Chapter 4

Development of the Rice Econometric Model with Endogenous Water in Thailand (REMEW-THAI)

4-1. Introduction

The world’s leading rice exporter is Thailand, and this country exported 7.43 million metric tons (mMT) in 2006 and followed by India, Vietnam, Pakistan, and the USA, with rice exports of 3.30 mMT, 4.74 mMT, 4.64 mMT, 3.69 mMT, and 3.30 mMT respectively. Thailand’s world rice trade was 24.3% in 2006; therefore, production trends affect the world food market. The variance of rice production depends in part on water supply changes and domestic policies.

There is an extensive body of existing literature on rice production and policies in Thailand. Siamwalla & Setboonsarng (1989) analyzed the effects of export taxes and price supports for rice, sugar, maize, and rubber by using a comparative static model. Kagatsume (1988) analyzed the impacts of a rice-premium policy on the market of rice in Thailand using a supply and demand model of rice, and found that this policy has a price stabilizing effect. O’Mara & Le-Si (1985) analyzed impacts of price changes of rice on agricultural income and production using an income classification model, and they shed light on the problem that farmers lost their incentives to produce through the rice-premium policy. Choeun, Go, & Hayami (2006) used a comparative static model and clarified the issue that the export tax was higher than the optimum value in the low-income era by politicians’ lead.

Tax revenue in Thailand increased due to the growth of the industrial sector, and the rice-premium policy was abolished in 1986. However, the policy had another function, the stabilization of domestic price of rice. The paddy mortgage scheme was started 1984 for the purpose of price stabilization.

The model developed in this chapter focuses on the analyses of impacts of water supply changes on the regional rice market; thus, analyses of the impacts of policy change is reserved for other articles. However, the understanding of the paddy mortgage scheme is quite important to understand the background of the supply and demand of rice in Thailand. The outline of the policy is described in the next section.

4-2. Paddy mortgage scheme

The paddy mortgage scheme allows the farmer to obtain financing from the Bank of Agricultural Cooperatives (BAAC) when the farmer pledges their paddy to the Public Warehouse Organization (PWO). If the market price is higher than the loan rate plus interest rate, the farmer will be able to buy back their paddy at this lower adjusted loan price. Conversely, if the market price is lower than the loan rate plus interest rate, pledged paddy of farmers will be confiscated by the government and the farmer retains the original payment.

Let’s examine the workflow in more detail. First, farmers apply to participate in the scheme to the office of the Ministry of Agriculture and Cooperatives (MOAC), and if the office affirms that the farmer cultivates his or her land, they will get a certificate of registration in the scheme. The farmers bring their paddy to a miller who is also a member of the scheme. The farmers will get a certificate of shipment after the examination of the water content of the paddy by the PWO. Farmers who get the certificate present it to the BAAC and obtain the bank loan. The paddy is milled by directive of the government and is brought to the warehouse of the PWO. Furthermore, the interest rate of the BAAC for the scheme in the wet season in 2008 was 3%, and the upper limit of the loan provision to an individual farm was 500,000 Baht.

If a farmer participates in the scheme and sells his or her paddy to the government at the loan rate, the farmer gets the revenue which is loan rate times sales quantity. The paddy mortgage scheme forms a floor revenue when the market price is lower than the loan rate. However, the percentage of paddy production enrolled in the scheme has varied between 2.89% in 1999 and 25.23% in 2005. Clearly, the loan rate is not the floor price for all farmers in Thailand.

Academic and business experts pointed out some problems of the scheme in our interviews in Bangkok and its suburb. The problems raised are as follows; (1) The scheme mainly assists rich farmers who cultivate rice in the dry season. (2) The scheme diminishes the function of price formation in the central market. (3) The scheme expands the budget deficit. (4) The price of the milled rice sold by the government is higher than the market price, and it lowers the competitive edge of Thai rice in the global market.

The loan rate in dry season has been higher than the average farm price from 2004 to 2008; however, the loan rate in wet season has been lower than the average farm price from 2002 to 2007. The
fluctuations in price of dry season rice is wider than that of wet season rice, so, the government may have set the loan rate at a relatively high level for dry season rice.

The price stabilization effect of the paddy mortgage scheme is one of the mitigation policies for reducing impacts of the water supply changes on producers.

### 4-3. Model

The supply and demand model of rice in Thailand is more detailed in the North-East region because of its location in the critical Mekong River basin. Yield and planted area functions are estimated for each province in the North-East region and those in the North, Central, and South regions are estimated at the regional aggregate. There are nineteen provinces in the North-East region. There are two cultivation types, i.e., major rice or rainy season rice and second rice or dry season rice. The generalized forms of the model are as follows:

**Yield function of major rice:**

\[ W' = f_{w}(T, ET_{jan}, ..., ET_{dec}), \]

**Planted Area function of major rice:**

\[ APW' = f_{ap}(APW', T, ET_{jan}, ..., ET_{dec}), \]

**Harvested area of major rice:**

\[ AHW' = APW' - ABW' = APW'(1-RABW') \]

**Production of major rice:**

\[ QW' = YW'AHW', QW = \sum QW', \]

**Yield function of second rice:**

\[ YD' = f_{d}(T, ET_{jan}, ..., ET_{jun}), \]

**Planted Area function of second rice:**

\[ APD' = f_{ap}(APD', T, ET_{jan}, ..., ET_{dec}), \]

**Harvested area of second rice:**

\[ AHD' = APD' - ABD' = APD'(1-RABD') \]

**Production of second rice:**

\[ QD' = YD'AHD', QD = \sum QD', \]

**Total production:**

\[ Q = 0.667(QW + QD), \]

**Export function:**

\[ EXP = f_{exp}(T, Q), \]

**Stock change function:**

\[ STC = f_{st}(T, FP, Q), \]

**Total supply:**

\[ QS = Q + IMP - EXP - STC, \]

**Demand function:**

\[ QS/POP = f_{ds}(RP, GDP/POP), \]

**Price linkage function:**

\[ FP = f_{fp}(RP), \]

where \( i \) is the province in the North-East region and in the regional aggregate elsewhere, \( t \) denotes that the data are measured at time \( t \), \( T \) is a time trend, \( ET_{jan} \) through \( ET_{dec} \) are evapotranspiration values for January through December, \( YW, AP, AHW, ABW, RABW, \) and \( QW \) are yield, planted area, harvested area, abandoned area, abandoned area ratio, and production of major season rice, \( YD, APD, AHD, ABD, RABD, \) and \( QD \) are yield, planted area, harvested area, abandoned area, abandoned area ratio, and production of second season rice, \( Q \) is total production, \( IMP \) is imports, \( EXP \) is exports, \( STC \) is the annual change of stocks, i.e., ending stock minus beginning stock, \( QS \) is total supply, \( POP \) is population, \( GDP \) is gross domestic products, \( EXR \) is exchange rate, \( FP \) is the producer price, \( RP \) is the retail price. The retail price is fed to the other three countries’ models through price linkage functions. The retail price of the Bangkok 5% broken is used to Laotian and Cambodian rice models, and that of the Bangkok 35% broken is used for Vietnamese rice model. All functions are specified as linear functions.

The planted area functions are based on the adaptive expectation model in which the ET is expected variable for farmers. There are a total of 80 functions in the Thai rice model and an additional 45 identities. Figure 4-1 and Figure 4-2 show flowcharts of the model for the production and the supply and demand sector.

### 4-4. Data

The source of the data of evapotranspiration (ET) is same as that of the Lao and Cambodian rice models.

The time series data for production and planted area of the two types of rice cultivations for each province are provided by the Center for Agricultural Information at the Office of Agricultural Economics of the Ministry of Agriculture and Co-operatives of Thailand. The farm price for rice is obtained from FAO-STAT and the retail price of rice is obtained from the IRRI, which is available from 1961 to 1997 and is held constant after 1997. These prices are a national average price for Thailand. CPI, GDP, and population are from the Asian Development Bank (ADB) and the exchange rate and the world price of rice are numbers from the International Monetary Fund (IMF). The estimation period for yield and planted area functions for each province in the North-East region and aggregated other regions, and import, stock change, and demand functions for the country as a whole are from 1982 to 2000 which starts in the earliest available year for statistics of production and ends in the last year of available ET values.
4-5. Estimation results of all functions

The estimation method of all functions is OLS, and the estimation period is from 1982 to 2000. First, yield functions of major rice in North East region for each province are shown, and yield functions of major rice in the other three aggregate regions, i.e., North, South, and Central regions follow them. Second, yield functions of second rice in these regions are shown. Third, planted area functions of major and second rice in these regions are shown. Finally, estimated results of export, stock change, demand, and price linkage function are shown.

4-5-1. Yield functions

4-5-1-1. Yield function of major rice

4-5-1-1-1. Yield function of major rice in North East region

4-5-1-1-1-1. Yield function of major rice in Nakhon Phanom

\[
YMH01 = +0.62083^{(1.58)} + 0.04878^{*}\text{TREND}^{(12.03)} - 0.00823^{*}\text{ETOIMAY}
\]
4-5-1-1-1-3. Yield function of major rice in Nong Khai

\[ \text{YMH03} = \begin{cases} +0.46487 & \text{TREND} \\ +0.01231 \times \text{TREND} & (1.65) \\ +0.00369 \times \text{ET03APR} & (3.40) \\ -0.00935 \times \text{ET03MAY} & (-4.99) \end{cases} \]

\[ +0.00176 \times \text{ET03AUG} & (5.95) \\
-0.36983 \times \text{D86} & (-4.47) \\
-0.37117 \times \text{D90} & (-4.42) \\
-0.14839 \times \text{D96} & (-2.33) \]

\[ \text{AdjR}^2 = 0.8657 \]
\[ \text{D.W.} = 2.057 \]

4-5-1-1-4. Yield function of major rice in Udon Thani

\[ \text{YMH04} = \begin{cases} +2.53763 & \text{TREND} \\ +0.00379 \times \text{ET04APR} & (4.18) \\ -0.00543 \times \text{ET04JUN} & (-1.53) \\ +0.00745 \times \text{ET04SEP} & (1.74) \\ -0.39942 \times \text{D87} & (-3.33) \end{cases} \]

\[ -1.45489 \times \text{D88} & (-12.02) \\
-0.43588 \times \text{D93} & (-2.43) \]

\[ \text{AdjR}^2 = 0.8953 \]
\[ \text{D.W.} = 2.066 \]
ET04SEP Evapotranspiration of September in Udon Thani
ET04NOV Evapotranspiration of November in Udon Thani
D87 Dummy Variable, 1 in 1987, 0 otherwise
D88 Dummy Variable, 1 in 1988, 0 otherwise
D93 Dummy Variable, 1 in 1993, 0 otherwise

4-5-1-1-5. Yield function of major rice in Loei

\[ \text{YMH06} = -1.17177 + 0.01282 \times \text{ET06MAY} - 0.02831 \times \text{ET06JL} + 0.03165 \times \text{ET06NOV} - 0.46734 \times \text{D82} + 0.59201 \times \text{D00} \]

AdjR² = 0.8507 D.W. = 1.817

YMH06 Yield of Major Rice in Loei
ET06MAY Evapotranspiration of May in Loei
ET06JL Evapotranspiration of July in Loei
ET06NOV Evapotranspiration of November in Loei
D82 Dummy Variable, 1 in 1982, 0 otherwise
D00 Dummy Variable, 1 in 2000, 0 otherwise

4-5-1-1-6. Yield function of major rice in Yasothon

\[ \text{YMH08} = 2.53918 + 0.02670 \times \text{TREND} + 0.00466 \times \text{ET08MAY} - 0.00327 \times \text{ET08JUN} + 0.00583 \times \text{ET08JLY} - 0.00972 \times \text{ET08AUG} + 0.46127 \times \text{D85} \]

AdjR² = 0.8828 D.W. = 2.237

YMH08 Yield of Major Rice in Yasothon
TREND Time Trend from 1982 to 2000
ET08MAY Evapotranspiration of May in Yasothon
ET08JUN Evapotranspiration of June in Yasothon
ET08JLY Evapotranspiration of July in Yasothon
ET08AUG Evapotranspiration of August in Yasothon
D85 Dummy Variable, 1 in 1985, 0 otherwise

4-5-1-1-7. Yield function of major rice in Ubon Ratchathani

\[ \text{YMH09} = 1.16657 + 0.01449 \times \text{TREND} - 0.00327 \times \text{ET09APR} + 0.00583 \times \text{ET09MAY} - 0.00972 \times \text{ET09JLY} + 0.00747 \times \text{ET09AUG} + 0.46127 \times \text{D85} \]

AdjR² = 0.8450 D.W. = 1.933

YMH09 Yield of Major Rice in Ubon Ratchathani
TREND Time Trend from 1982 to 2000
ET09APR Evapotranspiration of April in Ubon Ratchathani
ET09MAY Evapotranspiration of May in Ubon Ratchathani
ET09JLY Evapotranspiration of July in Ubon Ratchathani
ET09AUG Evapotranspiration of August in Ubon Ratchathani
D85 Dummy Variable, 1 in 1985, 0 otherwise

4-5-1-1-8. Yield function of major rice in Kalasin

\[ \text{YMH11} = 4.15186 + 0.03328 \times \text{TREND} - 0.00205 \times \text{ET11APR} + 0.00282 \times \text{ET11MAY} - 0.00970 \times \text{ET11JLY} - 0.00802 \times \text{ET11AUG} - 0.01067 \times \text{ET11NOV} + 0.57323 \times \text{D83} - 0.33656 \times \text{D98} \]

AdjR² = 0.8450 D.W. = 1.933

YMH11 Yield of Major Rice in Kalasin
TREND Time Trend from 1982 to 2000
ET11APR Evapotranspiration of April in Kalasin
ET11MAY Evapotranspiration of May in Kalasin
ET11JLY Evapotranspiration of July in Kalasin
ET11AUG Evapotranspiration of August in Kalasin
D85 Dummy Variable, 1 in 1985, 0 otherwise
D83 Dummy Variable, 1 in 1983, 0 otherwise
D98 Dummy Variable, 1 in 1998, 0 otherwise

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ET11NOV Evapotranspiration of November in Kalasin
D83 Dummy Variable, 1 in 1983, 0 otherwise
D934 Dummy Variable, 1 in 1993 to 1994, 0 otherwise
D989 Dummy Variable, 1 in 1998 to 1999, 0 otherwise

4-5-1-1-9. Yield function of major rice in Khon Kaen
YM12 = 2.51256
+ 0.00532*ET12JUN
(10.08) (3.23) [0.278]
- 0.00463*ET12JLY
(-2.66) [-0.253]
- 0.00577*ET12SEP
(-2.57) [-0.279]
+ 0.00401*ET12OCT
(3.01) [-0.227]
- 0.22654*D82
(-3.92)
- 0.40232*D87
(-8.41)
- 0.09938*D95
(-1.91)
AdjR²=0.8610
D.W.=2.095

YM12 Yield of Major Rice in Khon Kaen
TREND Time Trend from 1982 to 2000
ET12JUN Evapotranspiration of June in Khon Kaen
ET12JLY Evapotranspiration of July in Khon Kaen
ET12SEP Evapotranspiration of September in Khon Kaen
ET12OCT Evapotranspiration of October in Khon Kaen
D82 Dummy Variable, 1 in 1982, 0 otherwise
D87 Dummy Variable, 1 in 1987, 0 otherwise
D95 Dummy Variable, 1 in 1995, 0 otherwise

4-5-1-1-10. Yield function of major rice in Maha Sarakham
YM13 = 1.51352
(7.76)
+ 0.04631*TREND
(13.34)
- 0.00509*ET13JUN
(-2.10) [-0.262]
+ 0.44242*D835
(7.78)
- 0.30566*D99
(-4.06)
AdjR²=0.9083
D.W.=2.112

YM13 Yield of Major Rice in Maha Sarakham
TREND Time Trend from 1982 to 2000
ET13JUN Evapotranspiration of June in Maha Sarakham
ET13JLY Evapotranspiration of July in Maha Sarakham
ET13SEP Evapotranspiration of September in Maha Sarakham
D835 Dummy Variable, 1 in 1983 to 1985, 0 otherwise
D912 Dummy Variable, 1 in 1991 to 1992, 0 otherwise

4-5-1-1-11. Yield function of major rice in Roi Et
YM14 = 1.35644
(3.80)
+ 0.04313*TREND
(9.43)
AdjR²=0.9083
D.W.=2.112

YM14 Yield of Major Rice in Roi Et
TREND Time Trend from 1982 to 2000
ET14JUN Evapotranspiration of June in Roi Et
ET14JLY Evapotranspiration of July in Roi Et
D82 Dummy Variable, 1 in 1982, 0 otherwise
D989 Dummy Variable, 1 in 1998 to 1999, 0 otherwise

4-5-1-1-12. Yield function of major rice in Buri Ram
YM15 = 1.93605
(8.40)
+ 0.03113*TREND
(8.82)
- 0.00382*ET15APR
(-3.30) [-0.110]
- 0.00489*ET15OCT
(-2.30) [-0.281]
+ 0.56244*D835
(9.94)
- 0.22791*D912
(-3.71)
AdjR²=0.8882
D.W.=1.763

YM15 Yield of Major Rice in Buri Ram
TREND Time Trend from 1982 to 2000
ET15APR Evapotranspiration of April in Buri Ram
ET15OCT Evapotranspiration of October in Surin
D835 Dummy Variable, 1 in 1983 to 1985, 0 otherwise
D912 Dummy Variable, 1 in 1991 to 1992, 0 otherwise

4-5-1-1-13. Yield function of major rice in Surin
YM16 = 0.60350
(1.12)
+ 0.00411*ET16APR
(2.27) [0.109]
+ 0.00744*ET16JLY
(2.06) [0.390]
+ 0.00764*ET16AUG
(2.48) [0.407]
+ 0.00664*ET16SEP
(1.97) [0.325]
- 0.01085*ET16OCT
(-3.50) [-0.628]
+ 0.43567*D88
(3.17)
+ 0.68427*D94
(6.34)
+ 0.33107*D97
(9.40)

YM16 Yield of Major Rice in Surin
TREND Time Trend from 1982 to 2000
ET16APR Evapotranspiration of April in Surin
ET16JLY Evapotranspiration of June in Surin
ET16AUG Evapotranspiration of August in Surin
ET16SEP Evapotranspiration of September in Surin
ET16OCT Evapotranspiration of October in Surin
D88 Dummy Variable, 1 in 1988, 0 otherwise
D94 Dummy Variable, 1 in 1994, 0 otherwise
D97 Dummy Variable, 1 in 1997, 0 otherwise
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(3.50)  
AdjR$^2$ = 0.9041  
D.W. = 2.053

YM16 Yield of Major Rice in Surin  
ET16APR Evapotranspiration of April in Surin  
ET16JLY Evapotranspiration of July in Surin  
ET16AUG Evapotranspiration of August in Surin  
ET16SEP Evapotranspiration of September in Surin  
ET16OCT Evapotranspiration of October in Surin  
D88 Dummy Variable, 1 in 1988, 0 otherwise  
D94 Dummy Variable, 1 in 1994, 0 otherwise  
D97 Dummy Variable, 1 in 1997, 0 otherwise

4-5-1-1-14. Yield function of major rice in Si Sa Ket  
YM17 = -0.58471  
\[ (-1.19) \]  
+ 0.04291*TREND  
\[ (8.18) \]  
+ 0.00461*ET17MAY  
\[ (3.14) [0.232] \]  
- 0.01698*ET17JUN  
\[ (4.91) [-0.870] \]  
+ 0.01026*ET17JLY  
\[ (2.41) [0.554] \]  
+ 0.01248*ET17SEP  
\[ (3.31) [0.639] \]  
+ 0.01103*ET17NOV  
\[ (2.32) [0.582] \]  
- 0.31936*D923  
\[ (-4.54) \]  
- 0.39813*D989  
\[ (-5.32) \]

AdjR$^2$ = 0.8637  
D.W. = 2.222

YM18 Yield of Major Rice in Chaiyaphum  
ET18MAY Evapotranspiration of May in Chaiyaphum  
ET18JUN Evapotranspiration of June in Chaiyaphum  
ET18AUG Evapotranspiration of August in Chaiyaphum  
ET18SEP Evapotranspiration of September in Chaiyaphum  
ET18OCT Evapotranspiration of October in Chaiyaphum  
ET18NOV Evapotranspiration of November in Chaiyaphum  
D83 Dummy Variable, 1 in 1983, 0 otherwise  
D96 Dummy Variable, 1 in 1996, 0 otherwise  
D00 Dummy Variable, 1 in 2000, 0 otherwise

4-5-1-1-1-16. Yield function of major rice in Nakhon Ratchasima  
YM19 = +4.97683  
\[ (6.96) \]  
+ 0.00549*TREND  
\[ (9.31) \]  
- 0.00997*ET19APR  
\[ (-7.57) [-0.320] \]  
+ 0.00394*ET19MAY  
\[ (2.48) [0.202] \]  
- 0.00374*ET19JULY  
\[ (-1.54) [-0.204] \]  
+ 0.00084*ET19SEP  
\[ (2.90) [0.483] \]  
- 0.01299*ET19OCT  
\[ (-5.40) [-0.747] \]  
- 0.03524*ET19NOV  
\[ (-6.06) [-1.925] \]  
+ 0.64573*D825  
\[ (7.78) \]  
+ 0.26546*D89  
\[ (3.50) \]  
+ 0.35398*D98  
\[ (3.75) \]

AdjR$^2$ = 0.8924  
D.W. = 1.686

YM19 Yield of Major Rice in Nakhon Ratchasima  
TREND Time Trend from 1982 to 2000  
ET19APR Evapotranspiration of April in Nakhon Ratchasima  
ET19MAY Evapotranspiration of May in Nakhon Ratchasima  
ET19JULY Evapotranspiration of July in Nakhon Ratchasima  
ET19SEP Evapotranspiration of September in Nakhon Ratchasima  
ET19OCT Evapotranspiration of October in Nakhon Ratchasima  
ET19NOV Evapotranspiration of November in Nakhon Ratchasima  
D825 Dummy Variable, 1 in 1982 to 1985, 0 otherwise  
D89 Dummy Variable, 1 in 1989, 0 otherwise
4-5-1-1-2. Yield function of major rice in North region

\[ \text{YMH}_N = -0.30514 - 0.51 + 0.02299 \times \text{TREND} + 0.00734 \times \text{ETNJUN} - 0.00838 \times \text{ETNAUG} + 0.01499 \times \text{ETNSEP} - 0.01050 \times \text{ETNOCT} + 0.00876 \times \text{ETNDEC} \]

\[ - 0.29898 \times D90 - 0.20411 \times D97 \]

\[ + 0.33102 \times \text{SHIFT00} \]

\[ \text{AdjR}^2 = 0.8611 \]

4-5-1-1-3. Yield function of major rice in South region

\[ \text{YMH}_S = -0.62642 \]

\[ + 0.03423 \times \text{TREND} + 0.01348 \times \text{ETNJUN} + 0.01658 \times \text{ETNDEC} - 0.00532 \times \text{ETNSDEC} \]

\[ - 0.32229 \times D90 - 0.21043 \times D92 \]

\[ \text{AdjR}^2 = 0.8456 \]

4-5-1-2. Yield function of second rice

4-5-1-2-1. Yield function of second rice in North East region

4-5-1-2-1-1. Yield function of second rice in Nakhon Phanom

\[ \text{YSH01} = 1.76190 + 11.59 + 0.01774 \times \text{TREND} - 0.00912 \times \text{ET01MAR} + 0.01272 \times \text{ET01APR} - 0.40577 \times D91 + 0.59741 \times D97 \]

\[ \text{D.W.} = 1.772 \]

4-5-1-2-1-2. Yield function of second rice in Sakon Nakhon

\[ \text{YSH02} = -1.14695 \]

\[ - 1.74 - 0.01760 \times \text{TREND} + 0.02715 \times \text{ET02NOV(t-1)} - 0.04772 \times \text{ET02DEC(t-1)} \]

\[ \text{D.W.} = 1.631 \]
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Yield function of second rice in Nong Khai

\[
YSH02 = 3.76808 + 0.02507 * \text{TREND} - 0.04723 * \text{ET03NOV}(t-1) + 0.03150 * \text{ET03JAN} - 0.01500 * \text{ET03FEB} + 0.01446 * \text{ET03MAR} + 0.01958 * \text{ET03MAY} - 0.85520 * D87 - 0.93102 * D934 - 0.82979 * D91
\]

4.5.1.2.1-3. Yield function of second rice in Nong Khai

\[
YSH03 = + 0.20609 + 0.01645 * \text{TREND} + 0.05106 * \text{ET04NOV}(t-1) - 0.04324 * \text{ET04DEC}(t-1) + 0.33744 * D889 + 0.90961 * D90 + 0.88404 * D99
\]

4.5.1.2.1-4. Yield function of second rice in Udon Thani

YSH04 = + 3.00217 - 0.03449 * \text{ET06NOV}(t-1) + 0.01461 * \text{ET06MAR} + 0.89519 * D92 + 1.03827 * D96 - 0.43222 * D989

4.5.1.2.1-5. Yield function of second rice in Loei

YSH06 = + 1.64448 + 0.00870 * \text{ET03MAR} + 0.01958 * \text{ET03MAY} + 0.085520 * D87 - 0.93102 * D934 - 0.82979 * D90

\[
\text{Adj} R^2 = 0.8657 \quad D.W. = 2.216
\]

Yield function of second rice in Sakon Nakhon

ET02DEC Evapotranspiration of December in Sakon Nakhon
ET02JAN Evapotranspiration of January in Sakon Nakhon
ET02MAR Evapotranspiration of March in Sakon Nakhon
ET02APR Evapotranspiration of April in Sakon Nakhon
ET02MAY Evapotranspiration of May in Sakon Nakhon

\[
YSH02 = + 3.00217 - 0.03449 * \text{ET06NOV}(t-1) + 0.01461 * \text{ET06MAR} + 0.89519 * D92 + 1.03827 * D96 - 0.43222 * D989
\]

\[
\text{Adj} R^2 = 0.8740 \quad D.W. = 2.306
\]

TREND Time Trend from 1982 to 2000
ET04FEB Evapotranspiration of February in Udon Thani
ET04NOV Evapotranspiration of November in Udon Thani
ET04DEC Evapotranspiration of December in Udon Thani
D889 Dummy Variable, 1 in 1988 to 1989, 0 otherwise
D90 Dummy Variable, 1 in 1990, 0 otherwise
D99 Dummy Variable, 1 in 1999, 0 otherwise

D86 Dummy Variable, 1 in 1986, 0 otherwise
D90 Dummy Variable, 1 in 1990, 0 otherwise
D91 Dummy Variable, 1 in 1991, 0 otherwise

D87 Dummy Variable, 1 in 1987, 0 otherwise
D934 Dummy Variable, 1 in 1993 to 1994, 0 otherwise
D00 Dummy Variable, 1 in 2000, 0 otherwise
4-5-1-2-1-6. Yield function of second rice in Yasothon

\[ YSH08 = +4.03983\]
\[ -0.04115*ET08NOV(t-1)\]  
\[ (4.22)\]  
\[ -0.04115*ET08DEC(t-1)\]  
\[ (4.22)\]  
\[ +0.02063*ET08JUN\]  
\[ (7.06)\]  
\[ +0.01455*ET08FEB\]  
\[ (-2.29)\]  
\[ +0.05793*ET08MAR\]  
\[ (7.06)\]  
\[ -0.01455*ET08JUN\]  
\[ (-2.29)\]  
\[ +0.01455*ET08NOV(t-1)\]  
\[ (4.22)\]  
\[ +0.05793*ET08JUN\]  
\[ (7.06)\]  
\[ -0.02063*ET08FEB\]  
\[ (-2.29)\]  
\[ +1.02254*D92\]  
\[ (6.32)\]  
\[ +0.99383*D96\]  
\[ (7.03)\]  
\[ +0.86071*D98\]  
\[ (6.10)\]

\[ AdjR^2=0.8998\]  
\[ D.W.=1.968\]

4-5-1-2-1-7. Yield function of second rice in Khon Kaen

\[ YSH11 = +1.09285\]
\[ +0.07713*TREND\]  
\[ (8.45)\]  
\[ -0.01717*ET12NOV(t-1)\]  
\[ (-2.33)\]  
\[ +0.06347*ET12JAN\]  
\[ (4.54)\]  
\[ -0.01858*ET12MAR\]  
\[ (-4.79)\]  
\[ -0.00643*ET12JUN\]  
\[ (-2.26)\]  
\[ +0.02822*ET12JAN\]  
\[ (4.65)\]  
\[ +0.78400*D85\]  
\[ (4.40)\]  
\[ +0.15114*D93\]  
\[ (-7.50)\]  
\[ -0.89488*D95\]  
\[ (-5.96)\]

\[ AdjR^2=0.8744\]  
\[ D.W.=2.070\]

4-5-1-2-1-8. Yield function of second rice in Kalasin

\[ YSH12 = +4.85052\]
\[ +0.04600*TREND\]  
\[ (6.95)\]  
\[ +0.03074*ET11DEC(t-1)\]  
\[ (3.01)\]  
\[ -0.01383*ET11FEB\]  
\[ (-1.87)\]  
\[ -0.03550*ET11JAN\]  
\[ (-5.08)\]  
\[ +0.34197*D890\]  
\[ (2.46)\]  
\[ -1.06759*D94\]  
\[ (-4.29)\]

\[ AdjR^2=0.8744\]  
\[ D.W.=1.958\]
Development of the Rice Econometric Model with Endogenous Water in Thailand (REMEW-THAI)

4-5-1-2-1. Yield function of second rice in Maha Sarakham

\[
\text{YSH13} = \begin{cases} 
4.50255 
+ 0.0775 \times \text{TREND} 
- 0.02489 \times \text{ET13MAR} 
+ 0.00807 \times \text{ET13APR} 
+ 0.88063 \times \text{D890} 
+ 1.03944 \times \text{D98} 
\end{cases}
\]

4-5-1-2-1-10. Yield function of second rice in Maha Sarakham

\[
\text{YSH13} = \begin{cases} 
4.50255 
+ 0.0775 \times \text{TREND} 
- 0.02489 \times \text{ET13MAR} 
+ 0.00807 \times \text{ET13APR} 
+ 0.88063 \times \text{D890} 
+ 1.03944 \times \text{D98} 
\end{cases}
\]

4-5-1-2-1-11. Yield function of second rice in Roi Et

\[
\text{YSH14} = \begin{cases} 
2.87485 
+ 0.06625 \times \text{ET14NOV(t-1)} 
+ 0.02756 \times \text{ET14MAR} 
- 1.1150 \times \text{D82} 
- 1.15959 \times \text{D87} 
+ 0.58066 \times \text{D912} 
\end{cases}
\]

4-5-1-2-1-12. Yield function of second rice in Buri Ram

\[
\text{YSH15} = \begin{cases} 
3.88415 
- 0.03807 \times \text{ET15DEC(t-1)} 
\end{cases}
\]

AdjR² = 0.8735  D.W.=2.057

YSH15  Yield of Second Rice in Buri Ram

ET15JAN  Evapotranspiration of January in Buri Ram
ET15FEB  Evapotranspiration of February in Buri Ram
ET15MAR  Evapotranspiration of March in Buri Ram
ET15MAR  Evapotranspiration of May in Buri Ram
ET15JUN  Evapotranspiration of June in Buri Ram
ET15DEC  Evapotranspiration of December in Buri Ram
D87  Dummy Variable, 1 in 1987, 0 otherwise
D89  Dummy Variable, 1 in 1989, 0 otherwise
D93  Dummy Variable, 1 in 1993, 0 otherwise
4-5-1-2-1-14. Yield function of second rice in Si Sa Ket

\[
YSH17 = -0.89927 + 0.05499 \times ET17DEC(t-1) - 0.04007 \times ET17FEB - 0.04265 \times ET17MAR + 0.04484 \times ET17MAR + 0.00801 \times ET17APR - 0.63630 \times D87
\]

\[
YSH17 = -0.89927 + 0.05499 \times ET17DEC(t-1) - 0.04007 \times ET17FEB - 0.04265 \times ET17MAR + 0.04484 \times ET17MAR + 0.00801 \times ET17APR - 0.63630 \times D87
\]

\[
YSH17 = -0.89927 + 0.05499 \times ET17DEC(t-1) - 0.04007 \times ET17FEB - 0.04265 \times ET17MAR + 0.04484 \times ET17MAR + 0.00801 \times ET17APR - 0.63630 \times D87
\]

\[
\text{Adj}R^2 = 0.9356, \text{D.W.} = 2.224
\]

4-5-1-2-1-15. Yield function of second rice in Chaiyaphum

\[
YSH18 = + 6.00024 + 0.06028 \times T8292 - 0.02309 \times ET18DEC(t-1) + 0.05427 \times ET18JAN + 0.02342 \times ET18FEB + 0.00850 \times ET18MAR + 0.00648 \times ET18MAR - 0.02481 \times ET18JAN
\]

\[
\text{Adj}R^2 = 0.8592, \text{D.W.} = 2.380
\]

4-5-1-2-1-16. Yield function of second rice in Nakhon Ratchasima

\[
YSH19 = + 1.50479 + 0.00871 \times ET19DEC(t-1) + 0.00491 \times ET19APR + 0.00752 \times ET19APR + 0.72592 \times D89 + 1.09139 \times D92 - 0.33658 \times D96
\]

\[
\text{Adj}R^2 = 0.8578, \text{D.W.} = 2.631
\]
Development of the Rice Econometric Model with Endogenous Water in Thailand (REMEW-THAI)

\[ \text{Yield function of second rice in North region} \]
\[ \text{YSH}_N = +2.82790 \]
\[ (9.35) \]
\[ +0.19791*\text{T8789} \]
\[ (9.99) \]
\[ -0.00471*\text{ETSMAR}(t-1) \]
\[ (-2.59) [-0.172] \]
\[ -0.00411*\text{ETSFEB} \]
\[ (-3.47) [-0.101] \]
\[ +0.00316*\text{ETSNAR} \]
\[ (2.70) [0.070] \]
\[ -0.00287*\text{ETSAPR} \]
\[ (-2.81) [-0.080] \]
\[ +0.00672*\text{ETSMAY} \]
\[ (3.46) [0.233] \]
\[ -0.00383*\text{ETSJUN} \]
\[ (-1.14) [-0.136] \]
\[ +0.382326*\text{D82} \]
\[ (4.69) \]
\[ -0.57866*\text{D90} \]
\[ (-9.50) \]
\[ +0.34906*\text{D926} \]
\[ (-9.98) \]
\[ \text{AdjR}^2 =0.9629 \quad \text{D.W.} =2.302 \]

\[ \text{Yield function of second rice in South region} \]
\[ \text{YSH}_S = +2.82790 \]
\[ (9.35) \]
\[ +0.19791*\text{T8789} \]
\[ (9.99) \]
\[ -0.00471*\text{ETSMAR}(t-1) \]
\[ (-2.59) [-0.172] \]
\[ -0.00411*\text{ETSFEB} \]
\[ (-3.47) [-0.101] \]
\[ +0.00316*\text{ETSNAR} \]
\[ (2.70) [0.070] \]
\[ -0.00287*\text{ETSAPR} \]
\[ (-2.81) [-0.080] \]
\[ +0.00672*\text{ETSMAY} \]
\[ (3.46) [0.233] \]
\[ -0.00383*\text{ETSJUN} \]
\[ (-1.14) [-0.136] \]
\[ +0.382326*\text{D82} \]
\[ (4.69) \]
\[ -0.57866*\text{D90} \]
\[ (-9.50) \]
\[ +0.34906*\text{D926} \]
\[ (-9.98) \]
\[ \text{AdjR}^2 =0.9629 \quad \text{D.W.} =2.302 \]

\[ \text{Yield function of second rice in Central region} \]
\[ \text{YSH}_C = +3.46934 \] (48.39)
\[ +0.02075*\text{ETNFEF} \]
\[ (3.26) [0.119] \]
\[ +0.005186*\ln(\text{ETNMAR}) \]
\[ (2.08) [0.029] \]
\[ -0.573257*\text{D87}(-6.14) \]
\[ \text{AdjR}^2 =0.9669 \quad \text{D.W.} =2.064 \]

YSH_N Yield of Second Rice in North region
T8292 Time Trend from 1982 to 1992, 1 before 1982, 11 after 1992
T9600 Time Trend from 1996 to 2000, 1 before 1996
ETNAM Jan Evapotranspiration of January in North region
ETNAMAR Evapotranspiration of March in North region
D87 Dummy Variable, 1 in 1987, 0 otherwise

4-5-1-2-3. Yield function of second rice in South region

4-5-2. Planted area functions

4-5-2-1. Planted area function of major rice

4-5-2-1-1. Planted area function of major rice in North East region

4-5-2-1-1-1. Planted area function of major rice in Nakhon Phanom

APM01 = -57036
\[ (-0.80) \]
\[ +0.49673*\text{APM01}(t-1) \]
\[ (3.34) \]
\[ +5.66909*\text{FPR}(t-1)\text{CPI}(t-1)/100 \]
\[ (2.06) [0.153] \]
\[ -460.38753*\text{ET01MAY}(t-1) \]
\[ (-4.10) [-0.189] \]
\[ +751.20376*\text{ET01JULY}(t-1) \]
\[ (2.13) [0.331] \]
\[ +1223.51665*\text{ET01OCT}(t-1) \]
\[ (3.71) [0.631] \]
\[ -1336.95339*\text{ET01NOV}(t-1) \]
\[ (-3.02) [-0.529] \]
\[ +2137.33188*\text{ET01DEC}(t-1) \]
\[ (2.84) [0.410] \]
\[ -30740*\text{D823} \]
\[ (-9.86) \]
\[ -23189*\text{D92} \]
\[ (-3.88) \]
\[ \text{AdjR}^2 =0.9016 \quad \text{D.W.} =2.246 \]

YSH_S Yield of Second Rice in South region
T8789 Time Trend from 1987 to 1989, 1 before 1987, 3 after 1989
ETSFEB Evapotranspiration of February in South region
ETSMAR Evapotranspiration of March in South region
ETSAPR Evapotranspiration of April in South region
ETSMAY Evapotranspiration of May in South region
ETSJUN Evapotranspiration of June in South region
ETSDEC Evapotranspiration of December in South region
D82 Dummy Variable, 1 in 1982, 0 otherwise
D90 Dummy Variable, 1 in 1990, 0 otherwise
D926 Dummy Variable, 1 in 1992 to 1996, 0 otherwise

4-5-1-2-4. Yield function of second rice in Central region

YSH_C = +3.46934
\[ (48.39) \]
\[ +0.05174*\text{TREND} \]
\[ (11.15) \]
\[ +0.00581*\text{ETCMAR} \]
\[ (2.36) [-0.040] \]
\[ -0.33076*\text{D87} \]
\[ (-3.18) \]
\[ -1.87457*\text{D90} \]
\[ (16.68) \]
\[ +0.35704*\text{D96} \]
\[ (3.34) \]
\[ \text{AdjR}^2 =0.9699 \quad \text{D.W.} =2.094 \]

YSH_C Yield of Second Rice in Central region
TREND Time Trend from 1982 to 2000
ETCMAR Evapotranspiration of March in Central region
D87 Dummy Variable, 1 in 1987, 0 otherwise
D90 Dummy Variable, 1 in 1990, 0 otherwise
D96 Dummy Variable, 1 in 1996, 0 otherwise

APM01 = Planted Area of Major Rice in Nakhon Phanom
FPR Farm Price of Thai Rice (baht per KG)
CPI Consumer Price Index (1998=100)
ET01MAY Evapotranspiration of May in Nakhon Phanom
ET01JULY Evapotranspiration of July in Nakhon Phanom
ET01OCT Evapotranspiration of October in Nakhon Phanom
ET01NOV Evapotranspiration of November in Nakhon Phanom
ET01DEC Evapotranspiration of December in Nakhon Phanom
D823 Dummy Variable, 1 in 1982 to 1983, 0 otherwise
D92 Dummy Variable, 1 in 1992, 0 otherwise
### 4-5-2-1-1-2. Planted area function of major rice in Sakon Nakhon

\[ \text{APM02} = +325123 \]
\[ +0.59106 \times \text{APM02}(t-1) \]
\[ +21.16978 \times \frac{\text{FPR}(t-1) \times \text{CPI}(t-1)}{100} \]
\[ +981.21360 \times \text{ET02APR}(t-1) \]
\[ -1636.77096 \times \text{ET02MAY}(t-1) \]
\[ -2858.21242 \times \text{ET02AUG}(t-1) \]
\[ +3884.42246 \times \text{ET02SEP}(t-1) \]
\[ -4901.40208 \times \text{ET02NOV}(t-1) \]
\[ +52651 \times \text{D90} \]
\[ \text{Adj}R^2 = 0.9438 \]

D.W. = 2.397

<table>
<thead>
<tr>
<th>APM02</th>
<th>Planted Area of Major Rice in Sakon Nakhon</th>
</tr>
</thead>
<tbody>
<tr>
<td>FPR</td>
<td>Farm Price of Thai Rice (baht per KG)</td>
</tr>
<tr>
<td>CPI</td>
<td>Consumer Price Index (1998=100)</td>
</tr>
<tr>
<td>ET02APR</td>
<td>Evapotranspiration of April in Sakon Nakhon</td>
</tr>
<tr>
<td>ET02MAY</td>
<td>Evapotranspiration of May in Sakon Nakhon</td>
</tr>
<tr>
<td>ET02AUG</td>
<td>Evapotranspiration of August in Sakon Nakhon</td>
</tr>
<tr>
<td>ET02SEP</td>
<td>Evapotranspiration of September in Sakon Nakhon</td>
</tr>
<tr>
<td>D88</td>
<td>Dummy Variable, 1 in 1988, 0 otherwise</td>
</tr>
<tr>
<td>D91</td>
<td>Dummy Variable, 1 in 1991, 0 otherwise</td>
</tr>
<tr>
<td>D95</td>
<td>Dummy Variable, 1 in 1995, 0 otherwise</td>
</tr>
</tbody>
</table>

\[ \text{Adj}R^2 = 0.8748 \]

D.W. = 2.270

### 4-5-2-1-1-3. Planted area function of major rice in Nong Khai

\[ \text{APM03} = +257903 \]
\[ +0.20507 \times \text{APM03}(t-1) \]
\[ +10.00143 \times \frac{\text{FPR}(t-1) \times \text{CPI}(t-1)}{100} \]
\[ +1017.70684 \times \text{ET03MAR}(t-1) \]
\[ -1255.39328 \times \text{ET03APR}(t-1) \]
\[ +1626.82874 \times \text{ET03MAY}(t-1) \]
\[ -855.06144 \times \text{ET03JUN}(t-1) \]
\[ -122204 \times \text{D92} \]
\[ \text{Adj}R^2 = 0.8748 \]

D.W. = 2.270

<table>
<thead>
<tr>
<th>APM03</th>
<th>Planted Area of Major Rice in Udon Thani</th>
</tr>
</thead>
<tbody>
<tr>
<td>FPR</td>
<td>Farm Price of Thai Rice (baht per KG)</td>
</tr>
<tr>
<td>CPI</td>
<td>Consumer Price Index (1998=100)</td>
</tr>
<tr>
<td>ET03MAR</td>
<td>Evapotranspiration of March in Udon Thani</td>
</tr>
<tr>
<td>ET03APR</td>
<td>Evapotranspiration of April in Udon Thani</td>
</tr>
<tr>
<td>ET03MAY</td>
<td>Evapotranspiration of May in Udon Thani</td>
</tr>
<tr>
<td>ET03JUN</td>
<td>Evapotranspiration of June in Udon Thani</td>
</tr>
<tr>
<td>D92</td>
<td>Dummy Variable, 1 in 1982, 0 otherwise</td>
</tr>
<tr>
<td>D00</td>
<td>Dummy Variable, 1 in 2000, 0 otherwise</td>
</tr>
</tbody>
</table>

\[ \text{Adj}R^2 = 0.8748 \]

D.W. = 2.270

### 4-5-2-1-1-4. Planted area function of major rice in Loei

\[ \text{APM06} = -94713 \]
\[ +0.62760 \times \text{APM06}(t-1) \]
\[ +38527 \times \text{D90} \]
\[ \text{Adj}R^2 = 0.7933 \]

D.W. = 2.657

<table>
<thead>
<tr>
<th>APM06</th>
<th>Planted Area of Major Rice in Loei</th>
</tr>
</thead>
<tbody>
<tr>
<td>FPR</td>
<td>Farm Price of Thai Rice (baht per KG)</td>
</tr>
<tr>
<td>CPI</td>
<td>Consumer Price Index (1998=100)</td>
</tr>
<tr>
<td>ET04MAR</td>
<td>Evapotranspiration of March in Udon Thani</td>
</tr>
<tr>
<td>ET04APR</td>
<td>Evapotranspiration of April in Udon Thani</td>
</tr>
<tr>
<td>ET04MAY</td>
<td>Evapotranspiration of May in Udon Thani</td>
</tr>
<tr>
<td>ET04JUN</td>
<td>Evapotranspiration of June in Udon Thani</td>
</tr>
<tr>
<td>D92</td>
<td>Dummy Variable, 1 in 1982, 0 otherwise</td>
</tr>
<tr>
<td>D00</td>
<td>Dummy Variable, 1 in 2000, 0 otherwise</td>
</tr>
</tbody>
</table>

\[ \text{Adj}R^2 = 0.7933 \]

D.W. = 2.657

### 4-5-2-1-1-5. Planted area function of major rice in Leel

\[ \text{APM06} = -94713 \]
\[ +0.62760 \times \text{APM06}(t-1) \]
\[ +4.77205 \times \frac{\text{FPR}(t-1) \times \text{CPI}(t-1)}{100} \]
\[ \text{Adj}R^2 = 0.7933 \]

D.W. = 2.657

<table>
<thead>
<tr>
<th>APM06</th>
<th>Planted Area of Major Rice in Leel</th>
</tr>
</thead>
<tbody>
<tr>
<td>FPR</td>
<td>Farm Price of Thai Rice (baht per KG)</td>
</tr>
<tr>
<td>CPI</td>
<td>Consumer Price Index (1998=100)</td>
</tr>
<tr>
<td>ET04MAR</td>
<td>Evapotranspiration of March in Udon Thani</td>
</tr>
<tr>
<td>ET04APR</td>
<td>Evapotranspiration of April in Udon Thani</td>
</tr>
<tr>
<td>ET04MAY</td>
<td>Evapotranspiration of May in Udon Thani</td>
</tr>
<tr>
<td>ET04JUN</td>
<td>Evapotranspiration of June in Udon Thani</td>
</tr>
<tr>
<td>D92</td>
<td>Dummy Variable, 1 in 1982, 0 otherwise</td>
</tr>
<tr>
<td>D00</td>
<td>Dummy Variable, 1 in 2000, 0 otherwise</td>
</tr>
</tbody>
</table>

\[ \text{Adj}R^2 = 0.7933 \]

D.W. = 2.657
(3.23) [0.436] + 589.4453*ET06SEP(t-1) (3.84) [0.767] + 505.5908*ET06OCT(t-1) (3.33) [0.721] + 18958*D85 (4.86) + 7332*D93 (2.10) + 9301*SHIFT00 (2.23) 

AdjR²=0.8869 D.W.=2.078

APM06 Planted Area of Major Rice in Loei
FPR Farm Price of Thai Rice (baht per KG)
CPI Consumer Price Index (1998=100)
ET06SEP Evapotranspiration of September in Loei
ET06OCT Evapotranspiration of October in Loei
D85 Dummy Variable, 1 in 1985, 0 otherwise
D93 Dummy Variable, 1 in 1993, 0 otherwise
SHIFT00 Dummy Variable, 1 after 2000, 0 otherwise

4-5-2-1-1-7. Planted area function of major rice in Ubon Ratchathani

APM09 = + 76398 (-1.03) + 0.89135*APM09(t-1) (8.71) + 15.51384*[FPR(t-1)/CPI(t-1)/100] (3.69) [0.144] - 403.52314*ET09MAY(t-1) (-1.90) [-0.057] - 958.50868*ET09AUG(t-1) (-2.38) [-0.143] - 2583.35305*ET09SEP(t-1) (5.07) [0.389] + 863.17759*ET09OCT(t-1) (2.41) [0.154] - 1521.1993*ET09NOV(t-1) (-2.68) [-0.236] - 63632*D82 (-6.03) - 26533*D913 (-4.58) + 76450*D94 (5.51) 

AdjR²=0.9446 D.W.=2.095

APM09 Planted Area of Major Rice in Ubon Ratchathani
FPR Farm Price of Thai Rice (baht per KG)
CPI Consumer Price Index (1998=100)
ET09MAY Evapotranspiration of May in Ubon Ratchathani
ET09AUG Evapotranspiration of August in Ubon Ratchathani
ET09SEP Evapotranspiration of September in Ubon Ratchathani
ET09OCT Evapotranspiration of October in Ubon Ratchathani
ET09NOV Evapotranspiration of November in Ubon Ratchathani
D82 Dummy Variable, 1 in 1982, 0 otherwise
D93 Dummy Variable, 1 in 1991 to 1993, 0 otherwise
D94 Dummy Variable, 1 in 1994, 0 otherwise

4-5-2-1-1-8. Planted area function of major rice in Kalasin

APM11 = + 56220 (0.98) + 0.24723*APM11(t-1) (2.24) + 21.91551*[FPR(t-1)/CPI(t-1)/100] (3.97) [0.678] - 1706.0635*ET11JUN(t-1) (-3.45) [-0.832] - 1313.66003*ET11SEP(t-1) (2.54) [0.625] + 810.50056*ET11OCT(t-1) (2.28) [0.448] - 2465.92084*ET11DEC(t-1) (-3.74) [-0.465] - 95808*D82 (-8.65) + 35211*D87 (2.92)

AdjR²=0.8391 D.W.=1.609

APM08 Planted Area of Major Rice in Yasothon
FPR Farm Price of Thai Rice (baht per KG)
CPI Consumer Price Index (1998=100)
ET08APR Evapotranspiration of April in Yasothon
ET08MAY Evapotranspiration of May in Yasothon
ET08JLY Evapotranspiration of July in Yasothon
ET08AUG Evapotranspiration of August in Yasothon
ET08SEP Evapotranspiration of September in Yasothon
D82 Dummy Variable, 1 in 1982, 0 otherwise
D94 Dummy Variable, 1 in 1994, 0 otherwise
D99 Dummy Variable, 1 in 1999, 0 otherwise

4-5-2-1-1-6. Planted area function of major rice in Yasothon

APM08 = + 200244 (6.45) + 0.16365*APM08(t-1) (1.56) + 6.05595*[FPR(t-1)/CPI(t-1)/100] (2.98) [0.203] + 243.19072*ET08APR(t-1) (2.19) [0.061] - 452.47485*ET08MAY(t-1) (-3.24) [-0.223] - 1022.97716*ET08JLY(t-1) (-4.80) [-0.543] - 400.05764*ET08AUG(t-1) (-1.81) [-0.206] + 635.83002*ET08SEP(t-1) (3.12) [0.339] - 71917*D82 (-11.14) + 34551*D94 (5.05) + 18432*D99 (2.47) 

AdjR²=0.9446 D.W.=2.095

APM08 Planted Area of Major Rice in Yasothon
FPR Farm Price of Thai Rice (baht per KG)
CPI Consumer Price Index (1998=100)
ET08APR Evapotranspiration of April in Yasothon
ET08MAY Evapotranspiration of May in Yasothon
ET08JLY Evapotranspiration of July in Yasothon
ET08AUG Evapotranspiration of August in Yasothon
ET08SEP Evapotranspiration of September in Yasothon
D82 Dummy Variable, 1 in 1982, 0 otherwise
D94 Dummy Variable, 1 in 1994, 0 otherwise
D99 Dummy Variable, 1 in 1999, 0 otherwise

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Planted Area of Major Rice in Kalasin
FPR  Farm Price of Thai Rice (baht per KG)
CPI  Consumer Price Index (1998=100)
ET11JUN Evapotranspiration of June in Kalasin
ET11SEP Evapotranspiration of September in Kalasin
ET11OCT Evapotranspiration of October in Kalasin

Planted Area of Major Rice in Khon Kaen
FPR  Farm Price of Thai Rice (baht per KG)
CPI  Consumer Price Index (1998=100)
TREND Time Trend from 1982 to 2000
ET12OCT Evapotranspiration of October in Khon Kaen
D834 Dummy Variable, 1 in 1983 to 1984, 0 otherwise
D89 Dummy Variable, 1 in 1989, 0 otherwise
D00 Dummy Variable, 1 in 2000, 0 otherwise

Planted Area of Major Rice in Maha Sarakham
FPR  Farm Price of Thai Rice (baht per KG)
CPI  Consumer Price Index (1998=100)
ET13APR Evapotranspiration of April in Maha Sarakham
ET13JUN Evapotranspiration of June in Maha Sarakham
ET13JLY Evapotranspiration of July in Maha Sarakham
ET13AUG Evapotranspiration of August in Maha Sarakham
ET13SEP Evapotranspiration of September in Maha Sarakham
D86 Dummy Variable, 1 in 1989, 0 otherwise
D990 Dummy Variable, 1 in 1999 to 2000, 0 otherwise

Planted Area of Major Rice in Roi Et
FPR  Farm Price of Thai Rice (baht per KG)
CPI  Consumer Price Index (1998=100)
ET14APR Evapotranspiration of April in Roi Et
ET14JLY Evapotranspiration of July in Roi Et
ET14AUG Evapotranspiration of August in Roi Et
ET14OCT Evapotranspiration of October in Roi Et
D84 Dummy Variable, 1 in 1984, 0 otherwise
D85 Dummy Variable, 1 in 1985, 0 otherwise
D88 Dummy Variable, 1 in 1988, 0 otherwise

Planted Area of Major Rice in Buri Ram
FPR  Farm Price of Thai Rice (baht per KG)
CPI  Consumer Price Index (1998=100)
ET15APR Evapotranspiration of April in Buri Ram
ET15OCT Evapotranspiration of October in Buri Ram
D84 Dummy Variable, 1 in 1984, 0 otherwise
D85 Dummy Variable, 1 in 1985, 0 otherwise
D88 Dummy Variable, 1 in 1988, 0 otherwise
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(3.97) + 54.86962*FPR(t-1)/CPI(t-1)/100
(6.27) [0.715]
+ 3133.8034*TREND
(3.72)
- 854.62530*ET15APR(t-1)
(-2.92) [-0.094]
+ 6822.75234*ET15MAY(t-1)
(10.20) [1.270]
- 9528.72585*ET15AUG(t-1)
(7.63) [-2.075]
- 7128.03099*ET15SEP(t-1)
(-9.60) [-1.399]
+ 6507.67104*ET15OCT(t-1)
(5.20) [1.481]
+ 2904.03314*ET15NOV(t-1)
(4.40) [0.590]
+ 6919.87444*ET15DEC(t-1)
(6.11) [0.690]
+ 216618*D84
(8.97)
- 78318*D86
(6.87)
+ 50616*D93
(2.93)
AdjR²=0.9299
D.W.=2.336

APM15 Planted Area of Major Rice in Buri Ram
FPR Farm Price of Thai Rice (baht per KG)
CPI Consumer Price Index (1998=100)
TREND Time Trend from 1982 to 2000
ET15APR Evapotranspiration of April in Buri Ram
ET15MAY Evapotranspiration of May in Buri Ram
ET15AUG Evapotranspiration of August in Buri Ram
ET15SEP Evapotranspiration of September in Buri Ram
ET15OCT Evapotranspiration of October in Buri Ram
ET15NOV Evapotranspiration of November in Buri Ram
ET15DEC Evapotranspiration of December in Buri Ram
D84 Dummy Variable, 1 in 1982 to 1983, 0 otherwise
D86 Dummy Variable, 1 in 1986, 0 otherwise
D93 Dummy Variable, 1 in 1993, 0 otherwise
D00 Dummy Variable, 1 in 2000, 0 otherwise

4-5-2-1-1-14. Planted area function of major rice in Si Sa Ket
APM17= - 656675
(-2.71)
+ 0.22264*APM17(t-1)
(1.31)
+ 36.97384*FPR(t-1)/CPI(t-1)/100
(4.28) [0.481]
+ 4041.36742*TREND
(2.98)
- 472.37718*ET17MAY(t-1)
(-1.54) [-0.110]
+ 3749.95561*ET17OCT(t-1)
(3.97) [0.690]
+ 5086.39557*ET17NOV(t-1)
(-3.44) [-1.253]
+ 3902.32737*ET17DEC(t-1)
(3.25) [0.421]
+ 59252*D85
(2.94)
+ 171277*D92

(3.42) [0.619]
- 3201.25189*ET16OCT(t-1)
(-3.58) [-0.364]
- 3482.64124*ET16NOV(t-1)
(-2.28) [-0.508]
- 5804.47477*ET16DEC(t-1)
(-5.05) [-0.528]
+ 118036*D823
(8.51)
+ 118036*D93
(4.06)
+ 123196*D00
(6.78)

AdjR²=0.9623
D.W.=2.366

APM16 Planted Area of Major Rice in Surin
FPR Farm Price of Thai Rice (baht per KG)
CPI Consumer Price Index (1998=100)
ET16APR Evapotranspiration of April in Surin
ET16MAY Evapotranspiration of May in Surin
ET16JUN Evapotranspiration of June in Surin
ET16JLY Evapotranspiration of July in Surin
ET16AUG Evapotranspiration of August in Surin
ET16OCT Evapotranspiration of October in Surin
ET16NOV Evapotranspiration of November in Surin
ET16DEC Evapotranspiration of December in Surin
D823 Dummy Variable, 1 in 1982 to 1983, 0 otherwise
D93 Dummy Variable, 1 in 1993, 0 otherwise
D00 Dummy Variable, 1 in 2000, 0 otherwise
(6.21)  
- 85476*D980

(-5.85)  
AdjR²=0.8454  D.W.=2.385

APM17  
Planted Area of Major Rice in Si Sa Ket
FPR  
Farm Price of Thai Rice (baht per KG)
CPI  
Consumer Price Index (1998=100)
TREND  
Time Trend from 1982 to 2000
ET17JLY  
Evapotranspiration of July in Si Sa Ket
ET17JUN  
Evapotranspiration of June in Si Sa Ket
ET17AUG  
Evapotranspiration of August in Si Sa Ket
ET17JUL  
Evapotranspiration of July in Si Sa Ket
ET17SEP  
Evapotranspiration of September in Si Sa Ket
ET17OCT  
Evapotranspiration of October in Si Sa Ket
ET17NOV  
Evapotranspiration of November in Si Sa Ket
ET17DEC  
Evapotranspiration of December in Si Sa Ket
D83  
Dummy Variable, 1 in 1983, 0 otherwise
D92  
Dummy Variable, 1 in 1992, 0 otherwise
D980  
Dummy Variable, 1 in 1998 to 2000, 0 otherwise

4-5-2-1-1. Planted area function of major rice in Chaiyaphum
APM18  
- 93877  
(-9.4)
+ 0.39721*APM18(t-1)  
(4.49)
+ 26.42655*[FPR(t-1)/CPI(t-1)/100]  
(3.68)  
[0.744]
- 5940.53421*T9299  
(-2.23)
- 900.92307*ET18APR(t-1)  
(-2.87)  
[-0.205]
+ 891.39063*ET18MY(t-1)  
(3.07)  
[0.373]
- 803.50716*ET18AUG(t-1)  
(-1.63)  
[-0.359]
+ 1293.83482*ET18OCT(t-1)  
(2.34)  
[0.624]
+ 51111*D83  
(3.88)
- 54500*D845  
(-5.77)
- 39337**D90  
(-2.35)
AdjR²=0.8516  D.W.=1.385

APM18  
Planted Area of Major Rice in Chaiyaphum
FPR  
Farm Price of Thai Rice (baht per KG)
CPI  
Consumer Price Index (1998=100)
T9299  
Time Trend from 1992 to 1999, 0 before 1992, 0 after 1999
ET18APR  
Evapotranspiration of April in Chaiyaphum
ET18APR  
Evapotranspiration of May in Chaiyaphum
ET18AUG  
Evapotranspiration of August in Chaiyaphum
ET18OCT  
Evapotranspiration of October in Chaiyaphum
D83  
Dummy Variable, 1 in 1983, 0 otherwise
D845  
Dummy Variable, 1 in 1984 to 1985, 0 otherwise

D90  
Dummy Variable, 1 in 1990, 0 otherwise

4-5-2-1-1-16. Planted area function of major rice in Nakhon Ratchasima
APM19  
- 894888  
(-3.46)
+ 0.70340*APM19(t-1)  
(7.81)
+ 32.87640*[FPR(t-1)/CPI(t-1)/100]  
(3.53)  
[0.396]
- 999.44193*ET19MY(t-1)  
(-2.12)  
[-0.180]
+ 4430.01488*ET19OCT(t-1)  
(3.74)  
[0.806]
+ 2052.08192*ET19NOV(t-1)  
(2.25)  
[0.414]
+ 4289.62393*ET19OCT(t-1)  
(3.05)  
[0.821]
+ 95151*D88  
(3.77)
- 19257*D90  
(-3.97)
+ 96474*D93  
(3.47)
AdjR²=0.8760  D.W.=1.903

APM19  
Planted Area of Major Rice in Nakhon Ratchasima
FPR  
Farm Price of Thai Rice (baht per KG)
CPI  
Consumer Price Index (1998=100)
ET19APR  
Evapotranspiration of April in Nakhon Ratchasima
ET19OCT  
Evapotranspiration of October in Nakhon Ratchasima
ET19NOV  
Evapotranspiration of November in Nakhon Ratchasima
D88  
Dummy Variable, 1 in 1988, 0 otherwise
D90  
Dummy Variable, 1 in 1990, 0 otherwise
D93  
Dummy Variable, 1 in 1993, 0 otherwise

4-5-2-1-2. Planted area function of major rice in North region
APM_N  
+ 344651  
(0.87)
+ 0.72682*LAG(APM_N)  
(4.83)
+ 29.84673*[FPR/(CPI/100)](t-1)  
(1.60)  
[0.083]
- 1979.04416*ET19APR(t-1)  
(-2.65)  
[-0.043]
- 6466.43149*ET19NOV(t-1)  
(-3.71)  
[-0.247]
+ 8486.67984*ET19OCT(t-1)  
(2.70)  
[0.314]
+ 319584*D88  
(6.14)
- 195605*D89  
(-2.76)
- 122122*D92  
(-2.67)
4.5.2-1.3. Planted area function of major rice in South region

\[
APM_S = -70160 \cdot 0.49 + 0.89397 \cdot APM_S(t-1) + 11.96174 \cdot \frac{TPR}{CPI} + 875.51807 \cdot ETSJUL(t-1) + 1888.96266 \cdot ETSOCT(t-1) - 1885.89685 \cdot ETCMAY(t-1) - 1886.73497 \cdot ETCNOV(t-1) - 85669 \cdot D834
\]

\[
D.W. = 2.489
\]

4.5.2-2. Planted area function of second rice in North East region

\[
APM_S = +1281911 \cdot (4.15) - 50080 \cdot D892 + 0.52558 \cdot APM_S(t-1)
\]

\[
\text{Adj}R^2 = 0.8956 \quad D.W. = 2.247
\]
FPR  Farm Price of Thai Rice (baht per KG)
CPI  Consumer Price Index (1998=100)
ETO1APR  Evapotranspiration of April in Nakhon Phanom
ETO1MAY  Evapotranspiration of May in Nakhon Phanom
ETO1JUN  Evapotranspiration of June in Nakhon Phanom
ETO1NOV  Evapotranspiration of November in Nakhon Phanom
ETO1DEC  Evapotranspiration of December in Nakhon Phanom
D989  Dummy Variable, 1 in 1998 to 1999, 0 otherwise

4-5-2-2-1-2. Planted are function of second rice in Sakon Nakhon

\[
\begin{align*}
\text{APS02} = & -7991.74998 + 0.47788 \times \text{APS02}(t-1) + 0.49060 \times \frac{\text{FPR}(t-1)}{\text{CPI}(t-1)/100} + 51.00659 \times \text{ETO2FEB}(t-1) + 12.73450 \times \text{ETO2MAR}(t-1) - 19.01202 \times \text{ETO2MAY}(t-1) + 76.76855 \times \text{ETO2JUN}(t-1) + 4-5-2-2-1-3. Planted area function of second rice in Nong Khai

\[
\text{APS03} = -1987.90745 + 0.40458 \times \text{APS03}(t-1) + 0.36758 \times \frac{\text{FPR}(t-1)}{\text{CPI}(t-1)/100} - 74.48689 \times \text{ETO3NOV}(t-2) + 66.07381 \times \text{ETO3DEC}(t-2) + 4-5-2-2-1-4. Planted area function of second rice in Udon Thani

\[
\text{APS04} = -8197.84994 + 0.02368 \times \text{APS04}(t-1) + 0.22650 \times \frac{\text{FPR}(t-1)}{\text{CPI}(t-1)/100} + 196.94825 \times \text{ETO4NOV}(t-2) - 283.71352 \times \text{ETO4DEC}(t-2) + 4-5-2-2-1-5. Planted area function of second rice in Loei

\[
\text{APS06} = -1298.89276 + 0.40449 \times \text{APS06}(t-1) + 0.36758 \times \frac{\text{FPR}(t-1)}{\text{CPI}(t-1)/100} - 74.48689 \times \text{ETO3NOV}(t-2) + 66.07381 \times \text{ETO3DEC}(t-2) - 235.4613 \times \text{ETO6DEC}(t-2)
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### 4.5.2.2.1-6. Planted area function of second rice in Yasothon

\[
\begin{align*}
\text{APS08} & = -3094.03126 + 0.53993 \times \text{APS08}(t-1) + 0.30103 \times \left[\frac{\text{FPR}(t-1)}{\text{CPI}(t-1)}\right] + 310.56930 \times \text{ET08NOV}(t-2) - 88.84498 \times \text{ET08DEC}(t-2) - 134.94665 \times \text{ET08MAR}(t-1) + 125.76263 \times \text{ET08APR}(t-1) - 3062.02409 \times \text{D83} + 156.76263 \times \text{D89} \\
\text{D.W.} & = 2.376
\end{align*}
\]

### 4.5.2.2.1-8. Planted area function of second rice in Kalasin

\[
\begin{align*}
\text{APS11} & = +24807 + 0.852677 \times \text{APS11}(t-1) + 0.51460 \times \left[\frac{\text{FPR}(t-1)}{\text{CPI}(t-1)}\right] + 3189.24007 \times \text{ET11DEC}(t-2) - 1640.72617 \times \text{ET11JAN}(t-1) + 31.31688 \times \text{ET11MAR}(t-1) - 31.12215 \times \text{ET11APR}(t-1) - 161.89174 \times \text{ET11MAY}(t-1) \\
\text{D.W.} & = 1.504
\end{align*}
\]
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(-6.43) [-1.410]
- 126.64852*ET11JUN(t-1)
(-3.74) [-1.199]
+ 4640.36286*D86
(3.21)
- 19145*ET11JUN(t-1)
(-11.82)
- 23325*ET11JUN(t-1)
(-14.24)
AdjR²=0.9906 D.W.=2.527

APS11 Planted Area of Second Rice in Kalasin
FPR Farm Price of Thai Rice (baht per KG)
CPI Consumer Price Index (1998=100)
LT87 Logarithm of time trend from 1987, 0 otherwise
ET11JAN Evapotranspiration of January in Kalasin
ET11MAR Evapotranspiration of March in Kalasin
ET11APR Evapotranspiration of April in Kalasin
ET11MAY Evapotranspiration of May in Kalasin
ET11JUN Evapotranspiration of June in Kalasin
ET11DEC Evapotranspiration of December in Kalasin
D86 Dummy Variable, 1 in 1986, 0 otherwise
D94 Dummy Variable, 1 in 1994, 0 otherwise
D99 Dummy Variable, 1 in 1999, 0 otherwise

4-5-2-2-1-10. Planted area function of second rice in Maha Sarakham

APS13 = -37565
(-3.83)
+ 0.91330*APS13(t-1)
(10.15)
+ 0.03654*[FPR(t-1)/CPI(t-1)/100]
(0.77) [0.669]
+ 294.81708*ET13NOV(t-2)
(2.78) [3.077]
+ 382.10238*ET13JAN(t-1)
(2.04) [0.667]
- 298.89046*ET13FEB(t-1)
(-3.32) [-0.614]
+ 193.01579*ET13MAR(t-1)
(3.11) [0.666]
- 138.52959*ET13APR(t-1)
(-3.39) [-0.828]
+ 164.15449*ET13MAY(t-1)
(3.34) [1.590]
+ 3654.77905*D99
(1.36)
-12115*D94
(-4.25)
AdjR²=0.9299 D.W.=2.006

APS13 Planted Area of Second Rice in Maha Sarakham
FPR Farm Price of Thai Rice (baht per KG)
CPI Consumer Price Index (1998=100)
ET13JAN Evapotranspiration of January in Maha Sarakham
ET13FEB Evapotranspiration of February in Maha Sarakham
ET13MAR Evapotranspiration of March in Maha Sarakham
ET13APR Evapotranspiration of April in Maha Sarakham
ET13MAY Evapotranspiration of May in Maha Sarakham
ET13NOV Evapotranspiration of November in Maha Sarakham
D89 Dummy Variable, 1 in 1989, 0 otherwise
D94 Dummy Variable, 1 in 1994, 0 otherwise

4-5-2-2-1-11. Planted area function of second rice in Roi Et

APS14 = -30287
(-3.57)
+ 0.36316*APS14(t-1)
(3.36)
+ 0.19654*[FPR(t-1)/CPI(t-1)/100]
(0.40) [0.225]
+ 468.41894*ET14NOV(t-2)
(3.37) [7.661]
- 818.83755*ET14DEC(t-2)
(-2.85) [-5.635]
+ 663.14523*ET14JAN(t-1)
(1.85) [1.824]
+ 144.23248*ET14FEB(t-1)
(2.07) [0.473]
+ 322.33002*ET14MAR(t-1)
(2.93) [2.286]
+ 2923.10947*D89
(2.27)
+ 10046*D92
(2.27)

APS14 Planted Area of Second Rice in Roi Et
FPR Farm Price of Thai Rice (baht per kg)
CPI Consumer Price Index (1998=100)
ET12JAN Evapotranspiration of January in Roi Et
ET12MAR Evapotranspiration of March in Roi Et
ET12APR Evapotranspiration of April in Roi Et
ET12NOV Evapotranspiration of November in Roi Et
D85 Dummy Variable, 1 in 1985, 0 otherwise
D87 Dummy Variable, 1 in 1987, 0 otherwise
D89 Dummy Variable, 1 in 1989, 0 otherwise
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\[ (6.97) \]
\[ -3821.74466 \times D94 \]
\[ (-2.67) \]

\[ \text{AdjR}^2 = 0.9309 \quad \text{D.W.} = 1.983 \]

APS14 \: \text{Planted Area of Second Rice in Roi Et}
FPR \: \text{Farm Price of Thai Rice (baht per KG)}
CPI \: \text{Consumer Price Index (1998=100)}
ET14JAN \: \text{Evapotranspiration of January in Roi Et}
ET14FEB \: \text{Evapotranspiration of February in Roi Et}
ET14JUN \: \text{Evapotranspiration of June in Roi Et}
ET14NOV \: \text{Evapotranspiration of November in Roi Et}
D89 \: \text{Dummy Variable, 1 in 1989, 0 otherwise}
D92 \: \text{Dummy Variable, 1 in 1992, 0 otherwise}
D94 \: \text{Dummy Variable, 1 in 1994, 0 otherwise}

4-5-2-2-1-12. Planted area function of second rice in Buri Ram
\[
\text{APS15} = -3238.14066 \\
(4.23) + 0.52715 \times \text{APS15(t-1)} \\
(8.18) + 0.13450 \times \frac{\text{FPR(t-1)} \times \text{CPI(t-1)}}{100} \\
(2.18) + 26.50944 \times \text{ET15NOV(t-2)} \\
(3.57) - 9.74792 \times \text{ET15FEB(t-1)} \\
(1.53) + 9.10498 \times \text{ET15MAR(t-1)} \\
(1.74) + 1024.55174 \times D889 \\
(8.48) + 989.19506 \times D92 \\
(5.96)
\]

\[ \text{AdjR}^2 = 0.8414 \quad \text{D.W.} = 2.258 \]

APS15 \: \text{Planted Area of Second Rice in Buri Ram}
FPR \: \text{Farm Price of Thai Rice (baht per KG)}
CPI \: \text{Consumer Price Index (1998=100)}
ET15FEB \: \text{Evapotranspiration of February in Buri Ram}
ET15MAR \: \text{Evapotranspiration of March in Buri Ram}
ET15NOV \: \text{Evapotranspiration of November in Buri Ram}
D889 \: \text{Dummy Variable, 1 in 1988 to 1989, 0 otherwise}
D92 \: \text{Dummy Variable, 1 in 1992, 0 otherwise}

4-5-2-2-1-13. Planted area function of second rice in Surin
\[
\text{APS16} = -6780.41533 \\
(-5.81) + 0.63350 \times \text{APS16(t-1)} \\
(9.98) + 0.07752 \times \frac{\text{FPR(t-1)} \times \text{CPI(t-1)}}{100} \\
(1.23) + 145.56050 \times \text{ET8289} \\
(7.36) + 133.81691 \times \text{LT95} \\
(3.42) + 40.50127 \times \text{ET16NOV(t-2)} \\
(3.48)
\]

\[ + 36.22501 \times \text{ET16IAN(t-1)} \\
(3.18) + 6.78789 \times \text{ET16APR(t-1)} \\
(2.07) + 23.46808 \times \text{ET16JUN(t-1)} \\
(5.32) + 243.75092 \times D89 \\
(-1.05) + 1096.64935 \times D92 \\
(8.41)
\]

\[ \text{AdjR}^2 = 0.9199 \quad \text{D.W.} = 1.823 \]

APS16 \: \text{Planted Area of Second Rice in Surin}
FPR \: \text{Farm Price of Thai Rice (baht per KG)}
CPI \: \text{Consumer Price Index (1998=100)}
ET16IAN \: \text{Evapotranspiration of January in Surin}
ET16APR \: \text{Evapotranspiration of April in Surin}
ET16JUN \: \text{Evapotranspiration of June in Surin}
ET16NOV \: \text{Evapotranspiration of November in Surin}
D89 \: \text{Dummy Variable, 1 in 1989, 0 otherwise}
D92 \: \text{Dummy Variable, 1 in 1992 to 1993, 0 otherwise}

4-5-2-2-1-14. Planted area function of second rice in Si Sa Ket
\[
\text{APS17} = -5854.12296 \\
(-3.77) + 0.26837 \times \text{APS17(t-1)} \\
(3.12) + 0.59373 \times \frac{\text{FPR(t-1)} \times \text{CPI(t-1)}}{100} \\
(3.94) - 43.96068 \times \text{ET17JAN(t-1)} \\
(-1.71) - 20.39977 \times \text{ET17MAY(t-1)} \\
(-2.46) + 66.11579 \times \text{ET17JUN(t-1)} \\
(4.37) + 3220.64128 \times D846 \\
(10.76) + 2240.93639 \times D88 \\
(4.72) + 2035.05369 \times D92 \\
(4.77)
\]

\[ \text{AdjR}^2 = 0.9199 \quad \text{D.W.} = 1.823 \]

APS17 \: \text{Planted Area of Second Rice in Si Sa Ket}
FPR \: \text{Farm Price of Thai Rice (baht per KG)}
CPI \: \text{Consumer Price Index (1998=100)}
ET17IAN \: \text{Evapotranspiration of January in Si Sa Ket}
ET17MAY \: \text{Evapotranspiration of May in Si Sa Ket}
ET17JUN \: \text{Evapotranspiration of June in Si Sa Ket}
D846 \: \text{Dummy Variable, 1 in 1984 to 1986, 0 otherwise}
D88 \: \text{Dummy Variable, 1 in 1988, 0 otherwise}
D92 \: \text{Dummy Variable, 1 in 1992, 0 otherwise}

4-5-2-2-1-15. Planted area function of second rice in Chaiyaphum
\[
\text{APS18} = -4934.88547 \\
(3.48)
\]

APS18 \: \text{Planted Area of Second Rice in Chaiyaphum}
\[-3.10\] + \(0.33270 \times \text{APS18}(t-1)\) (2.69) \\
+ \(0.16210 \times \frac{\text{FPR}(t-1)}{\text{CPI}(t-1)}\) (0.91) \[0.720\] \\
+ \(21.48022 \times \text{ET18NOV}(t-2)\) (1.43) [1.448] \\
- \(88.04848 \times \text{ET18JAN}(t-1)\) (-3.22) \[-1.107\] \\
+ \(49.12046 \times \text{ET18JUN}(t-1)\) (3.16) [3.473] \\
+ \(2747.09344 \times \text{ET18MAR}(t-1)\) (5.79)

\[\text{AdjR}^2=0.8797\] \\
D.W.=1.921

\begin{align*}
\text{APS18} & \quad \text{Planted Area of Second Rice in Chaiyaphum} \\
\text{FPR} & \quad \text{Farm Price of Thai Rice (baht per KG)} \\
\text{CPI} & \quad \text{Consumer Price Index (1998=100)} \\
\text{ET18JAN} & \quad \text{Evapotranspiration of January in Chaiyaphum} \\
\text{ET18MAR} & \quad \text{Evapotranspiration of March in Chaiyaphum} \\
\text{ET18APR} & \quad \text{Evapotranspiration of April in Chaiyaphum} \\
\text{ET18MAY} & \quad \text{Evapotranspiration of May in Chaiyaphum} \\
\text{ET18JUN} & \quad \text{Evapotranspiration of June in Chaiyaphum} \\
\text{ET18NOV} & \quad \text{Evapotranspiration of November in Chaiyaphum} \\
\text{D889} & \quad \text{Dummy Variable, 1 in 1988 to 1989, 0 otherwise} \\
\text{D92} & \quad \text{Dummy Variable, 1 in 1992, 0 otherwise}
\end{align*}

4-5-2-2-1-16. Planted area function of second rice in Nakhon Ratrasima

\begin{align*}
\text{APS19} = -32297 & \quad (-8.74) \\
- 0.61102 \times \text{APS19}(t-1) \quad (8.11) \\
+ 0.35556 \times \frac{\text{FPR}(t-1)}{\text{CPI}(t-1)} \quad (2.43) \quad [0.456] \\
+ 282.85892 \times \text{ET18NBV}(t-2) \quad (9.06) \quad [5.737] \\
+ 80.58050 \times \text{ET19DEC}(t-2) \quad (11.22) \quad [0.868] \\
- 358.38272 \times \text{ET19FEB}(t-1) \quad (-11.82) \quad [-1.432] \\
+ 241.14504 \times \text{ET19MAR}(t-1) \quad (10.40) \quad [1.495] \\
+ 43.31809 \times \text{ET19APR}(t-1) \quad (3.23) \quad [0.500] \\
- 125.50027 \times \text{ET19MAY}(t-1) \quad (-9.02) \quad [-2.398] \\
+ 149.99681 \times \text{ET19JUN}(t-1) \quad (4.49) \quad [2.903] \\
- 8996.55486 \times \text{D90} \quad (-11.22) \\
- 8920.60848 \times \text{D98} \quad (-8.97) \\
+ 5938.94675 \times \text{D00} \quad (8.97)
\end{align*}

\[\text{AdjR}^2=0.9839\] \\
D.W.=1.615

\begin{align*}
\text{APS19} & \quad \text{Planted Area of Second Rice in Nakhon Ratchasima} \\
\text{FPR} & \quad \text{Farm Price of Thai Rice (baht per KG)} \\
\text{CPI} & \quad \text{Consumer Price Index (1998=100)} \\
\text{ET19JAN} & \quad \text{Evapotranspiration of January in Nakhon Ratchasima} \\
\text{ET19MAR} & \quad \text{Evapotranspiration of March in Nakhon Ratchasima} \\
\text{ET19APR} & \quad \text{Evapotranspiration of April in Nakhon Ratchasima} \\
\text{ET19MAY} & \quad \text{Evapotranspiration of May in Nakhon Ratchasima} \\
\text{ET19JUN} & \quad \text{Evapotranspiration of June in Nakhon Ratchasima} \\
\text{ET19NOV} & \quad \text{Evapotranspiration of November in Nakhon Ratchasima} \\
\text{ET19DEC} & \quad \text{Evapotranspiration of December in Nakhon Ratchasima} \\
\text{D90} & \quad \text{Dummy Variable, 1 in 1990, 0 otherwise} \\
\text{D98} & \quad \text{Dummy Variable, 1 in 1998, 0 otherwise} \\
\text{D00} & \quad \text{Dummy Variable, 1 in 2000, 0 otherwise}
\end{align*}

4-5-2-2-2. Planted area function of second rice in North region

\begin{align*}
\text{APS}_N & \quad -190405 \quad (-2.92) \\
\text{FPR} & \quad +13897.4 \times \text{TREND} \quad (7.50) \\
\text{CPI} & \quad +0.53896 \times \text{APS}_N(t-1) \quad (5.25) \\
\text{ET19JAN} & \quad +15.6997 \times \frac{\text{FPR}(t-1)}{\text{CPI}(t-1)} \quad (2.13) \quad [0.257] \\
\text{ET19MAR} & \quad +15656.5 \times \text{ET19JAN}(t-1) \quad (11.48) \quad [1.540] \\
\text{ET19APR} & \quad -15033.5 \times \text{ET19MAR}(t-1) \quad (-7.48) \quad [-1.058] \\
\text{ET19MAY} & \quad +4129.81 \times \text{ET19JAN}(t-1) \quad (6.43) \quad [0.290] \\
\text{ET19JUN} & \quad -2378.73 \times \text{ET19MAR}(t-1) \quad (-5.74) \quad [-0.579] \\
\text{ET19NOV} & \quad +194653 \times \text{D86} \quad (7.05) \\
\text{ET19DEC} & \quad -138917 \times \text{D92} \quad (-8.67) \\
\text{D86} & \quad \text{Dummy Variable, 1 in 1986, 0 otherwise} \\
\text{D92} & \quad \text{Dummy Variable, 1 in 1992, 0 otherwise}
\end{align*}

\[\text{AdjR}^2=0.9839\] \\
D.W.=1.615

\begin{align*}
\text{APS}_N & \quad \text{Harvested Area of Second Rice in North region} \\
\text{TREND} & \quad \text{Time Trend: from 1982 to 2000} \\
\text{FPR} & \quad \text{Farm Price of Thai Rice (baht per KG)} \\
\text{CPI} & \quad \text{Consumer Price Index (1998=100)} \\
\text{ET19JAN} & \quad \text{Evapotranspiration of January in North region} \\
\text{ET19MAR} & \quad \text{Evapotranspiration of March in North region} \\
\text{ET19APR} & \quad \text{Evapotranspiration of April in North region} \\
\text{ET19MAY} & \quad \text{Evapotranspiration of May in North region} \\
\text{ET19JUN} & \quad \text{Evapotranspiration of June in North region} \\
\text{ET19NOV} & \quad \text{Evapotranspiration of November in North region} \\
\text{D86} & \quad \text{Dummy Variable, 1 in 1986, 0 otherwise} \\
\text{D912} & \quad \text{Dummy Variable, 1 in 1991 to 1992, 0 otherwise}
\end{align*}
4-5-2-2-3. Planted area function of second rice in South region

\[ APS_S = +38495.4 \]
\[ + 0.52253 \times APS_S(t-1) \]
\[ + 2.59221 \times \frac{FPR}{(CPI/100)}(t-1) \]
\[ - 354.600 \times ETSJAN(t-1) \]
\[ - 8558.75 \times D82 \]
\[ - 15921.4 \times D902 \]
\[ + 17528.6 \times D99 \]
\[ AdjR^2 = 0.8531 \]
\[ D.W.=2.167 \]

<table>
<thead>
<tr>
<th>APS_S</th>
<th>Harvested Area of Second Rice in South region</th>
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<tbody>
<tr>
<td>FPR</td>
<td>Farm Price of Thai Rice (baht per KG)</td>
</tr>
<tr>
<td>CPI</td>
<td>Consumer Price Index (1998=100)</td>
</tr>
<tr>
<td>ETSJAN</td>
<td>Evapotranspiration of January in South region</td>
</tr>
<tr>
<td>D82</td>
<td>Dummy Variable, 1 in 1982, 0 otherwise</td>
</tr>
<tr>
<td>D902</td>
<td>Dummy Variable, 1 in 1990 to 1992, 0 otherwise</td>
</tr>
<tr>
<td>D99</td>
<td>Dummy Variable, 1 in 1999, 0 otherwise</td>
</tr>
</tbody>
</table>

4-5-2-2-4. Planted area function of second rice in Central region

\[ APS_C = +370279 \]
\[ + 41541.3 \times \ln(T94) \]
\[ + 0.32570 \times APS_C(t-1) \]
\[ + 23.7520 \times \frac{FPR}{(CPI/100)}(t-1) \]
\[ + 8489.08 \times ETCDEC(t-2) \]
\[ - 13446 \times ETCJAN(t-1) \]
\[ + 5303.54 \times ETCFEB(t-1) \]
\[ + 1230.38 \times ETCAPR(t-1) \]
\[ - 5619.69 \times ETCMAY(t-1) \]
\[ + 65595.8 \times D89 \]
\[ - 181487 \times D91 \]
\[ AdjR^2 = 0.8844 \]
\[ D.W.=2.331 \]

<table>
<thead>
<tr>
<th>APS_C</th>
<th>Harvested Area of Second Rice in Central region</th>
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<tbody>
<tr>
<td>LT94</td>
<td>Log Time Trend from 1994, 0 before 1994</td>
</tr>
<tr>
<td>FPR</td>
<td>Farm Price of Thai Rice (baht per kg)</td>
</tr>
<tr>
<td>CPI</td>
<td>Consumer Price Index (1998=100)</td>
</tr>
<tr>
<td>ETCJAN</td>
<td>Evapotranspiration of January in Central region</td>
</tr>
</tbody>
</table>

4-5-3. Production

4-5-3-1. Production of major rice

4-5-3-1-1. Production of major rice in North East region

4-5-3-1-1-1. Production identity of major rice in Nakhon Phanom

\[ QM01 = YMHO1 \times (APM01-LM01) \]
\[ YMH01 \times (APM01-LM01) \]
\[ YMHO2 \times (APM02-LM02) \]
\[ YMH02 \times (APM02-LM02) \]
\[ YMHO3 \times (APM03-LM03) \]
\[ YMH03 \times (APM03-LM03) \]
\[ YMHO4 \times (APM04-LM04) \]
\[ YMH04 \times (APM04-LM04) \]
\[ YMHO5 \times (APM05-LM05) \]
\[ YMH05 \times (APM05-LM05) \]
\[ YMHO6 \times (APM06-LM06) \]
\[ YMH06 \times (APM06-LM06) \]
\[ YMHO7 \times (APM07-LM07) \]
\[ YMH07 \times (APM07-LM07) \]
\[ YMHO8 \times (APM08-LM08) \]
\[ YMH08 \times (APM08-LM08) \]

4-5-3-1-1-2. Production identity of major rice in Sakon Nakhon

4-5-3-1-1-3. Production identity of major rice in Nong Khai

4-5-3-1-1-4. Production identity of major rice in Udon Thani

4-5-3-1-1-5. Production identity of major rice in Loei

4-5-3-1-1-6. Production identity of major rice in Yasothon

4-5-3-1-1-7. Production identity of major rice in Ubon Ratchathani
4.5.3-1-1.8. Production identity of major rice in Kalasin
QM11= YMH11*(APM11-LM11)
QM11 Production of major rice in Kalasin (MT)
YMH11 Yield of major rice in Kalasin (MT/HA)
APM11 Planted area of major rice in Kalasin (HA)
LM11 Abandoned area of major rice in Kalasin (HA)

4.5.3-1-1.9. Production identity of major rice in Khon Kaen
QM12= YMH12*(APM12-LM12)
QM12 Production of major rice in Khon Kaen (MT)
YMH12 Yield of major rice in Khon Kaen (MT/HA)
APM12 Planted area of major rice in Khon Kaen (HA)
LM12 Abandoned area of major rice in Khon Kaen (HA)

4.5.3-1-1.10. Production identity of major rice in Maha Sarakham
QM13= YMH13*(APM13-LM13)
QM13 Production of major rice in Maha Sarakham (MT)
YMH13 Yield of major rice in Maha Sarakham (MT/HA)
APM13 Planted area of major rice in Maha Sarakham (HA)
LM13 Abandoned area of major rice in Maha Sarakham (HA)

4.5.3-1-1.11. Production identity of major rice in Roi Et
QM14= YMH14*(APM14-LM14)
QM14 Production of major rice in Roi Et (MT)
YMH14 Yield of major rice in Roi Et (MT/HA)
APM14 Planted area of major rice in Roi Et (HA)
LM14 Abandoned area of major rice in Roi Et (HA)

4.5.3-1-1.12. Production identity of major rice in Buri Ram
QM15= YMH15*(APM15-LM15)
QM15 Production of major rice in Buri Ram (MT)
YMH15 Yield of major rice in Buri Ram (MT/HA)
APM15 Planted area of major rice in Buri Ram (HA)
LM15 Abandoned area of major rice in Buri Ram (HA)

4.5.3-1-1.13. Production identity of major rice in Surin
QM16= YMH16*(APM16-LM16)
QM16 Production of major rice in Surin (MT)
YMH16 Yield of major rice in Surin (MT/HA)
APM16 Planted area of major rice in Surin (HA)
LM16 Abandoned area of major rice in Surin (HA)

4.5.3-1-1.14. Production identity of major rice in Si Sa Ket
QM17= YMH17*(APM17-LM17)
QM17 Production of major rice in Si Sa Ket (MT)
YMH17 Yield of major rice in Si Sa Ket (MT/HA)
APM17 Planted area of major rice in Si Sa Ket (HA)
LM17 Abandoned area of major rice in Si Sa Ket (HA)

4.5.3-1-1.15. Production identity of major rice in Chaiyaphum
QM18= YMH18*(APM18-LM18)
QM18 Production of major rice in Chaiyaphum (MT)
YMH18 Yield of major rice in Chaiyaphum (MT/HA)
APM18 Planted area of major rice in Chaiyaphum (HA)
LM18 Abandoned area of major rice in Chaiyaphum (HA)

4.5.3-1-1.16. Production identity of major rice in Nakhon Ratchasima
QM19= YMH19*(APM19-LM19)
QM19 Production of major rice in Nakhon Ratchasima (MT)
YMH19 Yield of major rice in Nakhon Ratchasima (MT/HA)
APM19 Planted area of major rice in Nakhon Ratchasima (HA)
LM19 Abandoned area of major rice in Nakhon Ratchasima (HA)

4.5.3-1-1.17. Production identity of major rice for whole North East region
QM_NE= QM01 + QM02 + QM03 + QM04 + QM06 + QM08 + QM09 + QM11 + QM12 + QM13 + QM14 + QM15 + QM16 + QM17 + QM18 + QM19
QM_NE Production of major rice in North East region (MT)
QM01 Production of major rice in Chaiyaphum (MT)
QM02 Production of major rice in Nakhon Ratchasima (MT)
QM03 Production of major rice in Phanom (MT)
QM04 Production of major rice in Surin (MT)
QM05 Production of major rice in Udon Thani (MT)
QM06 Production of major rice in Loei (MT)
QM08 Production of major rice in Roi Et (MT)
QM09 Production of major rice in Khon Kaen (MT)
QM11 Production of major rice in Maha Sarakham (MT)
QM12 Production of major rice in Roi Et (MT)
QM13 Production of major rice in Buri Ram (MT)
QM14 Production of major rice in Surin (MT)
QM15 Production of major rice in Si Sa Ket (MT)
QM16 Production of major rice in Nakhon Ratchasima (MT)
QM17 Production of major rice in Chaiyaphum (MT)
QM18 Production of major rice in Nakhon Ratchasima (MT)

4.5.3-1-2. Production of major rice in North region
QM_N= YMH_N*(APM_N - LM_N)
QM_N Production of major rice in North region (MT)
YMH_N Yield of major rice in North region (MT/HA)
APM_N Planted area of major rice in North region (HA)
LM_N Abandoned area of major rice in North region (HA)

4.5.3-1-3. Production of major rice in South region
QM_S= YMH_S*(APM_S - LM_S)
QM_S Production of major rice in South region (MT)
YMH_S Yield of major rice in South region (MT/HA)
APM_S Planted area of major rice in South region (HA)
LM_S Abandoned area of major rice in South region (HA)
4-5-3-1-4. Production of major rice in Central region

- **QM_C** = YMH_C *(APM_C - LM_C)
- **QM_C** = Production of major rice in Central region (MT)
- **YMH_C** = Yield of major rice in Central region (MT/HA)
- **APM_C** = Planted area of major rice in Central region (HA)
- **LM_C** = Abandoned area of major rice in Central region (HA)

4-5-3-1-5. Production of major rice for whole country

- **QM** = QM_N + QM_C + QM_S
- **QM_N** = Production of major rice in North region (MT)
- **QM_C** = Production of major rice in Central region (MT)
- **QM_S** = Production of major rice in South region (MT)

4-5-3-2. Production of second rice

4-5-3-2-1. Production identity of second rice in Nakhon Phanom

- **QS01** = YSH01 *(APS01-LS01)
- **QS01** = Production of second rice in Nakhon Phanom (MT)
- **YSH01** = Yield of second rice in Nakhon Phanom (MT/HA)
- **APS01** = Planted area of second rice in Nakhon Phanom (HA)
- **LS01** = Abandoned area of second rice in Nakhon Phanom (HA)

4-5-3-2-1-2. Production identity of second rice in Sakon Nakhon

- **QS02** = YSH02 *(APS02-LS02)
- **QS02** = Production of second rice in Sakon Nakhon (MT)
- **YSH02** = Yield of second rice in Sakon Nakhon (MT/HA)
- **APS02** = Planted area of second rice in Sakon Nakhon (HA)
- **LS02** = Abandoned area of second rice in Sakon Nakhon (HA)

4-5-3-2-1-3. Production identity of second rice in Nong Khai

- **QS03** = YSH03 *(APS03-LS03)
- **QS03** = Production of second rice in Nong Khai (MT)
- **YSH03** = Yield of second rice in Nong Khai (MT/HA)
- **APS03** = Planted area of second rice in Nong Khai (HA)
- **LS03** = Abandoned area of second rice in Nong Khai (HA)

4-5-3-2-1-4. Production identity of second rice in Udon Thani

- **QS04** = YSH04 *(APS04-LS04)
- **QS04** = Production of second rice in Udon Thani (MT)
- **YSH04** = Yield of second rice in Udon Thani (MT/HA)
- **APS04** = Planted area of second rice in Udon Thani (HA)
- **LS04** = Abandoned area of second rice in Udon Thani (HA)

4-5-3-2-1-5. Production identity of second rice in Loei

- **QS06** = YSH06 *(APS06-LS06)
- **QS06** = Production of second rice in Loei (MT)
- **YSH06** = Yield of second rice in Loei (MT/HA)

4-5-3-2-1-6. Production identity of second rice in Yasothon

- **QS08** = YSH08 *(APS08-LS08)
- **QS08** = Production of second rice in Yasothon (MT)
- **YSH08** = Yield of second rice in Yasothon (MT/HA)
- **APS08** = Planted area of second rice in Yasothon (HA)
- **LS08** = Abandoned area of second rice in Yasothon (HA)

4-5-3-2-1-7. Production identity of second rice in Ubon Ratchathani

- **QS09** = YSH09 *(APS09-LS09)
- **QS09** = Production of second rice in Ubon Ratchathani (MT)
- **YSH09** = Yield of second rice in Ubon Ratchathani (MT/HA)
- **APS09** = Planted area of second rice in Ubon Ratchathani (HA)
- **LS09** = Abandoned area of second rice in Ubon Ratchathani (HA)

4-5-3-2-1-8. Production identity of second rice in Kalasin

- **QS11** = YSH11 *(APS11-LS11)
- **QS11** = Production of second rice in Kalasin (MT)
- **YSH11** = Yield of second rice in Kalasin (MT/HA)
- **APS11** = Planted area of second rice in Kalasin (HA)
- **LS11** = Abandoned area of second rice in Kalasin (HA)

4-5-3-2-1-9. Production identity of second rice in Khon Kaen

- **QS12** = YSH12 *(APS12-LS12)
- **QS12** = Production of second rice in Khon Kaen (MT)
- **YSH12** = Yield of second rice in Khon Kaen (MT/HA)
- **APS12** = Planted area of second rice in Khon Kaen (HA)
- **LS12** = Abandoned area of second rice in Khon Kaen (HA)

4-5-3-2-1-10. Production identity of second rice in Maha Sarakham

- **QS13** = YSH13 *(APS13-LS13)
- **QS13** = Production of second rice in Maha Sarakham (MT)
- **YSH13** = Yield of second rice in Maha Sarakham (MT/HA)
- **APS13** = Planted area of second rice in Maha Sarakham (HA)
- **LS13** = Abandoned area of second rice in Maha Sarakham (HA)

4-5-3-2-1-11. Production identity of second rice in Roi Et

- **QS14** = YSH14 *(APS14-LS14)
- **QS14** = Production of second rice in Roi Et (MT)
- **YSH14** = Yield of second rice in Roi Et (MT/HA)
- **APS14** = Planted area of second rice in Roi Et (HA)
- **LS14** = Abandoned area of second rice in Roi Et (HA)

4-5-3-2-1-12. Production identity of second rice in Buri Ram

- **QS15** = YSH15 *(APS15-LS15)
- **QS15** = Production of second rice in Buri Ram (MT)
- **YSH15** = Yield of second rice in Buri Ram (MT/HA)
- **APS15** = Planted area of second rice in Buri Ram (HA)
- **LS15** = Abandoned area of second rice in Buri Ram (HA)
4-5-3-2-1-13. Production identity of second rice in Surin

\[ QS_{19} = YSH_{16} \times APS_{16} \times LS_{16} \]

\[ QS_{19} = YSH_{16} \times APS_{16} \times LS_{16} \]

\[ QS_{19} = YSH_{16} \times APS_{16} \times LS_{16} \]

\[ QS_{19} = YSH_{16} \times APS_{16} \times LS_{16} \]

\[ QS_{19} = YSH_{16} \times APS_{16} \times LS_{16} \]

4-5-3-2-1-14. Production identity of second rice in Si Sa Ket

\[ QS_{17} = YSH_{17} \times APS_{17} \times LS_{17} \]

\[ QS_{17} = YSH_{17} \times APS_{17} \times LS_{17} \]

\[ QS_{17} = YSH_{17} \times APS_{17} \times LS_{17} \]

\[ QS_{17} = YSH_{17} \times APS_{17} \times LS_{17} \]

\[ QS_{17} = YSH_{17} \times APS_{17} \times LS_{17} \]

4-5-3-2-1-15. Production identity of second rice in Chaiyaphum

\[ QS_{18} = YSH_{18} \times APS_{18} \times LS_{18} \]

\[ QS_{18} = YSH_{18} \times APS_{18} \times LS_{18} \]

\[ QS_{18} = YSH_{18} \times APS_{18} \times LS_{18} \]

\[ QS_{18} = YSH_{18} \times APS_{18} \times LS_{18} \]

\[ QS_{18} = YSH_{18} \times APS_{18} \times LS_{18} \]

4-5-3-2-1-16. Production identity of second rice in Nakhon Ratchasima

\[ QS_{19} = YSH_{19} \times APS_{19} \times LS_{19} \]

\[ QS_{19} = YSH_{19} \times APS_{19} \times LS_{19} \]

\[ QS_{19} = YSH_{19} \times APS_{19} \times LS_{19} \]

\[ QS_{19} = YSH_{19} \times APS_{19} \times LS_{19} \]

\[ QS_{19} = YSH_{19} \times APS_{19} \times LS_{19} \]

4-5-3-2-1-17. Production identity of second rice for whole North East region

\[ QS_{NE} = QS_{01} + QS_{02} + QS_{03} + QS_{04} + QS_{05} + QS_{06} + QS_{07} + QS_{08} + QS_{09} + QS_{10} + QS_{11} + QS_{12} + QS_{13} + QS_{14} + QS_{15} + QS_{16} + QS_{17} + QS_{18} + QS_{19} \]

\[ QS_{NE} = QS_{01} + QS_{02} + QS_{03} + QS_{04} + QS_{05} + QS_{06} + QS_{07} + QS_{08} + QS_{09} + QS_{10} + QS_{11} + QS_{12} + QS_{13} + QS_{14} + QS_{15} + QS_{16} + QS_{17} + QS_{18} + QS_{19} \]

\[ QS_{NE} = QS_{01} + QS_{02} + QS_{03} + QS_{04} + QS_{05} + QS_{06} + QS_{07} + QS_{08} + QS_{09} + QS_{10} + QS_{11} + QS_{12} + QS_{13} + QS_{14} + QS_{15} + QS_{16} + QS_{17} + QS_{18} + QS_{19} \]

\[ QS_{NE} = QS_{01} + QS_{02} + QS_{03} + QS_{04} + QS_{05} + QS_{06} + QS_{07} + QS_{08} + QS_{09} + QS_{10} + QS_{11} + QS_{12} + QS_{13} + QS_{14} + QS_{15} + QS_{16} + QS_{17} + QS_{18} + QS_{19} \]

\[ QS_{NE} = QS_{01} + QS_{02} + QS_{03} + QS_{04} + QS_{05} + QS_{06} + QS_{07} + QS_{08} + QS_{09} + QS_{10} + QS_{11} + QS_{12} + QS_{13} + QS_{14} + QS_{15} + QS_{16} + QS_{17} + QS_{18} + QS_{19} \]

4-5-3-2-2. Production of second rice in North region

\[ QS_{N} = YSH_{N} \times APS_{N} \times LS_{N} \]

\[ QS_{N} = YSH_{N} \times APS_{N} \times LS_{N} \]

\[ QS_{N} = YSH_{N} \times APS_{N} \times LS_{N} \]

\[ QS_{N} = YSH_{N} \times APS_{N} \times LS_{N} \]

\[ QS_{N} = YSH_{N} \times APS_{N} \times LS_{N} \]

4-5-3-2-3. Production of second rice in South region

\[ QS_{S} = YSH_{S} \times APS_{S} \times LS_{S} \]

\[ QS_{S} = YSH_{S} \times APS_{S} \times LS_{S} \]

\[ QS_{S} = YSH_{S} \times APS_{S} \times LS_{S} \]

\[ QS_{S} = YSH_{S} \times APS_{S} \times LS_{S} \]

\[ QS_{S} = YSH_{S} \times APS_{S} \times LS_{S} \]

4-5-3-2-4. Production of second rice in Central region

\[ QS_{C} = YSH_{C} \times APS_{C} \times LS_{C} \]

\[ QS_{C} = YSH_{C} \times APS_{C} \times LS_{C} \]

\[ QS_{C} = YSH_{C} \times APS_{C} \times LS_{C} \]

\[ QS_{C} = YSH_{C} \times APS_{C} \times LS_{C} \]

\[ QS_{C} = YSH_{C} \times APS_{C} \times LS_{C} \]

4-5-3-2-5. Production of second rice for whole country

\[ QS = QS_{NE} + QS_{N} + QS_{C} + QS_{S} \]

\[ QS = QS_{NE} + QS_{N} + QS_{C} + QS_{S} \]

\[ QS = QS_{NE} + QS_{N} + QS_{C} + QS_{S} \]

\[ QS = QS_{NE} + QS_{N} + QS_{C} + QS_{S} \]

\[ QS = QS_{NE} + QS_{N} + QS_{C} + QS_{S} \]

4-5-3-3. Total production in milled equivalent

\[ Q = QM + QS \]

\[ Q = QM + QS \]

\[ Q = QM + QS \]

\[ Q = QM + QS \]

\[ Q = QM + QS \]

4-5-4. Stock change function

\[ STC = -1084551(-5.66) + 118669 \times T86(6.39) - 301.624 \times [FPR(t-CPI(t-1)\times CPI(t-1)/100)](-2.60)[0.121] + 0.87999\times [Q_{ME}+Q_{ME}(t-1)](7.26)[1.408] + 1209462\times D857(4.10) \]
### 4-5-5. Export function

**Export Function**

\[
\text{EXP} = +1450479 \\
\quad +73960 \times \text{TREND} \\
\quad +0.13051 \times Q \\
\quad +1416706 \times D89 \\
\quad +1013411 \times D95 \\
\quad +889253 \times D989
\]

Adj\(R^2\) = 0.8685  
D.W. = 2.191

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<th>Description</th>
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<tr>
<td>EXP</td>
<td>Exportation of Rice (MT)</td>
</tr>
<tr>
<td>TREND</td>
<td>Time Trend from 1982 to 2000</td>
</tr>
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<td>Q</td>
<td>Total Production in paddy equivalent (MT)</td>
</tr>
<tr>
<td>D89</td>
<td>Dummy Variable, 1 in 1989, 0 otherwise</td>
</tr>
<tr>
<td>D95</td>
<td>Dummy Variable, 1 in 1995, 0 otherwise</td>
</tr>
<tr>
<td>D989</td>
<td>Dummy Variable, 1 in 1998 to 1999, 0 otherwise</td>
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</table>

### 4-5-6. Domestic supply identity in milled equivalent

**Domestic Supply Identity in Milled Equivalent**

\[
\text{QD} = \text{Q, ME} + \text{IMP} - \text{EXP} - \text{STC}
\]

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<td>QD</td>
<td>Domestic supply in milled equivalent (MT)</td>
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<tr>
<td>Q, ME</td>
<td>Total production in milled equivalent (MT)</td>
</tr>
<tr>
<td>IMP</td>
<td>Imports (MT)</td>
</tr>
<tr>
<td>EXP</td>
<td>Exports (MT)</td>
</tr>
<tr>
<td>STC</td>
<td>Stock change (Ending stock - Beginning stock) (MT)</td>
</tr>
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### 4-5-7. Per capita consumption

**Per Capita Consumption**

\[
\text{QC} = \frac{\text{QD}}{\text{POP}}
\]

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<th>Description</th>
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</thead>
<tbody>
<tr>
<td>QC</td>
<td>Per capita consumption (KG)</td>
</tr>
<tr>
<td>QD</td>
<td>Domestic supply in milled equivalent (MT)</td>
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<tr>
<td>POP</td>
<td>Population (thousand people)</td>
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### 4-5-8. Demand function

**Demand Function for Rice for Average of Thai Rice**

\[
\text{QC} = +329.064 \\
\quad -1.77086 \times \text{T8295} \\
\quad -0.00825 \times \frac{\text{RPRB}}{\text{CPI} \times 100} \\
\quad -1.32549 \times \frac{\text{GDP}}{\text{POP}} \\
\quad -10.9487 \times D856 \\
\quad +29.8603 \times D87
\]

Adj\(R^2\) = 0.9253  
D.W. = 2.186

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<tr>
<td>QC</td>
<td>Consumption of Rice per capita (KG)</td>
</tr>
<tr>
<td>T8295</td>
<td>Time Trend from 1982 to 1995, 0 before 1982, 0 after 1995</td>
</tr>
<tr>
<td>RPRB</td>
<td>Retail Price of Rice (Baht/MT)</td>
</tr>
<tr>
<td>CPI</td>
<td>Consumer Price Index (1998=100)</td>
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<tr>
<td>GDP</td>
<td>Realized Gross Domestic Products</td>
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<td>POP</td>
<td>Population</td>
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<td>D856</td>
<td>Dummy Variable, 1 in 1985 to 1986, 0 otherwise</td>
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<td>D87</td>
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<td>D89</td>
<td>Dummy Variable, 1 in 1989, 0 otherwise</td>
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<tr>
<td>D97</td>
<td>Dummy Variable, 1 in 1997, 0 otherwise</td>
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### 4-5-9. Price linkage function

**Price Linkage Function**

\[
\text{FPR} = +308.373 \\
\quad -624.972 \times \text{T9800} \\
\quad +0.42693 \times \text{RPRB} \\
\quad -783.421 \times D93
\]

Adj\(R^2\) = 0.9125  
D.W. = 2.155

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<td>Farm Price of Thai Rice (Baht/MT)</td>
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<td>T9800</td>
<td>Time Trend from 1998 to 2000, 1 before 1998, 3 after 2000</td>
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<tr>
<td>RPRB</td>
<td>Retail Price of Rice (Baht/MT)</td>
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<tr>
<td>D93</td>
<td>Dummy Variable, 1 in 1993, 0 otherwise</td>
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Table 4-1. Elasticities of yield of major rice for evapotranspiration and trend

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Table 4-2. Elasticities of yield of second rice for evapotranspiration and trend

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Chapter 4
Development of the Rice Econometric Model with Endogenous Water in Thailand (REMEW-THAI)

Table 4-3. Elasticities of planted area of major rice for farm price and evapotranspiration

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Table 4-4. Elasticities of planted area of second rice for farm price and evapotranspiration

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4-6. Simulation results

4-6-1. Results of estimation of yield functions

Table 4-1 and Table 4-2 show elasticities of yield for ET in wet and dry seasons. In the case of Nakhon Phanon, the elasticity of yield of major rice for ET in July is 0.668, indicating that if ET in July increases 1%, the yield of major rice in the province will increase 0.668%.

The planting period in major rice or rainy season rice is from May to August and the harvest period is from October to December. The planting period in second rice or dry season rice is from January to February and the harvest period is from May to June.

These results for major rice show that higher ET in July leads higher yield in many provinces of the North East region. The results suggest that the water supply available in the planting season is important for the growth of rice. The results of second rice also show that ET in December and January leads to a higher yield in many provinces. Therefore, the available water supply during transplanting season is quite critical for rice production.

4-6-2. Results of estimation of planted area functions

Planted area functions of major rice and second rice are specified as linear functions based on the adaptive expectation model. The explanatory variables are time trend, one-year lagged planted area, one-year lagged farm price, and one-year lagged ETs for each month. The elasticities evaluated on the average are shown in Table 4-3 and Table 4-4.

The planted area elasticities of major rice cultivation for ET in October are positive for many provinces. It suggests that if farmers expect an abundant water supply in the flowering season of major rice, they will increase their planted area for rainy season cultivation. Meanwhile, planted area elasticities of dry season cultivation for ET in November are very high. It suggests that the water supply just before the planting period is quite critical for second rice cultivation.

4-6-3. Simulation results of supply and demand model

The simulation term is from 2001 to 2015. The assumptions of the simulation are as follows; (1) the forecast growth value of CPI is the average annual growth between 1998 and 2002, (2) the growth value of real GDP is the average annual growth between 1998 and 2002, (3) the exchange rate is same as the number in 2002, (4) the growth value of population is the average annual growth between 1992 and 2002, (5) the linear trends of the yield functions are continued, (6) the trends of planted area functions are flat.

Figure 4-3 through Figure 4-6 show the simulation results for the production of major rice in the North East region, second rice in Central region, and two types of rice for Thailand as a whole.

The production of major rice in North East region is expected to stabilize around 9.6 million metric tons (mMT) after 2010. The production of second rice in the Central region will increase 210,000 metric tons (MT) from 2010 to 2015.

The production of major and second rice for whole Thailand will increase 594,000 MT and 378,000 MT respectively from 2010 to 2015. Productions of major rice in North and Central region will increase; however, production in the South region will decrease due to shrinking planted area. The production of second rice will increase in Central and North East regions and remain stable in the other two regions.
Figure 4-7 shows per capita rice consumption, which decreases from 121.3 kilogram (KG) in 2010 to 112.8 KG in 2015 due to a negative income elasticity, while total consumption expands with population. Figure 4-8 shows the simulation result of the equilibrium retail price. These prices are realized by CPI which is set to 100 in 1998. The farm price is estimated to be stable at around 14.6 Baht per KG.

4-7. Conclusions

A supply and demand model of rice in Thailand was developed for use in analyzing the impacts of changes in water supply in the provinces of the North East region and three other aggregate regions.

The supply and demand model can analyze changes in yield and planted area independently and consider supply responses and demand changes to the market price while bringing the market into equilibrium. The baseline analysis indicates that production of major rice steadily increases; however, productions in the rainy season in some regions is likely to decrease due to shrinking of planted area. The trends of production of second rice also vary widely for provinces in North East region, and the price elasticity of planted area determines the tendency of the production.

Nationwide per-capita income growth leads to a diversified diet, and rice consumption per capita will decrease as a result. This tendency is consistent with other countries in Indochina region. Stabilization of production is more important than an increase in production, while expansion of the export is also critical issue.