indonesia and

Table 2. ASEAN 5 economic data 2015.

	Population (million)	GDP per capita (US$)	Car per 1000 people	GDP growth rate (%)	Consumer price index (%)	Car production (10,000 units)	Car sales (10,000 units)
Indonesia	255	3362	82	4.8	6.4	109.9	101.3
Thailand	69	5742	227	2.8	−0.9	191.3	80
Malaysia	31	9557	400	5	2.1	61.5	66.7
Philippine	102	2858	23	5.8	1.4	9.9	28.9
Vietnam	92	2088	4	6.7	0.6	17.2	20.9

Source: Data from IMF, ASEAN automobile federation, Japan Automobile Federation, listed by author.

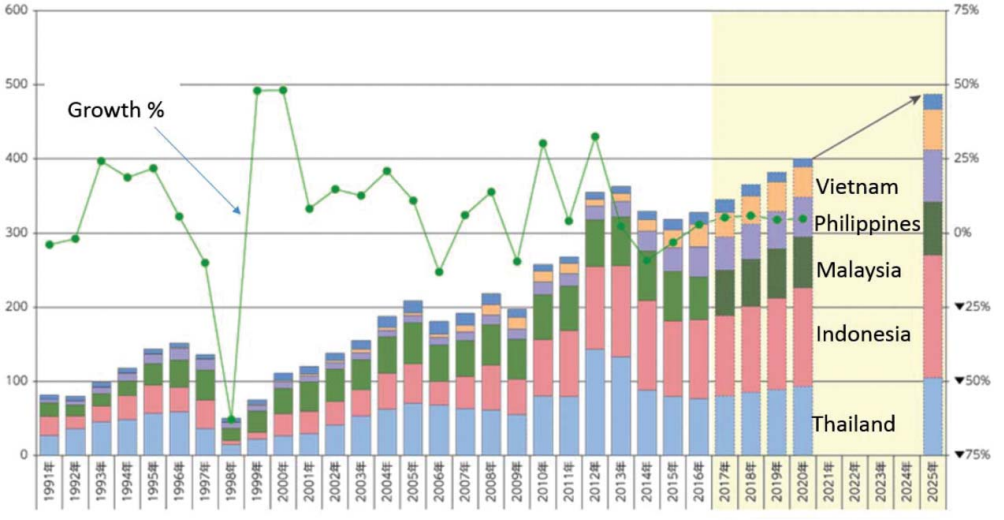

Figure 5. Automobile production volume, ASEAN, 1991–2025. Source: Adapted from Fourin (2017).
Note: Unit 10,000 vehicles.

Vietnam are considering to shift from the current Euro 2 to Euro 4 (Table 3). Gas emission gas regulations of Euro 2 to Euro 5 in each item are as shown in Table 4.

Having outlined the state of car production, emissions and Euro-environment initiatives, this section explains the environment policies on gas emission, environment tax and other policies related to automobiles in Thailand, Malaysia, Indonesia and the Philippines.

3.1. Thailand

Thailand's emission regulation policy framework is shown in Table 5 and Table 6. Its current emission policy is coordinated by the Ministry of Technology and Environment (MTE). The Euro 4 level regulations since 2012 are also handled by MTE (Table 5).

Thailand was the first country in South-East Asia to introduce the eco car programme, which is a high incentive scheme for automobile manufacturers to invest and produce eco cars. As shown in Table 7, Phase 1 of the eco car programme started in 2007. The following year, five auto makers were granted eco car status. Eco car phase 2 was started in 2013, which offers corporate income tax exemption over eight years, lower excise tax, exemption of import duty on machinery and 90% reduction of import duty on raw materials for two years. The incentives are slightly better in Phase 2.

Table 3. Introduction of Euro exhaust gas regulations, ASEAN, 1995–2022.

Country	95	96	97	98	99	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
EU	1	Euro 2					Euro 3				Euro 4			Euro 5					Euro 6								
Thailand			Euro 1		Euro 2							Euro 3						Euro 4										
Malaysia			Euro 1												Euro 2				Euro 4									
Indonesia											Euro 2																	
Philippines									Euro 1				Euro 2									Euro 4						
Vietnam													Euro 2										Euro 4					

Source: Compiled by Author from auto makers, Clean Air Asia publications.

Table 4. Gas emission regulations (g/km).

		Euro 2	Euro 3	Euro 4	Euro 5
Gasoline	CO	2.2	2.3	1	1
	HC	0.5	0.2	0.1	0.068
	NO_x	n/a	0.15	0.08	0.06
Diesel	CO	1	0.67	0.5	0.5
	HC	0.9	0.56	0.3	0.23
	NO_x	n/a	0.5	0.5	0.05
	PM	0.1	0.05	0.025	0.0025

Source: Author's hearing from auto makers.

Table 5. Thailand emission regulation (g/km).

	CO		HC		HC + NO_x		NO_x		PM
Category	Gas.	Dsl.	Gas.	Dsl.	Gas.	Dsl.	Gas.	Dsl.	Dsl.
M	1.00	0.50	0.10	–	–	0.30	0.08	0.25	0.025
N1I	1.00	0.50	0.10	–	–	0.30	0.08	0.25	0.025
N1II	1.81	0.63	0.13	–	–	0.39	0.10	0.33	0.040
N1III	2.27	0.74	0.16	–	–	0.46	0.11	0.39	0.060

Note: Gas. = gasoline; Dsl.= diesel.
Source: Mitsubishi UFJ Research & Consulting (2016).

Table 6. Vehicle tax, Thailand, 2016.

Car model	Old tax system			New tax system		
	Displacement	Fuel type	Tax %	Displacement	Fuel type	Tax %
Passenger car	<2000 cc	E10	30	<100 g/km	E10	30
		E20	25		E20	30
		E85	22		E85/ng	25
	2001–2500 cc	E10	35	<101–200 g/km	E10	35
		E20	30		E20	35
		E85	27		E85/ng	30
	2501–3000 cc	E10	40	200 g/km<	E10	40
		E20	35		E20	35
		E85	32		E85/ng	35
Eco car		Diesel	17	<100 g/km	Diesel	14
				101 g/km<	Diesel	17
		E85	17	<100 g/km	E85/ng	12
				101 g/km<	E85/ng	17
Hybrid vehicle	<3000 cc		10	<100 g/km		10
				101–150 g/km		20
				151–200 g/km		25
				201 g/km<		20
EV/fuel cell vehicle	<3000 cc		10			10
	3001 cc<		50			50
	<3250 cc		3	<200 g/km		3
				201 g/km<		5
Pick-up truck(single cab)	<3250 cc		3	<200 g/km		5
				201 g/km<		7
Pick-up truck(double cab)	<3250 cc		12	<200 g/km		12
				201 g/km<		14
PPV	<3250 cc		20	<200 g/km		25
				201 g/km<		30
Pick-up truck	3,251 cc<		50	3251 cc<		50

Source: Mitsubishi UFJ Research & Consulting (2016).

Table 7. Eco car policy, Thailand.

Year	2007	Applied by 2014 Produced by 2019
Fuel efficiency	<120 g/km (20 km/L<)	<100 g/km (23.3 km/L<)
Exhaust gas regulation	Euro 4	Euro 5
Displacement	1300 cc<	<1300 cc gasoline <1500 cc diesel
Others	100,000 units/year volume after the fifth year	100,000 units/year volume after the fourth year

Source: Compiled from Kasikorn Bank (2015).

3.2. Malaysia

Environmental regulation for automobiles in Malaysia involves two aspects: gas emission regulation and fuel efficiency for CO_2 reduction. Gas emission regulation policy for Euro 1 was first introduced in 1996 for diesel powered commercial and passenger cars. Euro 2 was introduced in 2000 for gasoline powered commercial and passenger cars. Euro 2 was applied for diesel powered commercial and passenger cars, while Euro 3 was introduced for gasoline powered commercial and passenger cars in 2012. Announcements for the introduction of Euro 4 were made in 2016.

Malaysia introduced energy efficient vehicles (EEV) targeting CO_2 emission to reduce GHG with fuel efficiency (L/km) set under the National Automotive Policy 2014. The EEV by categories are shown in Table 8.

Malaysian government offered tax incentives to promote EEVs. Initially tax incentives for EEV were for both imported and locally produced knock down (KD) HV and EV. However, the tax benefits on imported cars ended in 2013 leaving them only for KD or locally produced EEV (Figure 6). This strategy was to stimulate local auto makers to produce HV, EV and other EEV in Malaysia.

3.3. Indonesia

Gas emission regulations differ by type of passenger cars, trucks and motor bikes in Indonesia. Euro 2 regulations were started in 2005 to implement newly introduced models of passenger cars, small trucks and large trucks. In 2009, the Ministry of environment of

Table 8. Fuel efficiency regulations, Malaysia.

Category		Vehicle weight (kg)	Fuel efficiency (L/100 km)
A	Micro car	Under 800	4.5
	City car	891–1000	5.0
B	Super mini car	1001–1250	6.0
C	Mall family car	1251–1400	6.5
D	Large family car	1401–1550	7.0
	Compact Executive car		
E	Executive car	1551–1800	9.5
F	Luxury car	1801–2050	11.0
G	Large 4 × 4	2051–2350	11.5
	Others	2351–2500	12.0

Source: Malaysia (2014).

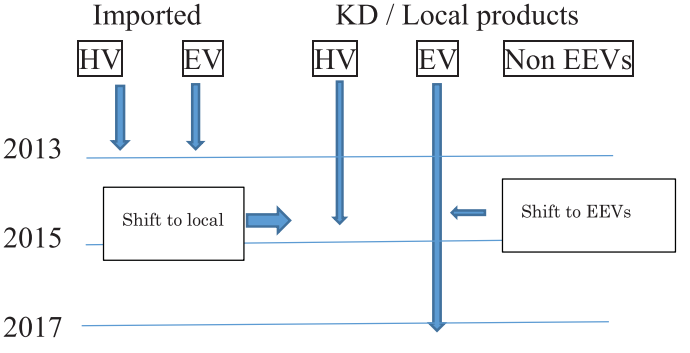

Figure 6. Tax incentives, EEVs, Malaysia. Source: Malaysia (2014).

Table 9. Gas emission regulations, Indonesia, based on Euro 2 (g/kg).

Reference weight		CO		$HC + NO_x$		PM
	Gasoline	Diesel	Gas	Diesel	Diesel	
1	Under 1250 kg	2.20	1.00	0.50	0.70	0.08
2	1250–1700 kg	4.00	1.25	0.60	1.00	0.12
3	Over 1700 kg	5.00	1.50	0.70	1.20	0.17

Source: The Council of the European Communities, 'Official Journal of the European Communities, No.L 295/1'.

Table 10. Gas emission regulations for passenger cars in Jakarta.

	CO	HC
Using gasoline vaporizer	Under 3%	Under 700 ppm
Using gasoline fuel injection	Under 2.5%	Under 500 ppm

Source: Energy and Environment Research, 'Exploring Variation of Maintenance Action and its Impacts on Emission and Cost in Jakarta City', December 2011.

Indonesia announced the shifting and upgrading plan from Euro 2 to Euro 4 by 2012.[1] However, this shift has not been implemented as of 2017. Table 9 and 10 show gas emission regulations for vehicles in different weight categories based on Euro 2.

For Indonesia, gasoline fuel prices paid by consumers are composed of basic price + VAT (value-added tax) + motor fuel tax (PBBKB) + enterprise profit. The motor fuel tax is a local tax, and tax rates vary by states. For example, in Java and Madura Islands, motor fuel tax is 5%, while it is 10% in the Bali Island.

In 2013, Indonesian government introduced tax benefit system for Low Cost Green Car which meets the following requirements can receive 10% tax exemption.

- ☐ Displacement:Gasoline – 1200 cc or less; Diesel – 1500 cc or less
- ☐ Fuel consumption rate:20 km/L or more
- ☐ Mobility: less than 4.6 m minimum turning radius
- ☐ Local content rate: 80% or more

3.4. Philippines

The Republic Act 8749 (Clean Air Act) was enacted in 1999 in the Philippines to mandate exhaust emission standards for industries and automobiles (See Table 11), which showed the highest emission standards in ASEAN. It was overtaken by the introduction of Euro 1 gas emission regulatory control in 2003, Euro 2 in 2005 and Euro 3 in 2008. Euro 4 is expected to be implemented in 2018.

Table 11. Exhaust emissions regulations, Philippines.

	CO (g/km)		$HC + NO_x$ (g/k)		
Light vehicles	2.72	0.97	0.14	PM (g/km)	
Light commercial vehicles		Weight (kg)	CO (g/km)	$HC + NO_x$ (g/km)	PM (g/km)
	Category 1	<1250	2.72	0.97	0.14
	Category 2	1250–1700	5.17	1.4	0.19
	Category 3	1700<	6.9	1.7	0.25
Heavy duty vehicles	CO (g/kWh)	HC (g/kWh)	NO_x (g/kWh)		PM (g/kWh)
	4.5	1.1	8		0.36

Source: Diaz (2017).

Table 12. Bio-ethanol and bio-diesel regulation timeframes, Philippines.

	2013–2015	2016	2020	2025	2030
Bioethanol	E10	E10	E10	E20	E20/E85
Biodiesel	B5	B5	B10	B20	B20

Note: B20: 20% bio-diesel, E20: 20% bio-ethanol.
Source: Foreign Agricultural Service, a 'Philippines Biofuels Annual: Philippines Biofuels Situation and Outlook', October 2013.

While the fuel efficiency regulations are yet to be implemented, the government of Philippines introduced the National Energy and Efficiency and Conservation Program through a national campaign seminar and workshops to meet 60% of energy self-sufficiency, to promote CO_2 reduction and through the Government Energy Management Program to reduce 10% of fuel use by public automobiles. In addition, the Bio-Fuel law (Republic Act 9367) was implemented to add 2% of bio-diesel to diesel fuel by 2009 (National Biofuels Plan (NBP) 2013–2030). The government also mandated to increase the use of bio-ethanol and biodiesel to 10% and 20%, respectively, by 2025 (Table 12).

The main automobile producing countries in ASEAN have introduced strong regulations to shift to environment-friendly technologies. Thailand, Malaysia and Philippines are ahead of other automobile producing nations in ASEAN in setting up higher and stricter emission regulations. Thailand and Malaysia have stepped up the provision of incentives to stimulate the production of eco cars. Especially in Thailand, most Japanese automobile manufacturers use the incentives to produce new global models. We examine in the next section the case of the Philippines.

4. Focused study on the Philippines: shifting from Euro 2 to Euro 4

The Philippines government announced officially to implement Euro 4 effective from January 2018. For the research question of this paper 'how does the higher regulation upgrade local capability' taking the case of Philippines, this empirical study examines the process of shifting Euro 2 to Euro 4 in Philippines and investigates the effects on capability to local automobile industries. Then, this section investigates what kinds of strategies and practices are in progress by auto manufacturers and parts suppliers in Philippines.

First, what is the required technology to shift from Euro 2 to Euro 4 exhaust gas regulations? The minimum toxic substances in Euro 2 to 4 are as shown in Table 2. All the toxic substances in exhaust gas had to be halved or lowered to meet Euro 4 regulation.

How the toxic substances from the exhaust gas are eliminated? In the case of gasoline engine vehicles, exhaust system is the key system. As Figure 7 shows, the exhaust system is located from engine to muffler as indicated.

The catalytic converter, which is located between the engine and the muffler, has the key function to eliminate the harmful substances as it purifies hydrocarbon, carbon monoxide and nitrogen oxide, and the exhaust emissions of water (H_2O), CO_2 and NO_2 (see Figure 8).

In the case of diesel engines, catalytic converters, NO occlusion catalysts, diesel and particulate filters are necessary to eliminate toxic substances (see Figure 9). These instruments will of course become irrelevant in Europe and Japan once the ban on the internal combustion engines takes effect in 2040 (Rasiah et al. 2017).

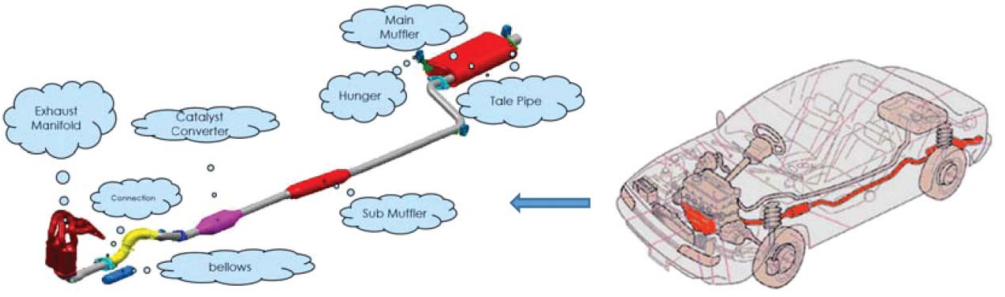

Figure 7. Exhaust system. Source: Drawn by author hearing from Mitsubishi Motors Cooperation.

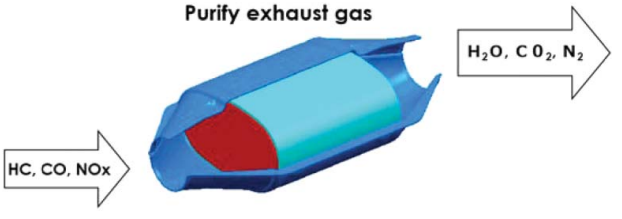

Figure 8. Function of catalysis converter. Source: Drawn by author hearing from Mitsubishi Motors Corporation.

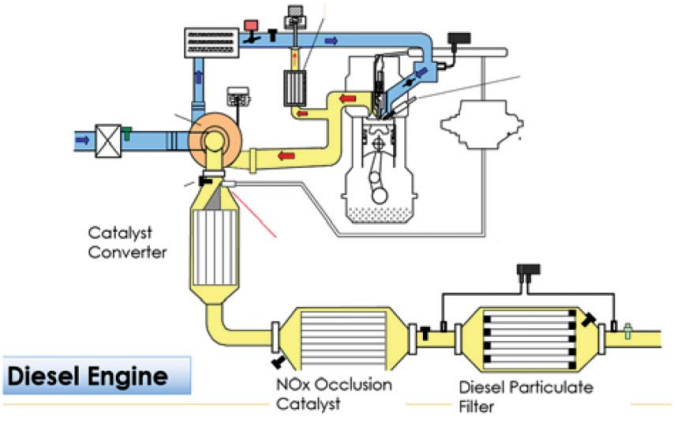

Figure 9. Diesel engine exhaust system.

In the Philippines, the Department of Environment and Natural Resources (DENR) set 31 December 2017 as the deadline for the initial new car registration deadline for non-Euro 4 compliant vehicles in the country. Although Philippines has shifted to Euro 4 emissions standard on 1 January 2016, the DENR has given car makers extension. With car makers citing 'long-term production planning of OEMs' and requiring a 'significant vehicle technology shift within the model life', the DENR gave two years for car makers to phase out the existing Euro 2 models. That extension though should have expired at the end of 2017 (DENR 2017), which means the DENR will no longer accept Euro 2 Certificates of Conformity as a basis of initial registration with the Land Transportation Office

or LTO from 1 January 2018. New vehicles that have not been registered and do not meet Euro 4 emissions standards cannot be registered from 2018. This ruling has no effect on vehicles already purchased and are already registered with the LTO. The Euro 2 emissions standard will be used for renewal of registration for vehicles purchased before 1 January 2018.

In light of the shift towards Euro 4 standards, auto makers accelerated efforts to meet such a standard. Hence, we examine the strategies of auto makers, and their MNC and local suppliers in the Philippines from research undertaken on Mitsubishi Motors Philippines Corporation (MMPC) in 2017. MMPC was first established in the Philippines in 1963 as Chrysler Phils. Corp and started production from 1964. Mitsubishi Motors Corporation (MMC) Japan (17.5%) and Nissho Iwai Corporation (NIC) (17.5%) became partners of this company in 1985. It is in 1996 that Japanese capital took full ownership of Philippine Automotive Manufacturing Corp to form MMPC with MMC taking 51% and NIC taking 49% equity. MMPC upgraded to 30,000 vehicle production capacity per year in 2014.

The shift to the Euro 4 model generally requires 1.5 years of preparation. The major processes and the division of labour are shown in Figure 10. For example, in the exhaust system the Philippines local exhaust pipe suppliers' capabilities needed upgrading as Roberts AIPMC supplies them to MMPC. MMC and MMPC started research and development (R&D) for its new Euro 4 model. Based on the design specifications, system suppliers, Futaba Japan and Roberts Philippines were selected by MMC and MMPC. Prototypes are then manufactured by Roberts with technical assistance from Futaba. Prototypes are tested several times by Futaba in Japan before they are sent from Philippines to Japan Futaba for further testing. Test results are reported to MMC and MMPC. MMPC has already prepared mass production lines. Once the tests are clear and are by MMPC, production of the Euro 4 model will start at suppliers and MMPC (Table 13).

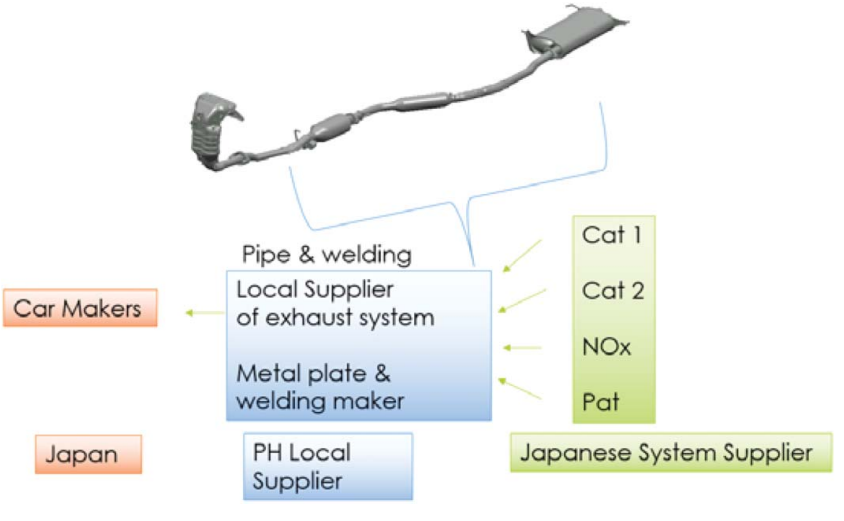

Figure 10. Exhaust system manufactured for Philippines. Source: Figure is cited from Japan Automobile Manufacture Association (2016, p. 25).

Table 13. Division of labour, Euro 4 Model, Philippines.

	Car makers	System suppliers (J)	Local suppliers (Ph)
R&D	✓		
Supplier selection	✓		
Prototype making		✓ →TA	✓
Second tier supplier selection		✓	
Prototype test	✓	✓	
Production preparation	✓		
Production tests and certificate	✓		

Source: Compiled by Author.

The entire exhaust systems are produced by local firm Roberts, Philippines with technology assistance (TA) of Japanese system supplier Futaba who was selected by MMC and MMPC. The Japanese systems supplier has been the main supplier of the Euro 4 exhaust system to MMC in Japan. The Japanese system supplier, Futaba has long experience and expertise for entire functions to upgrade the exhaust system to Euro 4 and select and purchase catalysis and other core parts and processes from other Japanese suppliers in Japan and the Philippines. Futaba organizes the core functional parts required before working with Roberts TA and the Philippines local suppliers on prototype making, testing, mass production and quality control. The finished exhaust systems are then delivered to MMPC.

Roberts AIPMC was first established in 1968 and its roots can be traced back to the RGC Group to manufacture uratex foam. It is one of the leading manufacturers of polyurethane foam in South-East Asia. The RGC Group has grown into the RGC Group of Companies and has diversified into product lines from foam products to include plastics, textiles and automotive and industrial parts. Futaba is hoping that the capability of Philippines suppliers can be upgraded to undertake testing there as it will reduce costs considerably.

As of 2018, the major players are Japanese car makers and system suppliers. Local suppliers are still disadvantaged by a lack of technological capability. However, local suppliers should upgrade their capabilities to obtain new TAs with higher value added components. This requires strengthening the R&D capabilities of local suppliers. Similar migration of high value added activities were achieved by Foxconn in the value chain controlled by Apple (Sturgeon 2002). Local suppliers can eventually move on to establish control through a wide range of strategies (see Yap and Rasiah 2017). Nevertheless, the survey showed that local suppliers were involved in prototype making, welding and final assembly for exhaust systems and those that show high potential to expand and upgrade. Interviews showed several problems faced by local suppliers. First, local suppliers have not been able to lower their cost of production to compete effectively with Japanese suppliers. It is more difficult to manufacture functional parts as they are more complex to produce than the simpler components they currently manufacture. Second, local suppliers lack the agility to meet changes in demand when involving short notices from changes in environmental regulations.

Owing to the state of supply capacity in the Philippines, MMPC chose to terminate some models by increasing output of Euro 2 models until the end of 2017. For example, MMPC increased production volume of one model from 1800 vehicles per month to 3000 until the end of 2017.

5. Conclusions

This paper examined the impact of environmental regulations on the automobile industry in selected ASEAN countries with a focus on the introduction of Euro 4 gas emission regulations in the Philippines. Among the major automobile production countries, Thailand, Indonesia, Malaysia and Philippines and their government environmental policies on higher and stricter exhaust gas emission regulating systems and incentives for producing eco-friendly cars were analysed.

Although the goals are similar, each government has taken different strategies and policies to regulate gas emission. Since Singapore does not have any car assemblers, Thailand has led the other ASEAN members with a strong eco car project, giving several incentives to auto makers to raise emission control standards. As an export oriented automobile production hub in ASEAN, Thailand had to meet the high regulation from the early stage to sustain exports. Malaysia followed next with the highest vehicle rate per 1000 people in ASEAN. It has launched the EEV project to shift to HV and EV for local production. Indonesia and Philippines follow next with a focus on shifting from Euro 2 to Euro 4 emission regulations from 2018.

Primary research on the Philippine showed that local supplier capabilities are evolving to support strategies to make the shift from Euro 2 to Euro 4 models from 2018. While government policies incentivize the new Euro 4 models, they also prohibit the manufacture of Euro 2 models. The findings show a retention of the existing division of labour between automobile assembles, systems manufacturers and local suppliers. Japanese-owned Futaba still dominates the designing and testing of the exhaust systems used by MMPC, which are then manufactured by local suppliers. It is important for local suppliers' focus on R&D operations to upgrade their technological capabilities, which can offer them the opportunity of extend their share of MMPC's value chain, as well as raise their competitiveness.

Notes

1. Asian Clean Fuels Association, 'ACFA News: Indonesia Gears Up for Better Fuel and Air Quality', November 2009.

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Disclosure statement

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