การวัดและเปรียบเทียบผลิตภาพแรงงานในอาเซียน

MEASUREMENT AND COMPARISON OF LABOUR PRODUCTIVITY IN THE ASEAN

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บทคัดย่อ

บทความนี้มีวัตถุประสงค์เพื่อวัดผลิตภาพแรงงานโดยใช้ฟังก์ชั่นการผลิตแบบ Cobb-Douglas และวัดดัชนีผลิตภาพแรงงาน นอกจากนี้ยังเปรียบเทียบผลิตภาพแรงงานในกลุ่มประเทศอาเซียน โดยจำแนกการเปรียบเทียบเป็น 3 กลุ่ม ได้แก่ 1) เปรียบเทียบระหว่าง กัมพูชา ลาว เมียนมา และเวียดนาม (CLMV) และบรูไน อินโดนีเซีย มาเลเซีย ฟิลิปปินส์ สิงคโปร์ และไทย (ASEAN6) 2) เปรียบเทียบตามระดับรายได้หรือระดับการพัฒนาประเทศ และ 3) เปรียบเทียบตามระยะเวลาการรวมกลุ่มทางเศรษฐกิจ ตั้งแต่ปี พ. ศ. 2514-2559 ผลการวิจัยพบว่า ผลิตภาพเฉลี่ยของแรงงาน (AP_L) ผลิตภาพส่วนเพิ่มของแรงงาน (MP_L) และดัชนีผลิตภาพแรงงาน (LPI) ใน ASEAN6 มีแนวโน้มลดลงในขณะที่ CLMV มีผลิตภาพแรงงานเพิ่มขึ้นอย่างต่อเนื่อง เมื่อเปรียบเทียบกับผลิตภาพแรงงานจำแนกตามระดับรายได้หรือระดับการพัฒนาประเทศพบว่าประเทศที่พัฒนาแล้วหรือประเทศที่มีรายได้สูงมีผลิตภาพแรงงานสูงกว่าประเทศที่มีรายได้ปานกลางและประเทศที่มีรายได้ต่ำ นอกจากนี้ เมื่อเปรียบเทียบผลิตภาพแรงงานตามระยะเวลาการรวมกลุ่มทางเศรษฐกิจ พบว่า ในช่วงแรกของการรวมกลุ่มทางเศรษฐกิจตั้งแต่ ปี พ. ศ. 2514-2534 ผลิตภาพแรงงานค่อนข้างต่ำในทุกประเทศ ต่อมาในปี พ.ศ. 2535-2559 มีข้อตกลงและความร่วมมือทางเศรษฐกิจที่เป็นรูปธรรมมากขึ้น ทำให้ผลิตภาพแรงงานของประเทศในกลุ่มอาเซียนเพิ่มขึ้น

คำสำคัญ: ผลิตภาพแรงงาน อาเซียน การรวมกลุ่มทางเศรษฐกิจ

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Abstract

The research aims to measure labour productivity of all countries of the Association of Southeast Asian Nations (ASEAN), using Cobb-Douglas production function and productivity index, and compare them with Cambodia, Lao PDR, Myanmar, and Vietnam (CLMV) and Brunei, Indonesia, Malaysia, the Philippines, Singapore, and Thailand (ASEAN6), based on income level, and the period of economic integration in the ASEAN from 1971–2016. The findings show that the average product of labour (APL), marginal product of labour (MPL), and the labour productivity index (LPI) in the ASEAN6 are likely to decrease, while continuously increasing in CLMV. When comparing labour productivity with national development based on income level, high-income economies are found to have the highest labour productivity in comparison to upper-middle-income and lower-middle-income economies. The comparison of labour productivity by economic integration demonstrates that the first period of economic integration from 1971–1991 produced a relatively low level of labour productivity in all countries. Later, from 1992–2016, there were more agreements and concrete economic integration, leading to an increase in labour productivity within the region.

Keywords: Labour Productivity, ASEAN, Economic Integration

Introduction

Economic growth is one of the major goals for global development. This is because economic development can improve the quality of life for the population (Komlos, 1994). Economic growth is mainly determined by the development of all production factors, particularly labour, which links to all systems in the economy, and is as important for consumers and producers as it is for inventors, developers, and technology users. Therefore, labour remains an important factor for economic development and increases international competitive capability. Since World War II, labour has been a major contributing factor to economic growth. Many countries seek to develop productivity in their domestic labour force to achieve a greater capacity for producing goods and services (McConnell, Brue, and Macpherson, 2016). The key to such development is human capital investment (Ehrenberg & Smith, 2000; Kaufman & Hotchkiss, 2003) and achieving technological progress in production (Salvatore, 2012).

When labour productivity rises, it results in increased economic growth for the country. If there is a lack of labour productivity, it may adversely affect economic growth. Therefore, economic growth and competitiveness resulting from labour do not necessarily mean that when one country has lower wages than another it can produce cheaper products due to devaluation. In fact, the competitive strength of the labour force comes from increased productivity since it makes the country more competitive (Santipolvut, Sukharomana,

Vesdapun, & Udomwitid, 2006; Dragomir & Tanasie, 2015). The population has a better standard of living and consequently sustains economic growth in both the short and long term (Nakamura, Kaihatsu, & Yagi, 2018).

Labour productivity does not simply mean the ratio of the quantity produced to the number of workers in the production process (Owyong, 2000) and does not merely represent a form of integrated labour efficiency and effectiveness (Matache, Geamanu, Dumitrescu, & Cristea, 2015; Mangu & Csiminga, 2017). Labour productivity also includes expertise and capacity in the use of technology, together with social and environmental management relating to factors in the economy. As a result, labour productivity is an important aspect of efficiency, and can also be compared to international economic growth.

In addition, the development of a country's productive inputs may be induced through economic integration. Economic integration results in the expansion of domestic output due to the larger size of the market for goods and services, resulting in higher production, productivity, technological advances, and an increase in the quantity and quality of labour (El-Agraa, 1988). For these reasons, some countries have established economic integration to develop productive inputs. For example, a group of countries in Southeast Asia are members of the Association of South East Asian Nations (ASEAN), which was established on 8 August 1967. The five founding nations of the ASEAN are Indonesia, the Philippines, Malaysia, Singapore, and Thailand, signing the Bangkok Declaration to establish cooperative association to increase economic growth, social development, cultural development, the preservation of peace and stability, and providing an opportunity to peacefully resolve arguments at the provincial level in each country. Brunei became the sixth country to join the ASEAN in 1987, followed by Vietnam in 1995, and Lao PDR and Myanmar in 1997. The last country to join the group was Cambodia in 1999. In addition, the ASEAN has developed important economic cooperation including investments, trade, and inputs development such as skilled labour, which is an important objective of the ASEAN economic integration.

The main objective of this study is to classify the methods for measuring labour productivity and their advantages and disadvantages. This study measures labour productivity using the production function and labour productivity index by comparing and classifying labour productivity in three cases: 1) Comparing labour productivity between ASEAN6 and CLMV; 2) Comparing labour productivity at income or development level of all member countries; and 3) Comparing labour productivity through economic integration across the ASEAN.

The other parts of this study are organised as follows: section 2 explains the measurement of labour productivity, section 3 presents the data and methodology, section 4 discusses the results, and section 5 offers the conclusions.

Literature Review

Numerous studies on labour productivity by distinguished economists have stated that theoretically there are several approaches to measuring labour productivity, including output and input data, but practically they usually employ only a single method. Hannula (2002), Crawford and Vogl (2006) and Reinsdorf (2015) stated that labour productivity can be measured in two forms: partial productivity and total factor productivity (TFP). Partial productivity is used to compare the output with any single input such as labour productivity or capital productivity. The productivity of input can be measured in various ways. The simplest and most prevalent method is to use the ratio between output and any single input. For instance, TFP, also known as multi-factor productivity (MFP) is used to compare the output with all inputs in the production process. Since partial productivity only reveals the production capacity of a single input to produce goods and services in a specific period of time, it cannot measure the overall production efficiency resulting from other inputs apart from labour or capital such as factor change, factor substitution, technological management change, and the emergence of new technologies. This productivity value cannot be measured using only a single specific input (OECD 2001; Brandt, Schreyer, & Zipperer, 2017). However, the measurement of partial productivity has certain disadvantages since it does not consider the balance between labour and other inputs in the production of goods and services (Windle & Dresner, 1992). Besides, it cannot determine the proportion of input (factor trade-off). On the other hand, the measurement of TFP can explain the relationship between inputs and goods produced such as capital, labour, and other factors. Despite its disadvantages, the measurement of partial productivity is used more extensively than that of TFP at both industry and country level. Salehi, Shirouyehzad, & Reza (2013) measured labour productivity using input, output, and econometric approach. Matache et al. (2015) measured labour productivity in New Zealand using the productivity index production function, growth accounting, and an econometric approach. Besides, the labour productivity index (LPI) can be measured by the ratio of output to input.

Apart from the measurement of labour productivity by output and input, it can also be measured by the type of data, classified into two types: Discrete data measures productivity by calculating the percentage change in output with respect to each input. Continuous data for measuring productivity starts from a simple model based on the neoclassical production function, showing the relationship between factors used in production, labour input, and capital input (Solow, 1957). Nevertheless, the production function is a popular econometric method for measuring labour productivity since it is able to estimate flexibility in the coefficients of labour, capital, and others. In addition, the econometric method also explains the relationships between production and inputs and whether they are positive or negative. This method is different from others in that the discrete data measurement is unable to estimate coefficient flexibility and define the relationship and direction between input and

product. Nevertheless, the coefficient is stable during the study period despite the econometric method having the advantage of being able to define flexibility. In fact, flexibility in coefficients always exists, to a greater or lesser extent.

In addition, the measurement of labour productivity can be classified into micro and macro levels. For example, Janssen and McLoughlin (2008) classified labour productivity into industry or micro and macro levels. Labour productivity can be measured at the macro level using the LPI. Puttharee, Suppamornkul, and Rugpenthum (2010) measured the LPI of Thailand using the same, previously mentioned approach. Similarly, the Census and Statistics Department (2017) measured the LPI of Hong Kong using the same method. The results showed that the LPI was an important economic indicator (Abraham, 1997). On the other hand, the LPI can be measured at the micro level by the value added of labour per total working hours (Velucchi & Viviani, 2011). Santipolvut (2002) explained that the value added of labour equates to sales minus the cost of goods sold (except labour remuneration). Sales represent the value of goods and services sold in any business unit. Total cost refers to the total expenses incurred from the sale of goods and other related factors.

The measurement of labour productivity at micro level indicates increasing or decreasing production capability and services (Heshmati & Rashidghalam, 2018). Such labour productivity is measured using the ratio between additional value per worked hours, where more value added by labour is part of selling goods and services, after deducting input and other expenses except labour wages and net profit. This method includes profit and business pay. Whether labour and producers are considered as the same input, this method may be acceptable, especially when measuring labour productivity in small businesses. Besides, labour productivity measured at the micro level with survey data could show a strong deviation in statistics if the survey questionnaires are limited or respondents do not fully cooperate.

Previous studies on the measurement of labour productivity in the ASEAN show a preference for using only one single selective method for the measurement. The following important studies are worthy of a brief mention. Takii and Ramstetter (2005) studied labour productivity at the industrial level in Indonesia by employing the method of production function. Similarly, Noor, Isa, Said, & Jalil (2011) studied the impact of foreign workers on labour productivity in Malaysia by making use of the neoclassical production function in the analysis. Ahmed (2011) studied the effects of labour productivity, capital deepening and TFP in the ASEAN5 plus 3. This study utilised the GDP per labour unit to analyse labour productivity, considered as a production function method. Studies on labour productivity in other countries outside the ASEAN also use only a single method. Dixon and Lim (2012) and Kinfemichael and Morshed (2019) measured labour productivity in the USA through the value added per labour unit. Similarly, Hara and Ichiue (2011) studied labour productivity in Japan using value added

per labour unit for calculation. Mbaye (2002) studied labour productivity, wages, and labour unit costs in Senegal using the value added method as well.

In summary, the measurement of labour productivity can be measured in several ways. It can be conclusively classified into three groups as shown in Figure 1. This study measures labour productivity based on partial and TFP, discrete and continuous data, and at the macro level. Additionally, it also attempts to compare labour productivity between CLMV and the ASEAN6, based on income as a proxy for the economic development level, and the period of ASEAN economic integration, from 1971–2016.

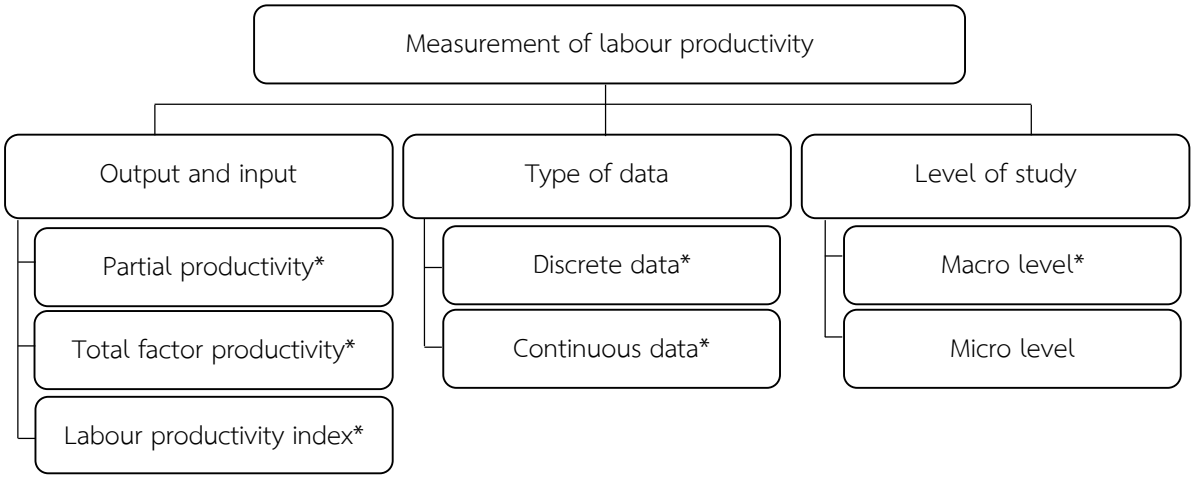

Figure 1 Labour productivity measurement
Source: Authors' classification
Note: * Refers to the methods used in this study

Data and Methodology

As previously mentioned, this study measures and compares labour productivity in all ASEAN member countries. Annual data on GDP, labour force, and gross fixed capital from 1971–2016 has been extracted from the databases of the World Bank, United Nations, International Labour Organization, and Asian Productivity Organization. The comparison of labour productivity can be classified into three aspects: Comparison of labour productivity between CLMV and the ASEAN6, income or economic development level, and the period of ASEAN economic integration. In addition, for the comparison of labour productivity, the t-test, Welch, and One-way ANOVA statistics are employed.

Labour productivity in the ASEAN is measured in terms of AP_L, MP_L, and LPI. The AP_L was measured by output per labour unit with the MP_L being derived from the Cobb-Douglas production function, as shown in equation (1), initially estimated by Ordinary Least Squares (OLS) and used to estimate the coefficient of equation (2) employed in the production function to calculate the coefficient of labour multiplied by partial goods per number of labour units to estimate the MP_L.

$$Y = AK^{\alpha}L^{\beta} \quad (1)$$

where Y is the total output, A is the parameter, K is the capital stock, and L is the number of workers involved in the production. $\alpha + \beta = 1$ indicates constant returns to scale, $\alpha + \beta > 1$ indicates increasing returns to scale and $\alpha + \beta < 1$ indicates decreasing returns to scale. The marginal product can be written as follows: From equation (1), the production function is adjusted into a natural double logarithmic model.

$$\ln Y = \ln A + \alpha \ln K + \beta \ln L \quad (2)$$

Equation (2) finds the differentiation with respect to each production factor provides equation (3)

$$\frac{dY}{Y} = \frac{dA}{A} + \alpha \frac{dK}{K} + \beta \frac{dL}{L} \quad (3)$$

Equation (3) finds the differentiation with respect to labour (L)

$$\frac{1}{Y}\frac{dY}{dL} = \beta \frac{1}{L}\frac{dL}{dL} \quad (4)$$

$$\frac{L}{Y}\frac{dY}{dL} = \beta \quad (5)$$

$$\frac{dY}{dL} = \beta \frac{Y}{L} \quad (6)$$

In equation (6), $\frac{Y}{L}$ is the AP_L and $\frac{dY}{dL}$ is the MP_L

The LPI is measured by comparing output and input, as shown in equation (7). The LPI in the ASEAN from 1971–2016 is calculated using 2010 as the base year, due to the GDP used by the World Bank defining 2010 as the baseline year for data reporting during the study period.

$$LPI = \frac{Q_t/Q_0}{L_t/L_0} \quad (7)$$

where Q_t/Q_0 is the index of output in the current year, (L_t/L_0) is the index of labour input (employed persons or hours worked) in the current year of 2010, t is the current year, and 0 is the base year. The LPI shown in equation (7) can be measured at aggregate or industry level.

Results and Discussions

Results from the production function

In this study, prior to analysis of data, the unit root test is applied to avoid mean and variance in stationarity during different periods to prevent spurious regression due to the use of secondary time series data. Analysis of the production function indicates a technical relationship between output and two types of input; capital and labour, as shown in equation (1). Y is output measured by GDP, with K as the gross fixed capital formation representing the proxy of capital stock, and L is the labour force. AP_L is calculated from the secondary data

between 1971-2016. When calculating the coefficient β of labour from the solving the equation (2), we can find the MP_L according to equation (6).

Analysis of the production function shows that the ASEAN capital stock and labour force form a significant relationship with the output. In addition, both factors are positively correlated with output across all ASEAN members. This means that when capital and labour are used up, output increases (Table 1). Furthermore, analyses of the production function of ASEAN, CLMV, and ASEAN6, classified by individual country, show that capital and labour are positively and statistically significant. This means that an increase in capital and labour increases output. In addition, each independent variable coefficient of capital and labour, (α+β) is greater than 1, or the overall production function in every ASEAN country shows increasing returns to scale, especially for CLMV which indicates greater increasing returns to scale than in ASEAN6 (Table 2).

Table 1 Analysis of the production function in the ASEAN, from 1971 to 2016

Independent Variable	ASEAN	ASEAN6	CLMV	Brunei	Cambodia	Indonesia	Lao PDR
				Coefficient			
Constant	-5.81	-3.51	-16.54	0.80	-15.22	2.32	-27.04
	(-1.66)*	(-1.01)ns	(-0.94)ns	(0.16)ns	(-4.72)***	(2.05)**	(-5.15)**
Capital stock (lnK)	0.72	0.77	0.10	0.23	0.23	0.79	0.20
	(13.52)***	(10.98)***	(2.58)*	(1.56)*	(4.75)***	(25.32)***	(4.98)***
Labour (lnL)	0.75	0.57	2.16	1.42	2.10	0.24	3.04
	(3.56)***	(2.18)**	(2.15)***	(2.35)**	(8.69)***	(2.77)***	(7.87)***
R^2	0.99	0.99	0.99	0.95	0.99	0.99	0.99
Adjusted R^2	0.99	0.99	0.99	0.95	0.99	0.99	0.99
F-statistic	6085.41	7441.34	38.52	244.52	2123.71	3005.22	2587.93
D.W.	1.91	2.08	1.87	1.71	1.94	1.93	1.93
n	46	46	46	46	46	46	46
Independent Variable	**Malaysia**	**Myanmar**	**Philippines**	**Singapore**	**Thailand**		**Vietnam**
				Coefficient			
Constant	-7.84	-6.50	-7.54	-9.74	-3.87		-22.71
	(-3.91)***	(-1.51)*	(-4.10)***	(-4.56)***	(-0.88)ns		(-1.64)*
Capital stock (lnK)	0.55	0.62	0.57	0.59	0.55		0.22
	(8.15)***	(10.97)***	(6.95)***	(6.84)***	(17.87)***		(7.97)***
Labour (lnL)	1.24	0.98	1.12	1.42	0.93		2.31
	(5.90)***	(3.39)***	(5.32)***	(5.21)***	(3.58)***		(2.82)***
R^2	0.99	0.98	0.99	0.99	0.99		0.98
Adjusted R^2	0.99	0.98	0.99	0.99	0.99		0.98
F-statistic	2672.30	653.54	2837.73	6085.52	5898.32		506.14
D.W.	1.99	2.07	2.04	1.90	2.06		1.91
n	46	46	46	46	46		46

Note: ***significant at 0.01, **significant at 0.05, *significant at 0.10 and ns not significant

Source: Authors' calculation based on equation (2)

Table 2 Returns to scale for ASEAN countries

Country	Returns to Scale
ASEAN	1.47
ASEAN6	1.34
CLMV	2.26
Brunei	1.65
Cambodia	2.33
Indonesia	1.03
Lao PDR	3.24
Malaysia	1.79
Myanmar	1.60
Philippines	1.69
Singapore	2.01
Thailand	1.48
Vietnam	2.53

Source: Authors' calculation of (α+β) from equation (2)

Comparison of labour productivity between CLMV and ASEAN6

Based on the above analysis of the production function, we can see that AP_L and MP_L from ASEAN are at an annual average of 3,019.22 and 2,215.50 $USD respectively. AP_L and MP_L from ASEAN did not grow at a faster pace with the average growth rate at 7.72 percent.

Comparing labour productivity from CLMV and ASEAN6 reveals that AP_L and MP_L from CLMV had increasing trends at the annual average rate of 848.52 and 1,831.91 $USD, compared to those of ASEAN6 at the annual average rate of 3,930.54 and 2,240.20 $USD. Although the AP_L and MP_L both continuously increase, they are 4.63 and 1.22 times lower compared to the ASEAN6. Throughout this period, average labour productivity growth among the CLMV increased by 7.76 percent, at a greater rate of 0.04 percent in comparison to ASEAN6 (Table 4).

In addition, when applying the hypothesis test using t-test statistics, which compares AP_L differences between CLMV and ASEAN6, the results show that the t-statistic is equal to -6.77 with a P-value of 0.00, demonstrating that the AP_L in CLMV and ASEAN6 is significantly different. In contrast, when comparing the MP_L differences the results show that the t-statistic is -1.06 and the P-value is 0.29, indicating that the MP_L in CLMV and ASEAN6 does not differ significantly.

Comparison of labour productivity by income level

Comparisons of labour production across ASEAN by income level, based on data from the World Bank and displayed in Table 3, show that labour productivity varies drastically. However, there is a control over basic differences in the production function estimation by using the same production model in $USD.

Table 3 Classification of ASEAN countries on the basis of income

Income Level	Country
1. High-income OECD members	-
2. High-income ($12,736 or more)	1. Singapore
	2. Brunei
3. Upper-middle-income ($4,126 to $12,735)	1. Malaysia
	2. Thailand
4. Lower-middle-income ($1,046 to $4,125)	1. Indonesia
	2. Philippines
	3. Lao PDR
	4. Vietnam
	5. Cambodia
	6. Myanmar
5. Low-income ($1,045 or less)	–

Source: World Bank (2018)

For high-income countries, from 1971–2016, Brunei had the highest AP_L and MP_L at an annual average of 44,622.56 and 63,466.58 $USD, respectively, followed by Singapore with an annual average of 40,074.39 and 57,059.44 $USD, respectively. Although such values are likely to drop continuously, MP_L is higher than AP_L, which suggests that the use of capital and labour factors positively affect output. However, in terms of average growth, high-income countries had an increase in labour productivity at an annual average rate of 8.21 percent. For upper-middle income countries, Malaysia had the highest AP_L and MP_L at an annual average of 9,883.26 and 12,242.22 $USD, respectively, followed by Thailand at 4,077.41 and 3,806.59 $USD, respectively. On average, the values of high-income countries are 6.07 and 4.19 times that of upper-middle-income countries. The average growth of AP_L and MP_L for the aforementioned countries stands at a positive annual rate of 7.42 percent. However, both AP_L and MP_L for Malaysia are decreasing. On the other hand, they are both increasing trends for Thailand.

For lower-middle income countries, the Philippines had the highest AP_L at an annual average of 2,817.73 $USD, followed by Indonesia at 2,761.83 $USD, Lao PDR at 1,048.95 $USD, Vietnam at 922.52 $USD, Cambodia at 713.96$USD, and Myanmar at 710.59 $USD, respectively. However, they are 15.84–62.80 times different compared to the high-income countries. Lao PDR had the highest MP_L at an annual average 3,186.01 $USD, followed by the Philippines at 3,160.01 $USD, Vietnam at 2,132.11 $USD, Cambodia at 1,499.05 $USD, Myanmar at 693.36 $USD, and Indonesia at 653.66 $USD, respectively. On average, the values of high-income nations are 28.31 and 17.82 times that of the lower-middle income countries. However, lower-middle income nations have a positive annual average growth rate of 7.67 percent. Furthermore, the comparison shows that AP_L for Lao PDR, the Philippines, Vietnam, and Cambodia is lower than MP_L. This indicates that labour and capital factors together increase

output. On the other hand, for Myanmar and Indonesia, AP_L is higher than MP_L, indicating that inputting labour and capital factors together decreases output. This is because the quantities of labour and capital are unsuitable and the labour force might not have sufficient knowledge and understanding to utilise the capital factor.

When testing the variance of AP_L and MP_L by income level using Levene's test method, it is found that the P-value equals 0.00, indicating that the variance of that value differs statistically. For this reason, we can only apply the Robust Tests of Equality of Means using Welch testing hypotheses instead of One-way ANOVA. (Tomarken & Serlin, 1986; Wanchanachai & Bumrungsup, 2010). The Welch statistics test shows that AP_L and MP_L values are less than 0.01, meaning that countries with different income levels statistically have significantly different AP_L and MP_L.

The comparison of labour productivity by income level shows that high-income and upper-middle-income countries have decreasing labour productivity. In contrast, lower-middle-income countries, especially among the CLMV, have steadily rising labour productivity. Consistent to the study by Van Ark and McGuckin (1999), comparing labour productivity between high-income (United States, the European Union, and Japan) and low-income countries (Asia excluding Japan, Latin America), revealed that high-income nations have higher labour productivity and less working hours than low-income countries (Sala & Silva, 2013; Nakamura et al., 2018). The reasons for higher labour productivity in developed countries over developing countries relates to the economic structure, education, good public health, and technology innovation development (Korkmaz & Korkmaz, 2017).

Table 4 Comparison of the average AP_L and MP_L in ASEAN, 1971–2016

Unit: $USD/person/year

Country	AP_L	t-statistic and Welch	MP_L	t-statistic and Welch	Average Growth Rate (%)
ASEAN	3,019.22		2,251.50		7.72
ASEAN6	3,930.54	-6.77***	2,240.20	-1.06^{ns}	7.76
CLMV	848.52		1,831.91		7.16
Brunei	44,622.56	144.70***	63,466.58	137.53***	8.18
Singapore	40,074.39		57,059.44		8.24
Malaysia	9,883.26		12,242.22		7.18
Thailand	4,077.41		3,806.59		7.65
Philippines	2,817.73		3,160.01		6.01
Indonesia	2,761.83		653.66		9.12
Lao PDR	1,048.95		3,186.10		9.11
Myanmar	710.59		693.36		7.23
Cambodia	713.96		1,499.05		5.46
Vietnam	922.52		2,132.11		9.08

Source: Authors' calculation

Note: ___Classification of ASEAN countries on the basis of income

Comparison of labour productivity based on the period of ASEAN economic integration

In this section, we analyse labour productivity based on the period of ASEAN economic integration. El-Agraa (1988) categorized economic integration into five periods from least to most significant, namely: a free trade area, customs union, common market, economic union, and political union. However, in the early years of 1967-1991, there was economic cooperation (Figure 2) but no practical effects or clear economic relationships (Naya & Imada 1992).

For this reason, the authors have divided labour productivity into two periods for comparison; 1971–1991 and 1992–2016. Comparison of labour productivity during the first period from 1971–1991 shows that both AP_L and MP_L of ASEAN is low with an average growth rate of 9.56 percent. In addition, when comparing ASEAN6 by country, Brunei had the highest AP_L and MP_L, followed by Singapore, Malaysia, Thailand, Philippines, Indonesia, Lao PDR, Myanmar, Cambodia and Vietnam, respectively (Table 5). For the second period from 1992–2016, Brunei also had the highest average AP_L and MP_L, followed by Singapore, Malaysia, Philippines, Thailand, Lao PDR, Cambodia, Vietnam, Indonesia and Myanmar, respectively. The hypothesis test using t-test statistics comparing AP_L differences between the years 1971–1991 and 1992–2016 showed that the t-statistic was equal to -11.56 with a P-value of 0.00. Corresponding differences in MP_L found that the t-statistic was equal to -10.35 and a P-value of 0.00, indicating a significant statistical AP_L and MP_L difference among ASEAN6 between these periods. In addition, when comparing AP_L between CLMV and ASEAN6 from 1992–2016, the t-statistic was found to be equal to -10.10 with a P-value of 0.00. Corresponding MP_L differences found that the t-statistic was equal to -8.87 and with a P-value equal to 0.00, indicating a significant AP_L and MP_L difference between CLMV and ASEAN6 during this period.

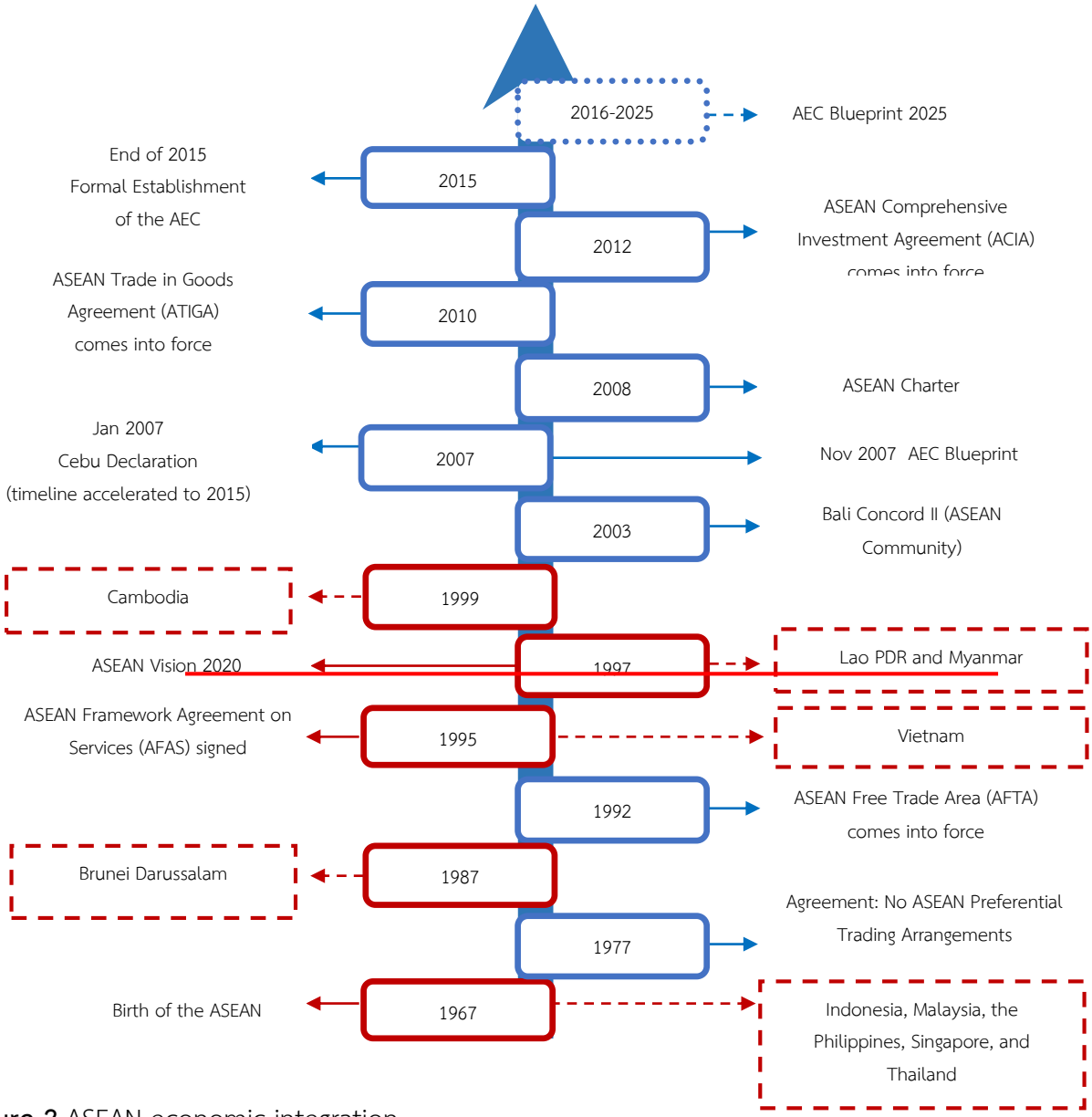

Figure 2 ASEAN economic integration
Source: Authors' summary of ASEAN economic integration

Furthermore, Lao PDR, Cambodia, Vietnam, and Myanmar had sustained an increase in AP_L and MP_L from 1992–2016, when compared with 1971–1991 (Figure 3-4). Even though Myanmar was at a lower level than Vietnam, Cambodia, and Lao PDR in terms of average AP_L and MP_L, it had the highest average growth rate at 11.17 percent, almost four times higher than any other ASEAN6 member. On the other hand, while ASEAN6 produces an increasing average AP_L and MP_L, the average growth rate is greatly reduced. In spite of the ASEAN Free Trade Area (AFTA) agreements and other economically cooperative agreements that could have created higher labour productivity in 1992, the growth rate decreased considerably throughout ASEAN (Azis, 2018), particularly in ASEAN6, due to the Asian financial crisis of 1997-1998 and global financial crisis of 2008–2009, although these events had little effect on CLMV.

Table 5 Comparison of the average AP_L and MP_L in ASEAN, from 1971–1991 and from 1992-2016

Unit: $USD/person/year

Country	1971–1991	1992–2016	t-statistic	1971–1991	1992–2016	t-statistic	1971 - 1991	1992 - 2016
	AP_L			MP_L			Average Growth (%)	Rate
ASEAN	1,219.59	909.48		4,530.91	3,378.81		9.56	6.25
ASEAN6	1,665.80	949.42	-11.56***	5,832.93	3,324.46	-10.35***	10.06	5.92
CLMV	230.29	497.19	-10.10***	1,367.83	2,953.08	-8.87***	2.86	10.61
Brunei	35,060.52	49,866.51		52,654.67	74,890.64		14.44	3.16
Singapore	12,205.89	17,379.21		63,483.93	90,390.83		11.99	5.24
Malaysia	4,310.52	5,339.37		14,564.35	18,040.61		9.75	5.12
Thailand	1,503.52	1,403.66		6,239.47	5,825.05		10.39	5.45
Philippines	1,489.92	1,670.91		3,933.09	4,410.85		6.5	5.61
Indonesia	1,290.42	305.41		3,997.81	946.19		11.32	7.37
Lao PDR	289.48	879.26		1,686.91	5,123.84		8.76	9.4
Myanmar	283.12	276.26		1,069.66	1,043.72		2.29	11.17
Cambodia	282.75	593.67		1,076.18	2,259.57		4.82	5.97
Vietnam	183.35	423.76		1,543.42	3,567.13		5.43	12

Note: ***significant at 0.01, **significant at 0.05, *significant at 0.10 and ^{ns} not significant

Source: Authors' calculation

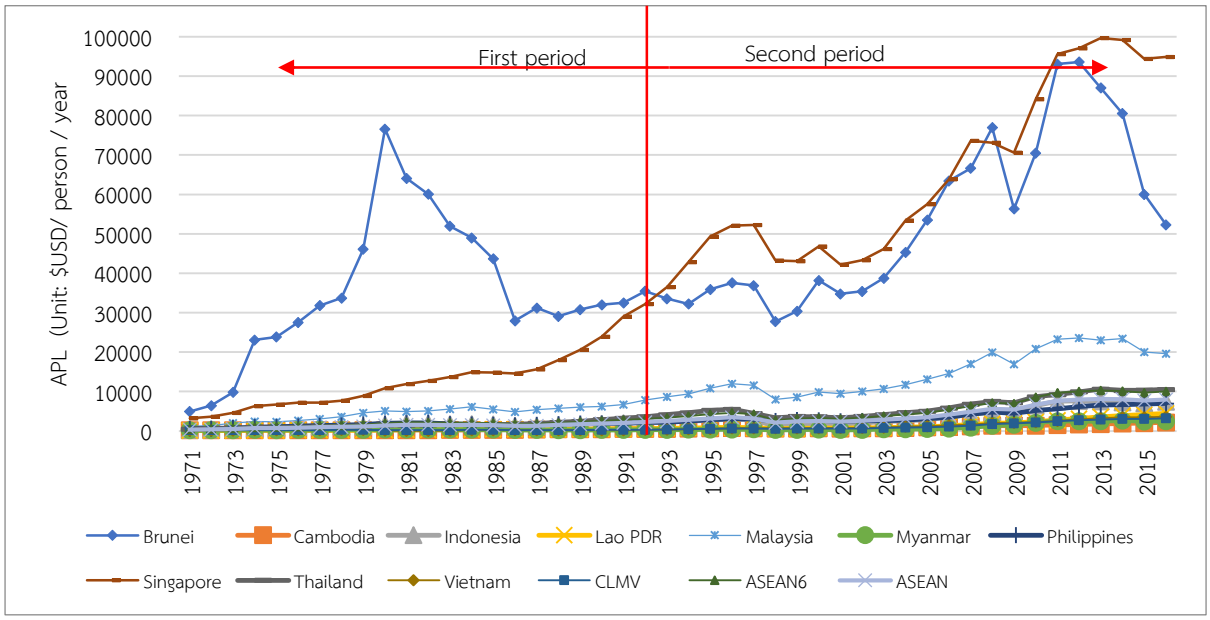

Figure 3 Average product of labour (AP_L), ASEAN, from 1971 to 2016

Source: Authors' calculation

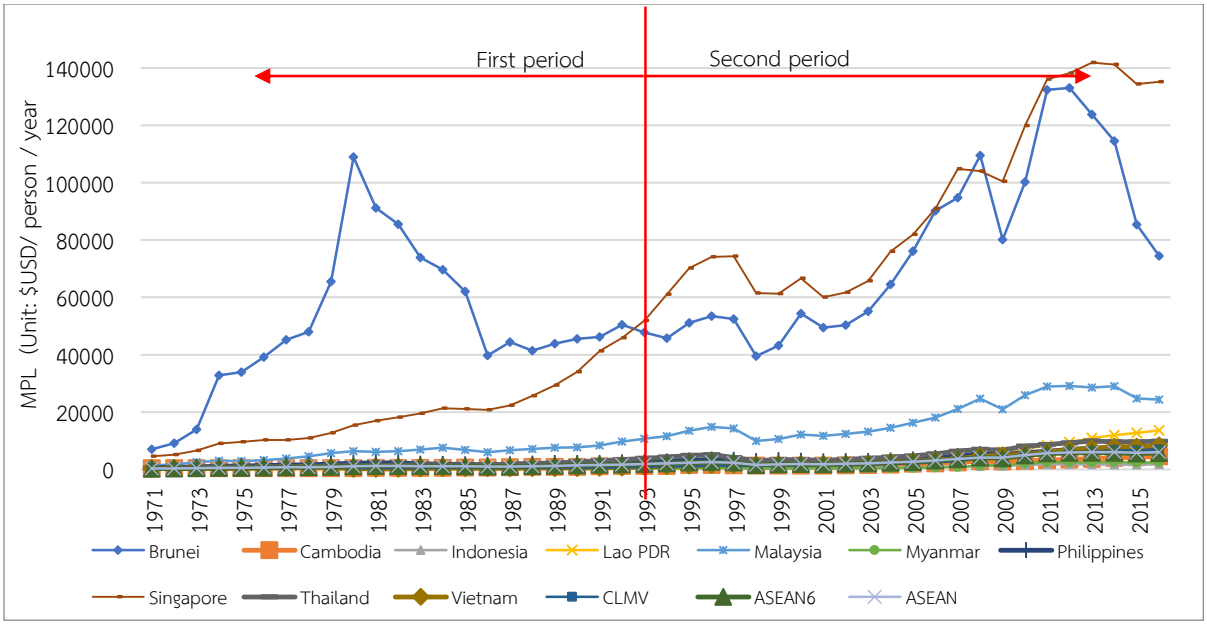

Figure 4 Marginal product of labour (MP_L), ASEAN, from 1971 to 2016
Source: Authors' calculation

Measurement of the labour productivity index

In this section, we compare labour productivity from 1971–2016, in terms of the labour productivity index. The results show that average labour productivity index (LPI) of ASEAN6 is 45.86 and 39.64 for CLMV with a growth rate of 7.67 and 7.16 percent, respectively (Figure no. 5 and Table no. 6). The hypothesis test using t-test statistics and comparing LPI differences between CLMV and ASEAN6 shows that the t-statistic was -0.76 and the P-value 0.45, indicating that the CLMV and ASEAN6 had statistically similar LPI. In addition, Table no. 6 presents the comparison of LPI by income level. The results revealed that for high-income countries, from 1971–2016, Brunei had the highest LPI at an annual average of 63.28, followed by Singapore at 47.60. For upper-middle countries, Malaysia had the highest LPI at an annual average of 47.35, followed by Thailand at 46.98. For lower-middle income countries, the Philippines had the highest APL at an annual average of 54.54, followed by Cambodia at 51.74, Lao PDR at 44.55, Indonesia at 42.79, Vietnam at 40.63 and Myanmar at 33.94, respectively. When comparing labour productivity growth, we find that labour productivity growth from high-income countries equals 8.21 percent followed by lower-middle-income and upper-middle-income countries at 7.42 and 7.67 percent, respectively. However, when testing the variance of the LPI by income level using Levene's test method, we find that the P-value equals 0.17, indicating that the variance is not different. Finally, we use the average differences from both tests by analysing One-way ANOVA.

The analysis of One-way ANOVA results shows that the F-statistic is 2.71 and the P-value 0.07. It is obvious that LPI differs significantly to the level of 0.10. That is, when the income levels of each different country, such values are significantly different. In addition, the

Post-hoc test using the Bonferroni method indicates that the average LPI differs significantly between high-income and lower-middle-income countries.

When comparing LPI between the two sub-periods (1971–1991 and 1992–2016), the average LPI of ASEAN is lower during the first period than the second period, especially in Vietnam (Table 7). However, labour productivity growth during the second period of CLMV increased continually. Performances in CLMV are outstanding with productivity accelerating from 5.43 to 12.00 percent in Vietnam, 2.29 to 11.17 percent in Myanmar, 8.76 to 9.40 percent in Lao PDR, and 4.82 to 5.97 percent in Cambodia, respectively. On the other hand, compared to the first period, labour productivity in the ASEAN6 tended to decrease markedly when compared to the first and second periods; 14.44 to 3.16 percent in Brunei, 11.99 to 5.24 percent in Singapore, 11.32 to 7.37 percent in Indonesia, 10.39 to 5.45 percent in Thailand, 9.75 to 5.12 percent in Malaysia, and 6.50 to 5.61 percent in the Philippines, respectively. The hypothesis test, using t-test statistics compared LPI differences from 1971–1991 and 1992–2016, indicates that the t-statistic is -9.20 with a P-value of 0.00, demonstrating that the ASEAN6 has a different LPI at the statistical significance level of 0.01. In contrast, when comparing the LPI between CLMV and ASEAN6 from 1992–2016, the t-statistic is -0.84 and the P-value is 0.40, indicating that during this period the LPI of CLMV and ASEAN6 is not significantly different statistically.

Table 6 Comparison the average LPI for ASEAN from 1971–2016

Country	LPI 1971-2016	t-statistic and F-statistic	Average Growth Rate (%)
ASEAN	45.04		7.72
ASEAN6	45.86	-0.76^{na}	7.76
CLMV	39.64		7.16
Brunei	63.28	2.71*	8.18
Singapore	47.6		8.24
Malaysia	47.35		7.18
Thailand	46.98		7.65
Philippines	54.54		6.01
Cambodia	51.74		5.46
Lao PDR	44.55		9.11
Indonesia	42.79		9.12
Vietnam	40.63		9.08
Myanmar	33.94		7.23

Note: ***significant at 0.01, **significant at 0.05, *significant at 0.10 and ^{ns} not significant

___Classification of ASEAN member countries on the basis of income

Source: Authors' calculation

Table 7 Comparison of the average LPI in ASEAN, from 1971–1991 and from 1992–2016

Country	1971-1991 LPI	1992-2016 LPI	t-statistic	Average Growth Rate (%)	
ASEAN	18.19	67.59		9.56	6.25
ASEAN6	19.44	68.06	-9.20***	10.06	5.92
CLMV	10.76	63.9	-0.84^{ns}	2.86	10.61
Brunei	49.72	74.67		14.44	3.16
Singapore	14.5	75.41		11.99	5.24
Malaysia	20.65	69.78		9.75	5.12
Thailand	17.32	71.89		10.39	5.45
Philippines	28.84	76.12		6.5	5.61
Cambodia	20.49	77.98		4.82	5.97
Lao PDR	12.29	71.65		8.76	9.4
Indonesia	19.99	61.94		11.32	7.37
Vietnam	8.08	67.98		5.43	12
Myanmar	13.52	67.59		2.29	11.17

Note: ***significant at 0.01, **significant at 0.05, *significant at 0.10 and ^{ns} not significant

Source: Authors' calculation

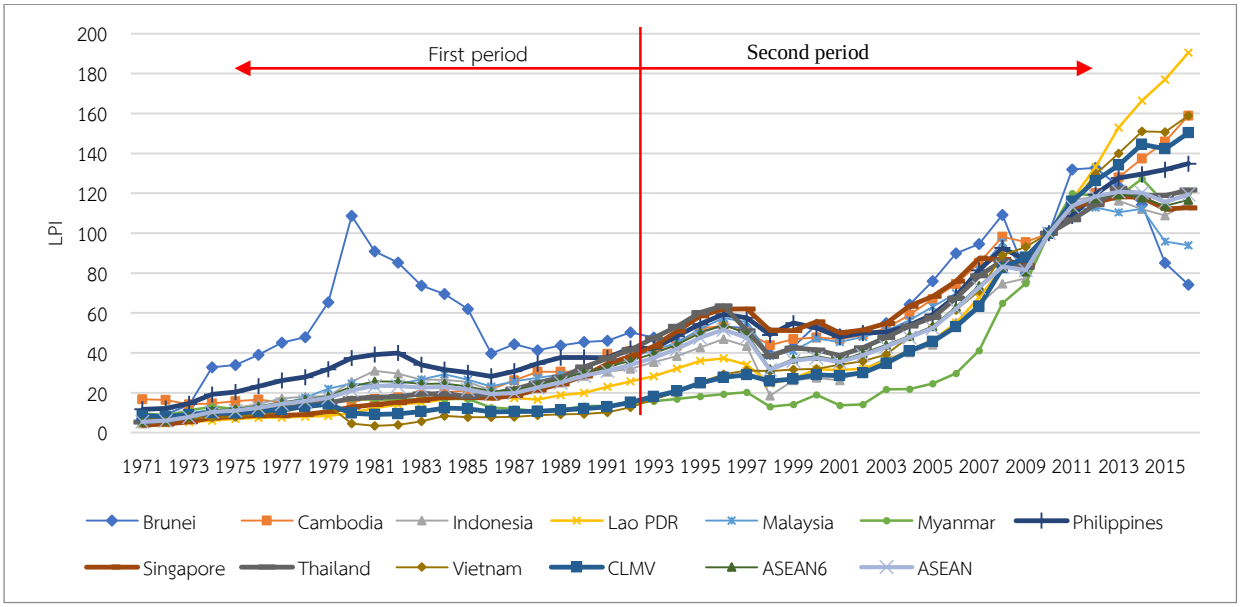

Figure 5 Labour productivity index (LPI), ASEAN, from 1971 to 2016

Source: Authors' calculation

Conclusions

Labour productivity measurements from both the production function and index reveal the same results. The ASEAN6 shows higher labour productivity than CLMV but the trend tends to decrease. However, the CLMV group displays a continuous increase in labour productivity. Based on income levels, high-income countries show higher labour productivity

than upper-middle-income and lower-middle-income countries due to the different economic, social, and technological advances in each nation. Comparison of labour productivity by economic integration, from 1971–1991, shows a period of no economic activity. The ASEAN member countries had low labour productivity, especially in the CLMV group. However, after the implementation of economic integration from 1992–2016, there was a continuous increase in labour productivity. These results indicate that ASEAN economic integration contributed to increased economic growth, as was its main purpose, through higher labour productivity in each member state.

In this study, labour productivity is measured using different methods based on the production function approach, type of data, and level of study. While the results of labour productivity measurement trends are similar, the most valid measurements should still be investigated in order that the most appropriate labour productivity indicators be recognised and its effect on ASEAN economic integration revealed, while at the same time, analysing the data for a true interpretation. By doing so, labour productivity can be used as a key component of other economically cooperative ASEAN agreements which may be implemented in accordance with economic, social, and environmental endowments throughout member countries. Eventually, ASEAN cooperative agreements could create higher labour productivity for all member countries.

Comparison of labour productivity using the t-test, Welch, and One-way ANOVA statistics can be summarised as follows: 1) Comparison of AP_L, MP_L, and LPI between CLMV and the ASEAN6 from 1971–2016 showed that these values were statistically different, but LPI was not. 2) Comparison of AP_L, MP_L, and LPI, classified by income level, found that such values were statistically different. 3) Comparison of the periods from 1971–1991 and 1992–2016 for the ASEAN6 found that AP_L, MP_L, and LPI were significantly different. Comparison of AP_L and MP_L from 1992–2016 between CLMV and the ASEAN6 found significant statistical differences, although LPI did not differ. Therefore, it is necessary to study changes and differences in labour productivity to gain deeper insight into factors that play a key role in understanding labour productivity.

In previous studies, labour productivity was generally measured using only a single method. Although this study does not use a new method, labour productivity is measured using three methods based on output and input, type of data, and the level of study. Moreover, this study represents the first attempt to compare labour productivity between CLMV and the ASEAN6, to ascertain the income or economic development level among all ASEAN member countries, in accordance with the period of ASEAN economic integration, since the improvement of labour skills is one of the main purposes of ASEAN economic integration. This study, therefore, focuses on the search for labour improvement through an increase in labour productivity.

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