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Time series econometric estimation of supply equation for Malaysian rice sector

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Abstract

Rice production in the country is characterized by two production seasons namely, main- season and off-season. Officially, the two production seasons data usually aggregated to form single data of domestic rice supply for the nation. This aggregation is refers to as all-season rice production. All the previous studies estimated supply equation based on the aggregated data thereby denying the opportunity of having a comprehensive insight into the structural relationship exist in the off-and-main season's rice production necessary for holistic policy analysis and decision. Hence, this study attempted estimating supply equation by disaggregation into main-season, off-season, and all-seasons' rice production equations. Time series data (1980-2012) were collected and analyzed using both co-integration and non-co-integration approaches. For valid inference, estimated coefficients were subjected to autocorrelation, heteroskedasticity, misspefication and structural stability diagnostic-tests. The results show that estimated coefficients for main-season and off-season paddy production equations exhibited common characteristics in terms of economic and statistical properties. Therefore, the estimated coefficients for all-season paddy production, which represents the aggregate information of main and off- season's paddy production, could still be adopted to explain relationship in supply side of the rice sector.

Keywords: Rice production seasons, estimated coefficients, policy analysis

Introduction

Agriculture remains a key sector of Malaysia's economy as it provides food for the nation and employment for about 12% of the total workforce of about 11.6 million. The sector contribution to the national GDP is about 7.3%, and provides high quality raw materials to the industrial sector under the agro- and resource-based industrial development strategies of the government (Dano and Samonte, 2005).

Rice is the most important cultivated crops, besides oil palm and rubber, in Malaysia covering a total land area of about 684,545 ha in 2012. About 76% of the rice farm land or 515,657ha is located in Peninsular Malaysia while Sabah and Sarawak constitute 6% (40,352 ha) and 18%

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(118,919 ha) respectively. It is a main staple crop which account for most of the country's food grain production and is considered strategically important crop for food security in the country.

Rice production in the country is characterized by two production seasons namely, main- season and off-season. According to the Malaysian Ministry of agriculture and Agro-based Industry (Agriculture Statistical Handbook, 2006), main-season paddy has a commencement Month of planting between August to February of the following year, while the off-season paddy production fall between April and July of the same year. Both off-season and main-season paddy farming take place in the eight designated granary areas with irrigation Facilities that facilitate double cropping. However, the main-season paddy farming is also take place in non-granary areas under rain-fed condition. The two production seasons 'data in terms of area planted to paddy, area harvested of paddy, paddy production and mean yield are officially aggregated to form single data of domestic rice supply for the nation. This aggregation is refers to as all-season paddy rice production (Agriculture Statistical Handbook, 2006).

Malaysia's rice/paddy production has witnessed an increasing trend in the last two decades. The figure 1 shows an increase of about 14% Million tonnes in the 1960s as compared to over 1.6 million tonnes produced in 2009. The figure 1 shows an increase of about 14% in rice national output from 1.2 million tonnes in 1990 to 1.4 million tonnes in 2000; which further increased by 20% to 1.7 million tonnes in 2012 for all-season rice production. The off-season rice production has shown a steady increase in output by 34% from 506,681 million tonnes in 1990 to 680,359 million tonnes in 2012. Within the same period, main-season rice production also witnessed an irregular increase of 15% from 793,256 million tonnes in 1990 to 908, 930 million tonnes in 2012.

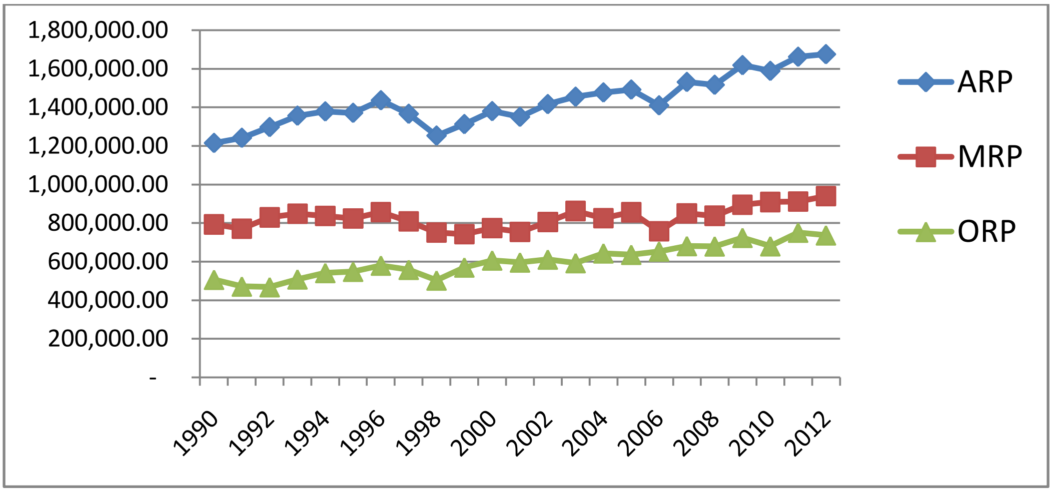

Figure 1: Rice grain production (tonnes) by season in Malaysia (1990-2012)

Note: ARP (All-season rice); MRP (Main-season rice Production); and, ORP (off-season rice production)
Sources: Paddy Statistics Unit, Malaysian MOA & AI (2013)

Malaysian government had been intervening in rice sector with production incentive and subsidy for the purpose of achieving self-sufficiency level in rice production, and, raising farm income and productivity. For instance, government spent RM 175million as fertilizer subsidy to paddy farmers and RM645million as paddy support price in 2012 alone. However, the interventions yielded different levels. of self-sufficiency in rice production. Table 1 show that the highest level of self-sufficiency (SSL) ever achieved in the country as a result of government intervention policy, in form of production subsidy and other incentives, was 92% during third Malaysia Plan of 1976-

1980. Since that feat of 92% SSL in 34 years ago, the self-sufficiency level has been fluctuating around 65-70%.

Table 1: National self-sufficiency level for paddy production

Malaysian plan/ national agri. plan (NAP)	Period	Self sufficiency level (SSL) targeted (%)	Self sufficiency level (SSL) Achieved (%)
1st Malaysia Plan	1966-1970	na	80
2nd Malaysia Plan	1971-1975	na	87
3rd Malaysia Plan	1976-1980	90	92
NAP i	1984-1991	65	75.9
4th Malaysia Plan	1981-1985	65	76.5
5th Malaysia Plan	1986-1990	65	75
6th Malaysia Plan	1991-1995	65	76.3
NAP ii	1992-2010	65	65
7th Malaysia Plan	1996-2000	65	71
NAP iii	1998-2010	65	71
8th Malaysia Plan	2001-2005	65	71
9th Malaysia Plan	2006-2010	65	72
National Food Security Policy	2008	80 by 2010	72
New Economic Model	2010	85 by 2020	na
National Agro-Food Policy (or NAP iv)	2011-2020	70 by 2012	na

Source: Fatima *et al.* (2011) Note: na (Not available)

The country usually resorts to importation of rice to augment deficit in demand-supply gap from mostly Asian countries namely, Vietnam, Thailand, Pakistan, Cambodia and India. Malaysia rice import increased by 14.2% from 935,244 tonnes in 2010 to over 1.06 million tonnes in 2013 due to population growth rate of about 2% and influx of foreign workers and tourists (GAIN Report, 2011).The rice import bill has also increased astronomically over the last two decades in the country. The value of rice import increase by over 500% from $99,737,000 in 1990 to $606,222,000 in 2012.

Government policy aim at achieving self-sufficiency and food security in rice sector must born out of clear understanding the nature of structural relationships exist among the major players in supply side of the rice sector. This is because a result-oriented policy analysis and implementation depend largely on the valid estimation of supply elasticities. Given the fact that all previous studies aimed at estimating supply equation of Malaysian rice sector was based on the aggregated data (all-season production), opportunity of having a comprehensive insight into the structural relationships and consequent policy-target at the off-season and main-season rice production in the country would be lacking.

For instance, Baharumshah (1993) undertook empirical assessment of alternative specification for a model of rice and wheat economy in Malaysia, using Seemingly Unrelated Regression (SUR) technique, reported that the estimate for the short-run price elasticity of supply for rice was 0.03 while for the long-run was 0.11. In this research, the estimation of elasticity supply of rice in Malaysia was based on aggregated data (all-season production). Also, Baharumshah (1991) examined specification issues and the estimation of supply equation for rice in Malaysia using Partial Adjustment and Adaptive Expectation Models for the periods of 1960 to 1987. The study observed that partial adjustment model is the preferred specification for the rice equation. Again, the estimation of elasticity of supply of rice in Malaysia is based on aggregated data (that is all-season production data).

In view of the above shortcomings and lack of information on the nature of functional relationships among variables of off-season and main season paddy production, prompted the need for this study. Therefore, in this study, effort is made to estimate supply equation, by comparing different production seasons namely, main-season paddy production, off-season paddy production, and all-season paddy in terms of respond to the adjustment in the following situations: paddy producer price, fertilizer subsidy and technological progress. In order to build credibility of this model for more accurate policy analysis and decision, diagnostic tests were exhaustively carried out.

Methodology

Time series data from the periods of 1980 to 2012 were collected from the Paddy Statistics Unit, Ministry of Agriculture and Agro-based Industry, and Food and Agricultural Organization (FAO) website. Data were collected and measured on the following variables: $APAP_t$ = All-season Paddy Area Planted (Ha) in period t, $MPAP_t$ = Main-season Paddy Area Planted (Ha) in period t, $OPAP_t$ = Off-season Paddy Area Planted (Ha) in period t, $APYD_t$ = All-season Paddy Yield (Kg/Ha) in period t, $MPYD_t$ = Main-season Paddy Yield (Kg/Ha) in period t, OPYDt=Off-season Paddy Yield (Kg/Ha) in period t, = Paddy Producer Price (RM/T) in period t, $FESUB_t$ = Fertilizer Subsidy (RM/annum) in period t, $TECH_t$ = Technological progress (Trend).

Dummy (DPAP) variable defined as Dum= 1, if paddy Area Planted (PAP_t) is greater than 1983 paddy area planted and 0 if PAP_t is less than or equal to 1983 paddy area planted was introduced to account for whether land area allocated to paddy, since introduction and implementation of first National Agricultural Policy in 1984, was higher than the year 1983 preceding the introduction of NAP 1. Since first National Agricultural Policy (NAP 1) placed much emphasis on new land development for commercial paddy farming and consolidation of uneconomic size land in the country.

The functional form of time series econometric estimation

In this study, the rice/paddy production is divided into area planted and yield, and further disaggregated into All-season, Main-season and Off-season.

Area planted equation

The area planted equation is the Nerlovian type where the paddy area planted (PAP_t) is written as a function of the lagged dependent variable, PAP_{t-1}, lagged paddy producer price, $PPPR_{t-i}$, and, dummy variable(DPAP). The lagged of area planted is included to capture the partial adjustment of cropland towards the desired level. It should be noted that the area planted equation is a restricted equation mainly due to heavy support and subsidy enjoyed by paddy farmers in the country. The area planted equation for all-season paddy, main-season paddy production and off-season paddy production was specified as follows:

$$LPAP_{it} = \beta_{i0} + \beta_{i1}LPAP_{it-1} + \beta_{i2}LPPPR_{it-i} + \beta_{i3}DPAP_{it} + \mu_{it} \ldots\ldots\ldots\ldots\ldots.1$$

Yield equation

The paddy/ rice yield is assumed to be determined by technology, $TECH_t$, (improved seed and management practices), and amount of fertilizer applied, which depend on fertilizer subsidy, $FESUB_t$. Thus, the paddy rice yield is function of technological development, and fertilizer subsidy. Again, yield equation was specified as a restricted equation in view of protectionist policy on the supply-side of rice sector. The yield equation for the all-season paddy, main-season paddy production and off-season paddy production was specified as follows:

$$LPYD_{it} = \delta_{i0} + \delta_{i1}LFESUB_{it} + \delta_{i2}TECH_{it} + \mu_{it} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 2$$

Where L = Natural Log, i = Different Seasons (all, main and off seasons), t = Time period, β_i and δ_i = Constants and coefficients for respective variables in different season equations, μ_{it} = White-noise error term in the respective equations.

The estimation of structural equations containing non-stationary variables but with stationary linear combinations or residuals is done using Auto Regressive Distributed lag (ARDL), Particularly, as the combining variables are integrated order of (0) and (1). However, for non- co-integrating equations, OLS multiple regression was used in estimating the relationships when the unit root problems in the series have been rid-off through first differencing of the series so as to avoid spurious results.

Autoregressive distributed lag approach (ARDL)

This approach of estimating long-run relationship has an edge over other single co-integration procedures, and, unlike multivariate co-integration techniques, particularly Johansen-Juselius' procedure, this method allows for co-integration relationship to be estimated by ordinary least square (OLS) once the lag order of the model is identified. The model accommodates a mixture of I(0) and I(1) variables in an equation. The estimates obtain from the ARDL method of co-integration analysis are unbiased and efficient (Narayan, 2004). This is because of the fact that it can be used to analyze small sample observation; and, it ensures estimation of long-run and short run component of the model. It is specified as follows:

$$Y_t = \alpha_0 + \sum_{i=1}^{K} \propto_{1i} Y_{t-i} + \sum_{i=0}^{K} \propto_{2i} x_{1t-i} + \sum_{i=0}^{K} \propto_{3i} x_{2t-i} + \beta_i M + \mathcal{E}_t \ldots\ldots\ldots\ldots\ldots 3$$

Normalized Long-run estimated coefficients

$$\alpha_0 = \frac{\propto_0}{1-\sum_{i=1}^{k}\propto_{1i}} \quad \propto_2 = \frac{\sum_{i=0}^{K}\propto_{2i}}{1-\sum_{i=1}^{k}\propto_{1i}} \quad \propto_3 = \frac{\sum_{i=0}^{K}\propto_{3i}}{1-\sum_{i=1}^{k}\propto_{1i}} \quad \beta_{i=} \frac{\beta}{1-\sum_{i=1}^{k}\propto_{1i}} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 4$$

Where, Y_t = Vector for dependent variables (PAP_t and PYD_t), Y_{t-i} = Vector for lag-dependent variables, X_t = Vector for exogenous variable in PAP_t and PYD_t equations, M = Dummy for paddy area planted in different season, α = Coefficients, β = Dummy coefficient, K = lag length, Ɛ = White noise error.

Error correction term / model

Engle and Granger (1987) observed that the presence of co-integration implied the existence of a corresponding error-correction representation. This shows that changes in the dependent variable are function of the level of disequilibrium in the co-integrating relationship, which is usually captured by the error –correction term, and changes in other exogenous variables (Masih and Masih, 2001). The Error Correction Model with Error Correction Term is specified as follows:

$$\Delta Y_t = \theta_0 + \sum_{i=1}^{P} \theta_{1i} \Delta Y_{t-i} + \sum_{i=0}^{P} \theta_{2i} \Delta x_{1t-i} + \sum_{i=0}^{P} \theta_{3i} \Delta x_{2t-i} + \beta_i M + \gamma (ECT)_{t-1} + \mathcal{E}_t \ldots\ldots\ldots\ldots\ldots 5$$

Where, Y_t = Vector for dependent variables (PAP_t and PYD_t), Y_{t-1} = Vector for lag-dependent variables, X_t = Vector for exogenous variables in PAP_t andPYD_t equations, Δ = First difference operator, Ɣ = Adjustment speed, P = Lag length, θ= Coefficients for the variables, β = Dummy coefficient, ECT_{t-1} = Error correction term lagged 1 period.

The OLS multiple regression model

The traditional OLS regression model takes the form:

$$Y_t = \alpha + \sum_{i=1}^{n} \lambda_i X_{it} + \beta iM + \mu t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 6$$

Where, Y_t = Vector for the dependent variables (PAP_t and $PYD_{t)}$, X_{it} = the ith exogenous variables in PAP_t and PYD_t equations, n = the number of explanatory variables in each equation, α and λ = intercept and coefficients that needed to be estimated empirically, β= Dummy coefficient, and μ_t = normally and independently distributed random error with zero mean and constant variance. The traditional regression model assume that the data series are stationary, otherwise there may be a problem of spurious regression. In this study, non-co-integrating equations were estimated using traditional multiple regression after taken first difference in the data series to make them stationary.

Unit root and co-integration tests

The popular test of stationary (or non-stationary) adopted for this study was the unit root test using Augmented Dickey-fuller (ADF) and Phillips-Perron (PP) tests.

Autoregressive and Distributed Lag, ARDL, (Bounds) testing approach to co-integration for determining the existence of a long run relationship was conducted using F-test statistic. The F-test statistic, tests the joint significant of one lagged level of the variables as given in the equation 7 below. That is, the null hypothesis, $H_o = \beta_1 = \beta_2 = 0$. The hypothesis was tested using the standard Wald statistics. The non-standard distribution of the F-test depends on the following conditions: whether the stationarity status of the variables in the ARDL model are I(0) or I(1); whether the ARDL model contains an intercept and/or trend; the number of regressors in the model; and, the sample size. Given the relatively small size sample for this study (33 observations), the critical value for small size sample generated by Narayan (2005) was used.

Auto Regressive Distribution Lag (ARDL) bound testing approach, which is also called Unrestricted Error Correction Model (UECM), is used in this study for testing the existence of long run relationship specified as follows:

$$\Delta Y_t = \phi_0 + \sum_{i=1}^{L} \phi_{1i} \Delta Y_{t-i} + \sum_{i=1}^{L} \phi_{2i} \Delta x_{1t-i} + \sum_{i=1}^{L} \phi_{3i} \Delta x_{2t-i} + \beta_1 Y_{t-1} + \beta_2 x_{1t-1} + \beta_3 x_{2t-1} + \mathcal{E}_t \ldots\ldots\ldots\ldots 7$$

The lag level coefficients (β_1, β_2, and β_3) were subjected to Joint significant-test (F-Test). The lag length selections for each equation was determined through Hendry's general to specific procedure with consideration to minimum value of SIC (Schwarz Information Criterion). The maximum lag in each case was two.

Results and discussion

Unit root test results

The results show that both ADF and PP concurred in classifying the following variables as I(1): LMPYD, LOPAP, LOPYD, LPPPR, LFESUB. The TECH variable was confirmed to be stationary at level (Table 2). For LAPAP variable, PP result contradicted the ADF, and therefore classified the variable as non-stationary at level. As result of this discrepancy, further effort was made to ascertain the true stationarity status of the variable by employing the method of plotting the correlogram of LAPAP as implemented by Ibrahim (2007) to further explore the stationarity property of the affected variable. It was observed that the autocorrelation function of the level LAPAP did not tend towards zero or die down, an indication of a non-stationary process, hence LAPAP is treated as an I(1) variable (Table 2).

Table 2: Results for unit root tests

Variables	Level		First Differencing	
	ADF	PP	ADF	PP
LAPAP	-3.56**	-3.54	-4.622***	-6.73***
LAPYD	-3.43	-3.26	-6.25***	-7.22***
LMPAP	-3.97**	-3.16	-4.27***	-7.00***
LMPYD	-3.28	-3.38	-7.39***	-9.71***
LOPAP	-1.21	-0.72	-7.5***	-7.43***
LOPYD	-3.53	-3.29	-4.12***	-10.35***
LPPPR	-1.36	-1.48	-4.04***	-4.04***
LFESUB	-1.03	-1.22	-4.59***	-4.59***
TECH	-	-15.40***		

Note: (**) and (***) denote level of significance at 5% and 1% respectively

Co-integration (bound) test results

The estimated results for each of the six functional equations (described by equations 1 and 2) satisfied no-autocorrelation tests and were dynamically stable confirmed through CUSUM Square tests. The equations of $LAPAP_t$, $LMPAP_t$, were confirmed to be co-integrated. However, Table 3 shows the equations of $LMPYD_t$ and $LOPAP_t$ were not co-integrated and hence no long-run relationship among the variables in the equations. The two remaining equations namely $LAPYD_t$ and $LOPYD_t$ were having inconclusive Bound test results (Table 3). But further confirmation tests such as the dynamic stability tests and the sign of error correction terms (which must be negative) obtained from the two equations suggested treating LAPYD as co-integrated equation, while LOPYD as no co-integration.

Table 3: Co-integration test results

Dep. Variables (Represent each equation)	K	SIC (Minimum Value)	F-Statistic	Narayan (2005) CV at 5%		Remark
				I(0)	I(1)	
$\Delta LAPAP_t$	1	-4.611	6.409***	5.393	6.350	Yes
$\Delta LAPYD_t$	2	-2.716	4.965**	4.269	5.473	Inc.
$\Delta LMPAP_t$	1	-4.143	7.239***	5.393	6.350	Yes
$\Delta LMPYD_t$	2	-2.553	2.743^{NS}	4.267	5.473	No
$\Delta LOPAP_t$	1	-3.783	2.160^{NS}	5.393	6.350	No
$\Delta LOPYD_t$	2	-2.406	4.602**	4.267	5.473	Inc.

Note: (NS), (**) and (***) denote no significance, significant at 5% and 1% respectively. K = exogenous variables in each equation; SIC = Schwarz Information Criterion (Minimum value in each equation); CV = Critical Values at 5% level of significant

Estimated long-run coefficients

The long-run coefficients were obtained by estimation of equations 3 and 4. The area planted equation specified structurally in Nerlovian form to capture the partial adjustment of area planted toward the desire level. Since paddy is an annual cereal crop, the effect of such adjustment decision could be better examined under short-run dynamic estimation using Error Correction Model. Hence, the long-run coefficients for exogenous variables of each of the equations were obtained after normalizing on the lag dependent variables (Narayan, 2004). The estimated long-run level equations satisfy no-autocorrelation hypothesis test and structural stability test as provided in the respective Tables. The estimated equations appear stable as CUSUM test statistics did not exceed the bounds at 5% level of significant (Narayan, 2004). Note: The actual graphs for CUSUM test are not included here for space constraint.

Estimated short-run coefficients

The short run coefficients which describe short term dynamic behaviour of the variables were estimated using equation 5. The residual from the co-integrating regression was used in estimating Error Correction Term (Dutta and Ahmed, 1999; and, Narayan, 2005). The estimated short run coefficients were tested for auto-correlation (LM), heteroskedasticity (HET), and misspecification (RESET). The respective Tables show that the test results indicating null hypotheses could not be rejected at 5% level of significant.

Estimated long-run and short-run coefficients for $LAPAP_t$-equation

The long run elasticity of paddy producer price (PPPR) has expected positive sign but shows no significant influence in all-season area planted (APAP) to paddy as shown in Table 4. The unexpected insignificant and low magnitude of paddy producer price elasticity of area planted may be attributed to limited availability of land for paddy cultivation as paddy land areas are been converted for other purposes. This factor has been previous reported as hindering responsiveness of rice farmers to paddy price changes in terms of area planted adjustment (Baharumshah, 1991; Ahmad and Tawang, 1999). Similar result was also reported by Baharumshah (1991) and Ahmad and Tawang (1999). The coefficient for dummy implies that there was significant increase in land area allocated to paddy cultivation since the introduction and implementation of first National Agricultural Policy in 1984 as compare to 1983 paddy land area planted. The result is in conformity with a priori expectation since the NAP1 emphasized on new land development and consolidation of uneconomic sized land in pursuance of food import substitution goal among other facilities embedded in the policy.

Table 5 shows that the estimated coefficient for the residual (ECT_{-1}) of LAPAPt-equation corrected the previous period's level of disequilibrium by 30% adjustment speed. The negative sign and statistical significant of the speed of adjustment is also an evidence for existence of co-integrating relationship among the variables in the $LAPAP_t$-equation (Dutta and Ahmed, 1999; and Narayan, 2005). The estimated coefficient for dummy variable is positive and significant at 1% level suggesting there was significant increase in land area allocation to all-season paddy since NAP1 in1984 as compared to the preceding year. The short run paddy producer price elasticity of all-season area planted to paddy is also small (0.026297) and insignificant. Small magnitude and insignificant short run coefficients for farm price with respect to rice supply was also reported by Baharumshah (1991). This is also attributed to limited land area for paddy. The partial adjustment of area planted toward the desire level captured by change in the lag dependent variable has expected positive sign but insignificant. This implies that there was insignificant adjustment in paddy land area within the study periods.

Table 4: $LAPAP_t$-Estimated long-run coefficients

Variable	Coefficient	Std. Error	T-Statistic
C	2.741367	1.283853	2.135266**
$LAPAP_{t-1}$	0.793249	0.095807	8.279621***
$LPPPR_{t-1}$	0.002096	0.008936	0.234596
DPAP	0.033557	0.004896	6.853828***
Normalized long-run relation			
C	13.25926	0.292495	45.33162***
$LPPPR_t$	0.010140	0.043088	0.235325
DPAP	0.034722	0.005242	6.623836***
R^2 =0.75			
DW=2.13			
LM=5.03			

Note: (**) and (***) denote significant level of 5% and 1% respectively

Table 5: $\Delta LAPAP_t$-estimated short-run coefficients

Variable	Coefficient	Std. Error	T-Statistic
C	0.002897	0.009484	0.305488
$\Delta LAPAP_{t-1}$	0.010739	0.097844	0.109754
ΔLPPR	0.026297	0.040699	0.646137
DPAP	0.033800	0.004535	7.452919***
ECT_{t-1}	-0.305233	0.103559	-2.947426***
R^2 =0.79			
DW=2.05			
LM=3.296529			
HET=3.441749			
RESET=0.123471			

Note: (***) denotes 1% significant level

Estimated long-run and short-run coefficients for $LAPYD_t$-equation

The long run coefficient for the trend variable ($TECH_t$) which capture the rice related technological progress has expected positive sign and statistically significant at 1% level. The magnitude of trend coefficient (0.142434) was higher than the value (0.0098) previously reported by Baharumshah (1991). This implies that there has been appreciable technological progress over the years since the first report in 1991. Also, Ahmad and Tawang (1999) reported positive and significant influence of technological progress on paddy yield in Malaysia. The long-run elasticity of fertilizer subsidy variable ($FESUB_{t)}$ with respect to all-season paddy yield shows a positive and insignificant relationship in the long-run as shown Table 6. The seemingly inelastic response of yield to the amount of fertilizer subsidy is in sharp contrast with apriori expectation. Considering the huge cost incur for paddy fertilizer subsidy annually, this result fall short of expectation. The insignificant response of paddy yield to fertilizer subsidy variable could be probably due to inefficiency in fertilizer input utilization by paddy farmers who are mostly smallholders.

The estimated coefficient for the Error Correction Term implies that deviation from long run equilibrium is corrected with a period lag by the variables in the equation at the speed of 37% per annum. Table 7 shows that the short run coefficient of trend indicated that while in the long run technological progress has significant influence on the paddy yield, in the short-run; change in technology has no significant effect on the paddy yield in the country. The short run coefficient for fertilizer subsidy implies that changes in the amount of fertilizer subsidy did not influence yield significantly.

Table 6: $LAPYD_t$-estimated long-run coefficients

Variable	Coefficient	Std. Error	T-Statistic
C	-1.713506	3.048768	-0.562032
$LAPYD_{t-1}$	0.671893	0.124725	5.386993***
$LFESUB_t$	0.225093	0.177601	1.267403
$TECH_t$	0.046734	0.018438	2.534630**
Normalized long run relation			
C	-5.222397	9.222433	-0.566271
$LFESUB_t$	0.686034	0.492667	1.392490
$TECH_t$	0.142434	0.042971	3.314619***
R^2 =0.85			
DW= 2.06			
LM=2.639912			

Note: (**) and (***) denote significant level of 5% and 1% respectively

Table 7: $\Delta LAPYD_t$ -Estimated short-run coefficients

Variable	Coefficient	Std. Error	T-Statistic
C	-0.004775	0.018765	-0.254473
$\Delta LAPYD_{t-1}$	0.001198	0.187969	0.006375
$\Delta LFESUB_t$	0.376359	0.274631	1.370419
ΔTECH	0.062898	0.146526	0.429262
ECT_{t-1}	-0.378657	0.160617	-2.357524**
R^2 =0.26			
DW=1.99			
LM=2.155181			
HET=4.623885			
RESET=0.548675			

Note: (**) denote significant level of 5%

Estimated long-run and short-run coefficients for $LMPAP_t$-equation

The long run coefficient for paddy producer price (PPPR) has no expected positive sign and shows insignificant influence on main-season area planted (MPAP). This probably implied that paddy farmers respond to increase in paddy producer price by non-optimal combination of inputs which probably result in higher cost of paddy production; hence causing left-wise shift in the main-season area planted function. This finding is supported by that of John *et al.* (2010). Also, data from Paddy Statistical Unit, Malaysian Ministry of Agriculture and Agro-based Industry (2013), indicated a decline of about 3% of paddy land area from 698,702 ha in 2000 to 677,884 ha in 2012. Much of this land area reduction happened in Peninsular Malaysia under main-season production. Since the period (2000 -2012) also witnessed increase in paddy producer price as a result of upward reviewer of paddy support price, thus, negative elasticity of paddy producer price to main-season paddy area planted might be justified. Table 8 also shows that dummy variable is insignificant in relation to main-season area planted to paddy. This implies there was no significant increase in land area allocated to main-season area planted since the launched of NAP1 as compared to the preceding year (1983).

The residual (ECT_{-1}) speed of adjustment shows LMPAPt-equation corrects the previous period's level of disequilibrium at the speed of 22% per annum. The estimated coefficient for dummy variable is positive and significant at 1% level suggesting that there has been significant increase in land area allocation to main-season farming since introduction of NAP1 within the short-run basis (Table 9). The paddy producer price elasticity of main-season area planted to paddy has expected sign but statistically insignificant in the short run. This contrasted the long run coefficient; implying that even though increase in paddy producer price has no positive influence on the main-season area planted to paddy in the long run, it has positive relationship in the short run. The partial adjustment of area planted toward the desire level has negative sign but insignificant.

Table 8: $LMPAP_t$-estimated long-run coefficients

Variable	Coefficient	Std. Error	T-Statistic
C	3.924099	1.476022	2.658564**
$LMPAP_{t-1}$	0.607211	0.183282	3.312993***
$LMPAP_{t-2}$	0.103847	0.142790	0.727275
$LPPPR_t$	-0.057403	0.081369	-0.705470
$LPPPR_{t-1}$	0.028925	0.083571	0.346109
DPAP	0.031132	0.009519	3.270455***
Normalized Long-run Relation			
C	7.901350	4.727351	1.671412
$LPPPR_t$	-0.057343	0.058886	-0.973794

DPAP	0.062686	0.052167	1.201642
R^2 =0.85			
DW=2.39			
LM=2.807238			

Note: (**), (***) denote significant level of 5% and 1% before normalization

Table 9: $\Delta LMPAP_t$-estimated short-run coefficients

Variable	Coefficient	Std. Error	T-Statistic
C	1.179419	0.488311	2.415306**
$\Delta LMPAP_{t-1}$	-0.110578	0.131234	-0.842605
$\Delta LPPPR_{t-1}$	0.025980	0.076528	0.339478
ECT_{t-1}	-0.221136	0.089178	-2.479716**
DPAP	0.032108	0.009041	3.551327***
R^2 =0.63			
DW=2.40			
LM= 2.906880			
HET=1.325919			
RESET=0.756651			

Note: (**) and (***) denote significant level of 5% and 1% respectively

Non-cointegrating equations estimation

The non-cointegrating equations were LMPYDt (main-Season Paddy Yield), $LOPAP_t$ (off-Season Area Planted), and $LOPYD_t$ (off-Season Paddy Yield). They were estimated using equation 6. To avoid spurious regression, first differencing of series was done on non-stationary variables and estimated equations were diagnosed for autocorrelation, heteroskedasticity and misspecification. The respective Tables show test results confirming that null hypotheses could not be rejected at 5% probability level.

Estimated coefficient for $LMPYD_t$-equation

The elasticity for fertilizer has expected positive sign but show insignificant influence on the yield. The insignificant response of paddy yield to fertilizer subsidy variable could be probably due to inefficiency in fertilizer input utilization by paddy farmers. The estimated coefficient for trend, $TECH_{t,}$ was significant at 5% level (Table 10). The significant coefficient suggests technological progress has appreciable impact on main season paddy yield.

Table 10: $LMPYD_t$-estimated coefficients

Variable	Coefficient	Std. Error	T-Statistic
C	0.695639	2.710078	0.256686
$LMPYD_{t-1}$	0.607787	0.160068	3.797063***
$LFESUB_t$	0.123048	0.162716	0.756216
$TECH_t$	0.044101	0.020033	2.201449**
R^2 =0.83.			
DW=2.14			
LM=1.909754			
HET=5.184559			
RESET=1.355110			

Note: (**) and (***) signify significant level of 5% and 1% respectively.

Estimated coefficient for $LOPAP_t$-equation

The equation for $LOPAP_t$ (off-Season Area Planted) specified structurally in Nerlovian form to capture the partial adjustment of area planted to paddy. The elasticity of paddy producer price (PPPR) has expected positive sign but also shows no significant relationship with OPAP. The insignificant and low magnitude (0.012) of paddy producer price elasticity of area planted is attributed to limited availability of land for off-season paddy production. The dummy variable (DPAP) has significant coefficient in relation to area planted to paddy. The lag dependent variable shows expected positive sign and also statistically significant at 1% level. This result suggests that off-season paddy farmers do make partial adjustment of paddy area planted toward the desire level within study period (Table 11).

Table 11: $LOPAP_t$-estimated coefficients

Variable	Coefficient	Std. Error	T-Statistic
C	0.636888	0.381290	1.670350
$LOPAP_{t-1}$	0.940058	0.038097	24.67554***
$LPPPR_{t-1}$	0.011852	0.020768	0.570689
DPAP	0.052346	0.007373	7.099628***
R^2 =0.98			
DW=2.74			
LM=5.248848			
HET=4.906329			
RESET=0.982888			

Note: (***) signifies 1% level of significant

Estimated coefficient for $LOPYD_t$-equation

Table 12 shows that elasticity for fertilizer has expected positive sign but insignificant in relation to yield; attributed to inefficiency in the utilization of fertilizer input provided through fertilizer subsidy. The estimated coefficient for trend, $TECH_{t,}$ was significant at 5% level. The significant coefficient suggests technological progress impacted the yield essentially under this production type.

Table 12: $LOPYD_t$-estimated coefficients

Variable	Coefficient	Std. Error	T-Statistic
C	-1.573086	3.539999	-0.44375
$LOPYD_{t-1}$	0.654192	0.141653	4.618282***
$LFESUB_t$	0.228316	0.201193	1.134810
$TECH_t$	0.043795	0.020607	2.125294**
R^2 =0.78			
DW=2.27			
LM=2.096151			
HET= 1.120868			
RESET=1.111241			

Note: (**) and (***) show significant level of 5% and 1% respectively

Summary, conclusion and recommendation

In comparison of estimated equations, the area planted response to an upward adjustment in paddy producer price (PPPR) as captured by the estimated coefficient values show that both APAP and OPAP had similar characteristics in terms of magnitude and sign of the coefficient. This implies that 1% increase in paddy producer price would result in insignificant increase of APAP and OPAP in hectare by 0.01% in the long-run. The value of coefficient for PPPR with respect to MPAP is negative but insignificant statistically. The short-run coefficient for PPPR in relation to APAP and MPAP is the same (0.03). It shows that any changes in paddy producer price would insignificantly influence the APAP and MPAP in the same direction. Adjustment in the area planted to desire level occurred in off-season paddy production as against main-season production. The response of area planted to dummy variable have similar characteristics in terms of magnitude, sign and statistical significant for both main-season and off-season paddy productions. The yield response to fertilizer subsidy as reflected in estimated coefficient or elasticity for FESUB (fertilizer subsidy) variable shows that OPYD has 0.23, which is greater than 0.12 obtained from MPAP. But for aggregate equation, APAP, the yield response to an increase in fertilizer subsidy is 0.69. But all the elasticities were insignificant statistically. The yield response to the influence of technological progress as captured by trend variable is the same for both seasons (main and off-seasons) in terms of magnitude (0.04) and statistical significant. For aggregate equation, APAP, the values is estimated at 0.14.

Therefore, the findings show similarity in the estimated coefficients for main-season and off-season paddy production equations in terms of economic and statistical properties; implying common characteristics in response of MPAP and OPAP to exogenous variables included in both equations. Thus, the estimated coefficients for all-season paddy production (APAP and APYD) which represents the aggregated information of main-season and off-season paddy productions could be adopted to explain relationship in supply side of the rice sector.

References

Agriculture Statistical Handbook (2006). Ministry of agriculture, Malaysia.

Ahmed, T. M. A., & Tawang, A. (1999). *Effect of trade liberalization on agriculture in Malaysia: commodity aspects*. The CGPRT center working paper series No. 46.

Baharumshah, A. Z. (1991). Specification issues and the estimation of supply equation for rice in Malaysia. *Jurnal Ekonomi Malaysia*, 24, 3-16.

Baharumshah, A. Z. (1993). *A model for rice and wheat economy in Malaysia*. In: Malaysian agricultural commodity forecasting and policy modeling by F. M. Arshad, M. N. Shamsudin, and S. Othman, *Eds;* Centre for agricultural policy studies (CAPS), UPM. pp 83-99.

Dutta, D., & Ahmed, N. (1999). An aggregate import demand function for Bangladesh: A cointegration approach. *Applied Economics*, 31(4), 465-472.

Dano, E. C., & Samonte, E. D. (2005). *Public sector intervention in the rice industry in Malaysia.* www.zef.de/module/register/media/2692. Accessed 23-01-2014.

Engle, R. F., & Granger, C. W. J. (1987). Cointegration and error correction: Representation estimation, and testing. *Econometrica*, 55, 251-276.

Fatimah, M. A., Emmy, F. A., Kusairi, M., and Muhammad, T. (2011). Food security: Self-sufficient of rice in Malaysia. *Int. J. Management Study*. 18(2), 83-100.

Global Agricultural Information Network (GAIN) report (2011). *Grain and feed annual report for Malaysia.* USDA Foreign Agricultural Service. *www.gain.fas.usda.gov*. Accessed 10/10/03.

Ibrahim, M. N. (2007). The role of the financial sector in economic development: The Malaysian case. *Int. Rev. Econ.* 54, 463-483.

John, Y. T., Darham, S., Mohd Noh, A. F., & Idris, N. (2010). Acreage response of paddy in Malaysia. *Agric. Econ-Czech*, 56(3), 135-140.

Masih, R., & Masih, A. M. M. (2001). Long and short term dynamic causal transmission amongst international stock markets. *Journal of International Money and Finance*, 20, 563-587.

Narayan, P. K. (2005). The saving and investment nexus for China: Evidence from cointegration tests. *Applied Economics*, 37, 1979-1990.

Narayan, P. K. (2004). *Reformulating critical values for the bounds F-statistics approach to cointegration: an application to the tourism demand model for Fiji*. A discussion papers. Depatment of Economics, Monash University,Australia. www.arrow.monash.edu.au:2167. Accessed 20-02-2014.