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Agricultural Investments in Extension, Subsidies and Irrigation and their Impact on Poverty Reduction and Agricultural Output: A Panel Data Analysis of ASEAN Countries

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The aim of the current study was to investigate the role of agricultural investment in extension (AGI), subsidies and agricultural irrigation (AI) in poverty reduction and agricultural output. For this purpose, the current study analyzed the impact of AGI, AI and subsidies on the poverty reduction and agricultural output of ASEAN countries. Two econometric models were developed in the current study to assess the relationships. The 30-year data set for ASEAN countries regarding current macroeconomic variables was extracted from secondary sources and analyzed through panel ARDL approach in which the short-term and the long term impacts of AGI, AI and subsidies on poverty reduction and agricultural output were checked. The panel unit root test and co-integration test were applied to prepare the data for ARDL approach. The results of panel ARDL approach revealed that AGI, AI and subsidies have significant impact on poverty reduction in long-run. The subsidies have short-term significant impact on poverty reduction while the other two variables did not show significant impact on poverty reduction in the short-term. The results further revealed that AGI, AI and subsidies have significant long-term impacts on

agricultural output however, there is no significant impact of any of these variables on agricultural output in the short-term. The current findings will be very helpful for researchers and policymakers in the agriculture field.

Key words: *Agricultural Investments in Extension, Subsidies, agricultural Irrigation, Poverty Reduction, Agricultural Output, ASEAN Countries.*

Introduction

Agricultural investment is ongoing research for most ASEAN economies as it delivers a source of income to a large section of these countries (Vo & Nguyen, 2016). ASEAN countries have applied abundant collaboration schemes in agriculture, where agricultural extension services are an operative instrument and method to deliver the agriculturalists the skills and information they need in their everyday agricultural practice (Torero, 2016). Agriculturalists are provided with numerous educational measures to prepare and permit them to recover their agriculture research, farming methods, increase yield, upsurge production competences and augment revenue levels, progress standards of livings, and raise the financial status of people, thereby reducing poverty (Thanh12 & Duong, 2016).
Agricultural subsidies are also important agricultural investments, as they reinforce support without the straight transmission of incomes from state to receivers (Torero, 2016). Other kinds of support generally involve transmission of capitals from purchasers to vendors by means of price variations due to regulations and market involvements (Nguyen, Dorin, & Duteurtre, 2017). Conversely, subsidies normally affect merchants and purchasers by price variations in addition to direct income transfers from the state. Subsidies are a prevalent piece of farming strategy in both low and high income ASEAN republics (Saylor, 2019), see Figure 1 below.

Figure 1. Last 10 years country wise AGI investment in ASEAN countries

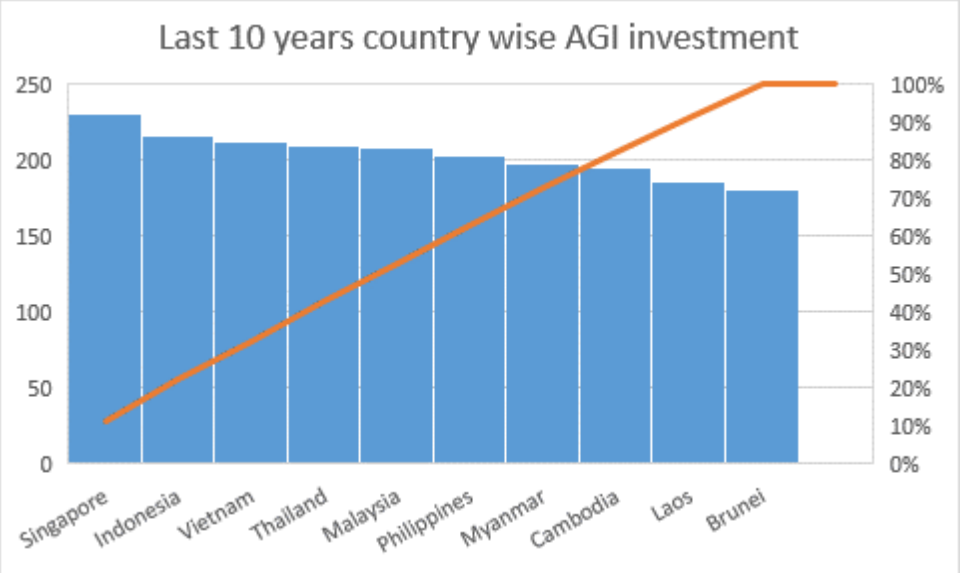


Figure 1 presents a bar graph of agricultural investment in ASEAN countries and results indicated that in Singapore investment in agriculture was the highest amount for the last 10 years. On the other hand, irrigated farming continues to be a requirement for many poor farmers in ASEAN countries because of the food security it delivers (Thanh12 & Duong, 2016). It also gives an opportunity for better farming and increasing output yield, thereby plummeting susceptibility (Oduro et al., 2018). Irrigation comprises about eighty per cent of the requirement for fresh water in most regions. In most ASEAN countries, improvements in irrigation are being achieved through the employment of high quality seeds and adequate dosages of fertilizers as well as extra complimentary contributions for example well-timed and satisfactory irrigation, which is recognized as "Green Revolution" (Karthikeyan, Pattanaik, & Agrawal, 2018).

In most ASEAN countries, agriculture is an important sector; however, investments are rarely done in extension services, subsidies and irrigation system (Torero, 2016). These agricultural investments are avoided due to multiple reasons, which can be either the lack of capital, market share, opportunities, low socio-economic level, lack of resources and or awareness (Saylor, 2019). However, they are vital for the progress of crop yield and to decrease the poverty levels of ASEAN countries (Oduro et al., 2018). The issue is present in most ASEAN countries as well as other international republics such as Uganda, Brazil, Pakistan, India, South Africa etc. as all these countries are constantly aiming for poverty reduction and to increase their agriculture output (Vo & Nguyen, 2016). Therefore, the investments in

extension services, subsidies and irrigation system are necessary and their impact on poverty reduction and agricultural output is significant to research.

A literature review was conducted and gaps were identified throughout the literature, since panel data was not obtained for ASEAN countries (Karthikeyan, Pattanaik, & Agrawal, 2018). Mostly studies were conducted for a specific country and how the agricultural investments in extension services, subsidies and irrigation system affect the poverty standard and crop yield however, there was no research for the entire ASEAN organization (Oduro et al., 2018). Hence, thorough exploration is prerequisite in this area, and the present study will emphasize assessing the influence of extension services, subsidies and irrigation system on poverty reduction and increased output. The research questions formulated for the current study are below:

1. To determine the agricultural investment on extension and its impact on poverty reduction and agricultural output of ASEAN countries
2. To determine the agricultural investment on subsidies and its impact on poverty reduction and agricultural output of ASEAN countries
3. To determine the role of agricultural investment on irrigation system and its impact on poverty reduction and agricultural output of ASEAN countries

In most ASEAN countries, the agricultural sector involves over sixty per cent of the employed and it is a dynamic driver for the reduction of poverty and increased agricultural output (Torero, 2016). An agricultural extension service has also been required for curtailing food insecurity and diminishing rural poverty by means of technological and managerial dissemination of knowledge (Girik Allo, Sukartini, & Widodo, 2017). Subsidies deliver inducements to farmers to raise output, by either decreasing the requirements of import or raising export levels from subsidizing republic. This in turn reduces the level of poverty in these republics (Friend et al., 2019). Moreover, individuals in the irrigated lands are aided directly by augmented and steady revenues from amplified cropping outputs, improved yields and novel farm expertise, and indirectly, through increase in their incomes as well as inferior rates of food. Therefore, poverty occurrence is 20 to 30 % lower in irrigated settings as compared to less-irrigated lands (Briones, 2018).

Literature Review

Theory and Model of Structural Change (Sociological model):

The economic factors (Ward & Geeraert, 2016) focus on structural and cultural change related to agricultural sector that involve agriculture production and agriculture performance with the help of agricultural polices as well as practices. There are many alternative models (Daniels, 2015) that explain the phenomena of agriculture change with subsidies, irrigation

and other practices of agriculture. However, studies (Ignatius & Haapasaari, 2018) reflect that extension services usually focus on the structural change model that completely identifies the formulation of agriculture using latest technology, techniques, methods and machinery to enhance the growth rate per GDP. According to past literature (Dan, 2017), large or small firms that deal with agriculture outcomes and facilitate the farmers and authorities significantly have positive consequences on farm competitiveness and as a result can gain competitive advantages.

Therefore, some new technologies prefer to perform as convenient farms operating system (Sundararaj, 2015) that polish the efficiency and skills of labor. A structural model defines agriculture farming (Abrahão & Hirakawa, 2017) as an emerging source of technical innovation, these techniques might increase farm size, while establishing a development mechanism to increase economic growth with the development of the agriculture sector. Farms costs include resources that result in the biodiversity and protection of the environment. Most empirical studies (Tiraieyari, Ricard, & McLean, 2019) have relied on the structural model and a very broad concept of structural change in agriculture while the focus goes immediately to the forces driving it. There are a wide range of theories that elaborate the concept of agriculture farming and agriculture structural changes (Grigg, 2019) that recombines the factors of production used on the farm.

Agricultural Investment in Extension Services and its impact on Poverty reduction

Tiwari, (2018) suggests that agriculture investment in extension services can increase the growth rate of agriculture production that will eventually reduce the rate of poverty within a Country at both rural and urban level. Fu and Akter (2016) state that usually farmers from rural areas are involved in agriculture farming; however they receive very less on behalf of their authorities and land owners, while they spend a lot of their time, use their abilities and skills, as well as use their full labor potential to work for the benefit of the land owner. A. Ali & Erenstein, (2017) found that farmers and laborers are becoming weaker and weaker while land owners are getting stronger. Extension services highlight the performance of farmers and laborers in the field of agriculture and whether they are being educated and well supplied with resources and well maintained machinery in order to enhance their skills at the rural level (Wossen et al., 2017), which will result in poverty reduction.

The theoretical framework of the socio-cultural model enhances the ability of agricultural investment that is responsible in investing in the area of agriculture and farming which will consequently increase the use of extension services for the benefit of the farmers and their families, therefore it will cause gradual decrease in the level of poverty faced by farmers and their families. Chiputwa, Spielman, & Qaim, (2015) believe that globally, farmers are being neglected due to weak authorities and unstable governments in many countries that cause

dispute between farmers and land owners over income in conditions of maximal input. Farmers and their family's rights (Chepchirchir, Macharia, Murage, Midega, & Khan, 2017) are being violated due to in inefficiency of extension services or perhaps non-availability of extension services in many rural areas. Therefore, it is considered the State's responsibility to promote the development of extension services especially in rural areas, where farmers can be facilitated appropriately and enabled to gain advantages regarding resources, provision of health facilities and availability of food products (Ragasa & Mazunda, 2018). In this way, extension services decrease the level of poverty. Thus, the following hypothesis is proposed:

H1: Agricultural investment in extension services has a significant impact on poverty reduction.

Agricultural Investments in Subsidies and its impact on poverty reduction

According to agriculture studies (Fox, Wimer, Garfinkel, Kaushal, & Waldfogel, 2015), the agriculture sector undertakes massive investment to promote the service of the subsidy within a Country in rural or urban areas. Subsidies depend upon the sum or amount of money assigned by the State government or higher authorities to a department or an industry or a sector. However, the agricultural sector or industry receives a large sum of subsidy to promote the facilities and services provided to the farmers and the laborers to minimise the rate of poverty within the Country. Socio-cultural theory and model both link rate of subsidy with the decreasing rate of poverty because according to an empirical analysis (Rentschler, 2016), farmers can earn a good sum of money from the agricultural sector or from farming only when, when that sector is given enough subsidy to build a prominent structure of the industry to promote its growth and performance.

Martinez-Aguilar, Fuchs, Ortiz-Juarez, & Del Carmen, (2017) explain different sources of subsidy that can be in the form of revenue or investment and can also be in the form of reforms or energy or in the form of potential power or sustainable workforce. Subsidy of all kinds can have a positive impact on the agriculture production level which can easily decrease the level of poverty. Kanbur (2017) believes that subsidies are a kind of welfare provided to the people of the State or to the industry employees, the agriculture sector labor force. This subsidy has the potential to reduce the poverty level for t farmers at all levels. Thus, the following hypothesis is proposed:

H2: Agriculture investment in subsidy has a significant impact on the reduction of poverty

Agricultural Investments in Irrigation and its impact on poverty reduction

Erban & Gorelick, (2016), found that agriculture investment in irrigation systems can decrease poverty level because irrigation helps farmers as a process that minimises water use in farming. With irrigation facilities, farmmers can easily grow crops of all types and kinds. Wendimu, Henningsen, & Gibbon, (2016), proved that the facility of irrigation as the source of income for the poor is a kind of infrastructure beneficial for working laborers, farmers who work day and night of irrigation at the rural or urban area. Socio-cultural theory of agriculture also provides conceptual evidence, that farmers and families can be facilitated while introducing new farming techniques and skills from which they can gain advantage (Dlodlo & Kalezhi, 2015). However, it is clear from various evidence, that relying on irrigation systems for crop growth can decrease the poverty level with the help of agriculture investment. Thus, the following hypothesis is proposed:

H3: Agriculture investment in irrigation has a significant impact on poverty reduction.

Agricultural Investments in Extension Services and its impact on Agricultural output

Agriculture investment in extension services influences the value of the agriculture output. Studies analyze (Hornbeck & Keskin, 2015) agriculture output of various types, as a form of investment, or amount of trade that consists of import or export or sale price or retail price. Researchers (D. Ali, Bowen, Deininger, & Duponchel, 2015) believe that everything that is earned at the end of the year or at the end of the season is considered to be the output of agriculture. However, it is a fact that there is more input in the agriculture sector then eventually there will be more output. A research article (Mogues, Fan, & Benin, 2015), analyzes that livestock and crops are the main outputs of agriculture that can be considered as the most valuable output. Extension services that are promoted by agriculture investment enable the farmers to produce maximum output beyond the level of perceived crop yield. Thus, the following hypothesis is proposed:
H4: Agriculture investment in extension services has a significant impact on agricultural output.

Agricultural investments in Subsidies and its impact on Agricultural output

Minviel & Latruffe's theoretical concept (2017), regarding the agriculture investment within the field of agriculture and farming shows the relationship between agricultural subsidies and agricultural output. However, Chen, Wen, Wang, & Nie, (2017) suggest that when the subsidies are high due to higher investment by the government in the agricultural sector than eventually, the rate of agricultural output in the form of crops, livestock and trade will be higher too. Greater output can only be achieved if the subsidies provided by the government

are greater; these subsidies will help farmers to maintain the standards of crops, fertilizers and cattle breeding to receive greater output. Thus, the following hypothesis is proposed:

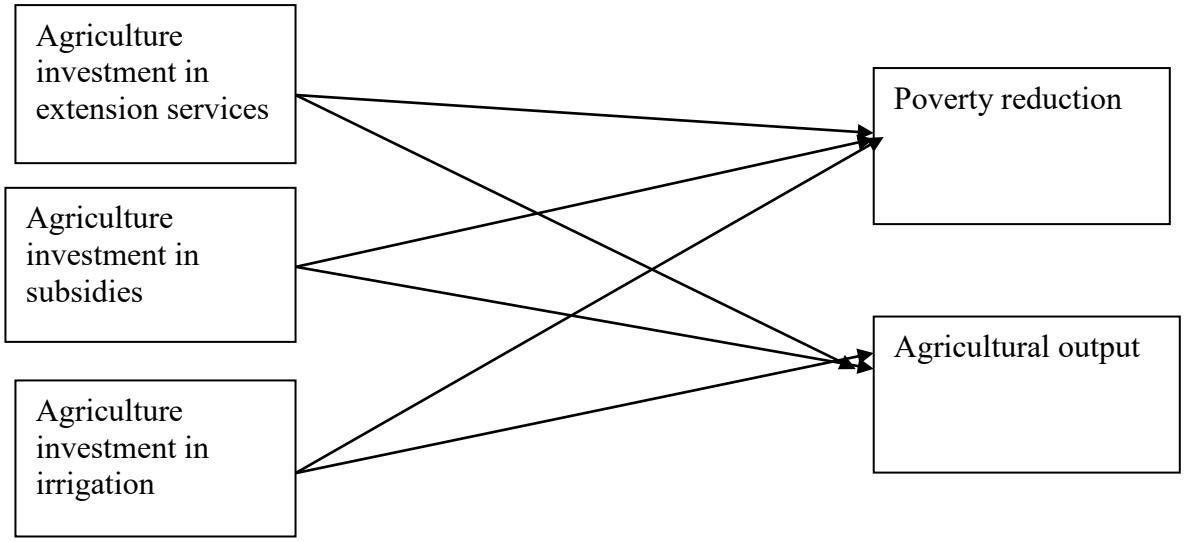
H5: Agricultural investment in subsidies has a significant impact on agricultural output.

Agricultural Investment in Irrigation and its impact on Agricultural output

Crosson and Brubaker (2016), recently developed a conceptual and theoretical framework regarding the effect of agricultural investment in irrigation on the level of agricultural output. Researchers (Rockström et al., 2017) investigated the introduction of the irrigation systems that are being installed in different farming localities to increase crop yield which will however, increase the level of production and agriculture output. Many countries around the world, whose trade consists of livestock and crops, make use of irrigation systems that will perhaps increase the level of output. Thus, the following hypothesis is proposed:

H6: Agricultural investment in irrigation has a significant impact on agricultural output.

Model:



Methodology

Sample and Data

This research was conducted from an ASEAN perspective therefore, 30 years of data about ASEAN countries was collected from secondary sources i.e. databases and archival references. The panel data for selected countries was analyzed through an ARDL approach.

Definition and Measurement of Variables

The following variables were involved in the current study:
Dependent variables: There are two dependent variables in this study: "poverty reduction" (PR) and "agricultural output" (AO). The PR was measured through "poverty index" in respective ASEAN countries in a respective year while the AO was measured as the crop production in the country in a respective year.

Independent variables: There are three independent variables in this study: "agricultural investment in extension" (AGI), "agricultural irrigation" (AI) and "subsidies". The AGI was measured by taking percentage of investments made in agriculture in respective country. The AI was measured by taking the percentage of irrigated land of total land and the data about the subsidies given in agriculture in each country was available on databases.

ARDL Modelling

The current study used the ARDL approach to analyze the short-term as well as long termsimpacts of AGI, AI, and subsidies on the poverty reduction and agricultural output. This approach is an "Autoregressive Distributed Lag" method which is used to check the "short-term and long-term relationships between variables" in a model. Two ARDL models for the long-run effects in the present study are given below:

$$\Delta PR_{it} = \alpha_i + \sum_{j=1}^{m-1}\beta_{ij}\,\Delta PR_{i,t-j} + \sum_{l=0}^{n-1}\varphi_{il}\,\Delta AGI_{i,t-l} + \sum_{r=0}^{p-1}\Upsilon_{ir}\,\Delta AI_{i,t-r} + \sum_{u=0}^{s-1}\theta_{iu}\,\Delta SUB_{i,t-u} + \delta_1 PR_{i,t-1} + \delta_2 AGI_{i,t-1} + \delta_3 AI_{i,t-1} + \delta_4 SUB_{i,t-1} + + \varepsilon_{1i,t}$$
, (1)

$$\Delta AO_{it} = \alpha_i + \sum_{j=1}^{m-1}\beta_{ij}\,\Delta AO_{i,t-j} + \sum_{l=0}^{n-1}\varphi_{il}\,\Delta AGI_{i,t-l} + \sum_{r=0}^{p-1}\Upsilon_{ir}\,\Delta AI_{i,t-r} + \sum_{u=0}^{s-1}\theta_{iu}\,\Delta SUB_{i,t-u} + \pi_1 PR_{i,t-1} + \pi_2 AGI_{i,t-1} + \pi_3 AI_{i,t-1} + \pi_4 SUB_{i,t-1} + \varepsilon_{2i,t}$$
, (2)

The PMG test was applied in this panel ARDL approach however, the prerequisites of this test i.e. "panel unit root test" and "co-integration test" were fulfilled before ARDL modelling. The null hypothesis in co-integration test stated that "There is no co-integration in the data" while alternative hypothesis stated that "there is co-integration in the data"

$$H_0: \delta_1 + \delta_2 + \delta_3 + \delta_4 + \delta_5 = 0$$
$$H_1: \delta_1 + \delta_2 + \delta_3 + \delta_4 + \delta_5 \neq 0$$

Similarly, the null and alternative hypotheses were developed for second model.

After analyzing the presence of integration among variables of the current study, the long-term association between them was estimated. The long-term relationship for the model (1) and model (2) was tested through following ARDL equation in this study is given below:

$$PR_{it} = \mu_i + \sum_{j=1}^{m-1}\lambda_{1j} PR_{i,t-j} + \sum_{l=0}^{n-1}\lambda_{2j} AGI_{i,t-l} + \sum_{r=0}^{p-1}\lambda_{3j} AI_{i,t-r} + \sum_{u=0}^{s-1}\lambda_{4j} SUB_{i,t-u} + \nu_{1i,t}$$

, (3)

$$AO_{it} = \mu_i + \sum_{j=1}^{m-1}\lambda_{1j} AO_{i,t-j} + \sum_{l=0}^{n-1}\lambda_{2j} AGI_{i,t-l} + \sum_{r=0}^{p-1}\lambda_{3j} AI_{i,t-r} + \sum_{u=0}^{s-1}\lambda_{4j} SUB_{i,t-u} + \nu_{1i,t}$$

, (4)

The "coefficients of long-term relationships" are assumed to stay the same for each country. The "error correction terms" for these model are as follow:

$$\Delta PR_{it} = \alpha_i + \sum_{j=1}^{m-1}\beta_{ij} \Delta PR_{i,t-j} + \sum_{l=0}^{n-1}\varphi_{il} \Delta AGI_{i,t-l} + \sum_{r=0}^{p-1}\Upsilon_{ir} \Delta AI_{i,t-r} + \sum_{u=0}^{s-1}\theta_{iu} \Delta SUB_{i,t-u} + aECT_{t-1} + e_{1i,t}$$

, (5)

$$\Delta AO_{it} = \alpha_i + \sum_{j=1}^{m-1}\beta_{ij} \Delta AO_{i,t-j} + \sum_{l=0}^{n-1}\varphi_{il} \Delta AGI_{i,t-l} + \sum_{r=0}^{p-1}\Upsilon_{ir} \Delta AI_{i,t-r} + \sum_{u=0}^{s-1}\theta_{iu} \Delta SUB_{i,t-u} + aECT_{t-1} + e_{1i,t}$$

, (6)

The model 5 and 6 were used to assess the short-term relationship between variables. $e_{ki,t}$ is the "residual" and ECT_{t-1} is the "error correction term" indicating "long-run equilibrium relationship" between variables.

Panel Unit Root Test

This test was used to confirm that the data set is stationery because the current data set included the macroeconomic variables. This test was applied through "ADF Fisher Chi-square (ADF Fisher) and Levin, Lin & Chi (LLC) unit root tests" methods to assess the stationery of data. The null hypothesis stated that "the data is not stationery" while the alternative hypothesis stated that "the data set is stationery".

Findings

The results of the current study that were found through ARDL modelling and other necessary tests have been presented in this section.

Descriptive statistics

The descriptive statistics ensured the normality and acceptability of the current data to be used for further analysis. Table 1 below shows the descriptive characteristics of the data.

Table 1: Descriptive statistics

	AGI	AI	AO	PR	SUB
Mean	13.99095	20.36526	134.6924	23.10744	1.420000
Median	12.94427	20.48525	124.2300	23.95500	1.000000
Maximum	38.10812	23.44257	246.3800	32.12000	2.000000
Minimum	0.024859	16.72494	93.48000	11.98000	1.000000
Std. Dev.	9.969641	1.556276	34.64955	4.946707	0.496045
Skewness	0.455153	-0.155860	1.703039	-0.509565	0.324176
Kurtosis	2.577215	2.435109	5.269991	2.683948	1.105090

The results of Table 2 below show that the data is normal and acceptable for further analysis because the mean values, skewness values and kurtosis values of AGI, AI, AO, PR and SUB are all acceptable and fall within threshold range so there is no outlier in the data and the data is ready for analysis.

Panel Unit Root Test

The "panel unit root test" was used to analyze the stationery of the data through which the following results were found.

Table 2: Panel Unit Root test

Variables	ADF Test		LLC Test	
	At level	1st difference	At level	1st difference
AGI	16.0356	52.0806***	-2.75739***	-7.80776***
AI	31.8269**	52.9478***	-8.10598***	-3.30127***
AO	57.9914***	38.8859***	-8.10598***	-8.28055***
PR	21.4725	34.2776**	-1.47758	-2.29834**
SUB	32.0343***	45.5022***	-3.09829***	-7.40760***

Note: ** indicates p-value <0.05 and *** indicates the p-value<0.01.
The values of p-values against statistics of "ADF Fisher Chi-square (ADF Fisher) and Levin, Lin & Chi (LLC) unit root tests" (<0.05 and <0.01) indicated that the current data is stationery because all the variables are stationery at maximum level of 1st difference.

Co-integration Analysis

After confirming that data is stationery, the co-integration of variables was checked by running a co-integration test and the results are presented in Table 3 below.

Table 3: Co-integration Test

Alternative hypothesis: common AR coefs. (within-dimension)					
				Weighted	
		Statistic	Prob.	Statistic	Prob.
Panel v-Statistic		-0.220312	0.5872	-1.106824	0.8658
Panel rho-Statistic		1.302119	0.9036	2.449637	0.9928
Panel PP-Statistic		-6.717063	0.0000	-2.723283	0.0032
Panel ADF-Statistic		3.544707	0.9998	0.448218	0.6730
Alternative hypothesis: individual AR coefs. (between-dimension)					
		Statistic	Prob.		
Group rho-Statistic		3.560069	0.9998		
Group PP-Statistic		-6.670048	0.0000		
Group ADF-Statistic		0.828910	0.7964		

The p-value against "group PP statistics" <0.05 and "panel PP statistics" <0.05 show that there is significant co-integration in the data. Furthermore, the insignificant values of "Panel rho-Statistic" and "Group rho-Statistic" are also confirming the presence of co-integration in the data so the null hypothesis is rejected.

Heteroscedasticity Test

The heteroscedasticity test was applied for both current models to check the heteroscedasticity issue. The results of this test are presented in Table 4 below for both models.

Table 4: Heteroscedasticity test

	Value	**Df**	**Probability**
Likelihood ratio Model (1)	137.9968	10	0.4733
Likelihood ratio Model (2)	222.2146	10	0.7438

The Table 4 results indicate that p-value for heteroscedasticity tests of both models is >0.05 thus showing the insignificance of the results therefore the null hypothesis is not rejected and it is found that there is no heteroscedasticity issue in the current data.

ARDL Model

To assess the long-term and short-term impact of AGI, AI, and subsidies on AO and poverty reduction, the ARDL modelling was performed for two econometric models in which the "PMG method" was adopted. Since, this method requires the assumption regarding presence of co-integration therefore the prerequisite of this test was fulfilled through the previously discussed results. The results of ARDL modelling for model 1 are presented in Table 5 below.

Table 5: ARDL Results (dependent Variable: PR)

Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.***
	Long Run Equation			
AGI	0.333272	0.111429	2.990898	0.0044
AI	1.837183	0.412268	4.456279	0.0001
SUB	2.856507	0.806511	3.541808	0.0009
	Short Run Equation			
COINTEQ01	-0.118136	0.039107	-3.020846	0.0041
D(AGI)	-4.894120	4.775343	-1.024873	0.3107
D(AI)	-0.411557	0.208889	-1.970219	0.0547
D(SUB)	-0.460640	0.215944	-2.133141	0.0382
C	-2.684494	0.887326	-3.025374	0.0040
Mean dependent var	-0.174333	S.D. dependent var		0.461398
S.E. of regression	0.402260	Akaike info criterion		0.619341
Sum squared resid	7.605232	Schwarz criterion		2.000081
Log likelihood	22.03295	Hannan-Quinn criter.		1.178151

The ARDL results for model 1 showed that there is significant and positive impact of AGI, AI and subsidies on poverty reduction in long run (p-value < 0.05). The findings further revealed that there are no significant impacts of AGI and AI on poverty reduction in the short term however the subsidies have significant but negative short-term impact on poverty reduction. The results of ARDL modelling of model 2 with dependent variable of agricultural output are presented in Table 6 below.

Table 6: ARDL Results (dependent Variable: AO)

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
	Long Run Equation			
AGI	14.36493	5.342357	2.688875	0.0099
AI	9.961368	2.218086	4.490974	0.0000
SUB	13.60231	3.531611	3.851588	0.0004
	Short Run Equation			
COINTEQ01	-0.065138	0.056911	-1.144559	0.2582
D(AGI)	110.4759	110.2873	1.001711	0.3216
D(AI)	2.500202	3.295898	0.758580	0.4519
D(SUB)	0.253774	1.103189	0.230037	0.8191
C	-15.50841	8.816819	-1.758957	0.0851
Mean dependent var	2.950222	S.D. dependent var		6.393405
S.E. of regression	3.784127	Akaike info criterion		4.726542
Sum squared resid	673.0219	Schwarz criterion		6.107282
Log likelihood	-183.3271	Hannan-Quinn criter.		5.285352

The results presented in Table 6 indicate that AGI, AI and subsidies have significant and positive impact on AO in the long run (p-value<0.05 and t-statistics>t-tabulated) however, there is no significant short-term impact of any of these variables on the AO.

Discussion

The aim of this study was to determine the impact of Agricultural Investments (AI), Extension Subsidies (ES) and Agricultural Irrigation (AIN) on Poverty Reduction (PR) and Agricultural Output (AO). This study proposed some hypotheses after a detailed review of literature relevant to the variables under study and then these hypotheses were subjected to rigorous testing techniques. After those tests and subsequent analysis, the results about the relationship between these variables was found are presented here. The first hypothesis proposed was that, "AI has a significant impact on PR." This hypothesis is accepted for the long terms as results indicate, according to PS. Stefan's research work, that long-term, AI positively and significantly impacts PR while in the short run its impact is insignificant on PR (Basnet & Upadhyaya, 2015).

The second hypothesis was that, "ES has a significant impact on PR", this hypothesis is accepted for both the short and long term as ES positively and significantly impacts PR,

according to ER. Goldwin. The third hypothesis stated that, "AIN has a significant impact on PR." According to TW. Schultz's transformation report, AIN significantly and positively impacts PR in the long term while it has an insignificant impact in the short term. The fourth hypothesis proposed was that, "AI has a significant impact on AO." This hypothesis is accepted in the case of long term results as in the short term, the impact of AI on AO is insignificant and the long run impact is significant (Dawe, 2015). The fifth hypothesis was that "AIN has a significant impact on AO." This is accepted in the long term however AIN has insignificant impact in case of short run. The sixth hypothesis proposed was that, "ES has a significant impact on AO." According to M. Nesbitt, ES significantly impacts AO in the long term and in the short term, the impact is insignificant.

Conclusion

The study aimed to determine about the impact of AI, AIN and ES on PR and AO. The study was conducted through panel data analysis technique, by collecting data about the economic indicators from the past thirty years provided by the World Bank reports of Indonesia, Thailand, Malaysia, Singapore, Philippines, Vietnam, Brunei, Cambodia, Myanmar and Laos and accessed from their economic development sites. Data analysis results showed that AI, AIN and ES impact PR and AO significantly in the long term whereas, all of these impacts were insignificant in the short term on AO. While, AI and AIN have insignificant impact on PR in the short term, ES has significant impact on PR in the short term.

Implications of the study

This study has significantly contributed to increasing information about the impacts of AI, AIN and ES in increasing or decreasing the PR and AO. This study can contribute significantly if it is considered in the policy making process in order to make the variables an important part of policies for the practical implication of AI, AIN and ES in order to reduce poverty and to increase global agricultural outputs.

Limitations and future research implications

This study was conducted by collecting data about the ASEAN countries only which makes it limited to these areas only whereas the problem of poverty is worldwide in different percentages so the same study can be conducted by targeting other countries and sectors as well. Moreover, control variables such as agricultural land and arable land can also be included in future studies.

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