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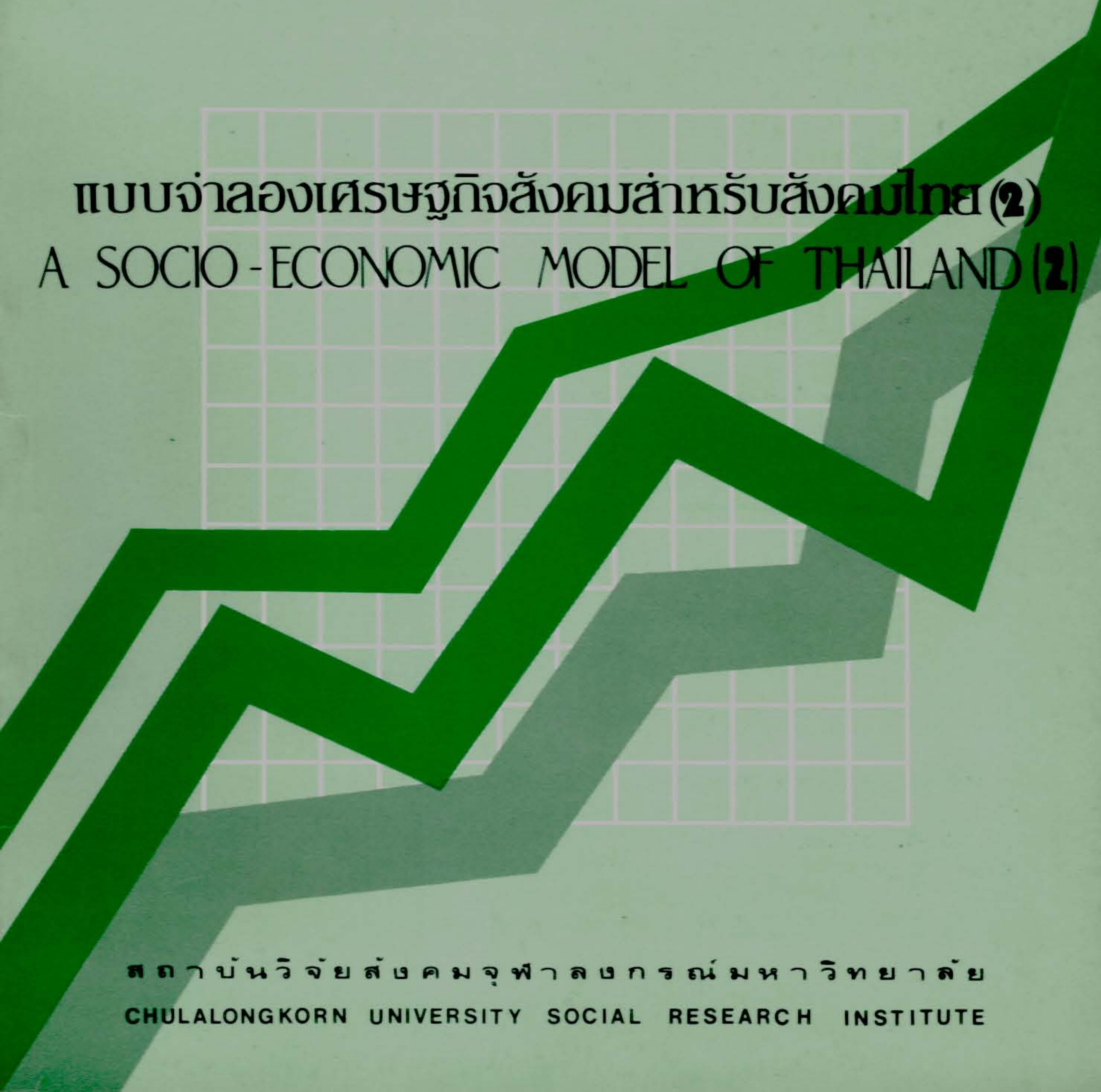
แบบจำลองเศรษฐกิจสังคมสำหรับสังคมไทย (2)
A SOCIO-ECONOMIC MODEL OF THAILAND (2)



สถาบันวิจัยสังคม จุฬาลงกรณ์มหาวิทยาลัย

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บทบรรณาธิการ

วารสารวิจัยสังคมฉบับนี้เป็นฉบับที่ต่อเนื่องจากฉบับที่แล้วกล่าวคือ เป็นการนำเสนอการวิเคราะห์เชิงปริมาณจากแบบจำลองทางเศรษฐมิติและสังคม ซึ่งเป็นผลงานของกลุ่มนักวิจัยในหน่วยพยากรณ์ทางเศรษฐกิจสังคมของสถาบันวิจัยสังคม จุฬาลงกรณ์มหาวิทยาลัย ในครั้งนี้บทความที่นำเสนอ 2 เรื่องได้แก่

1. วิธีการประมาณการและปริมาณสูญเสียของข้าวหลังการเก็บเกี่ยว

2. การวิเคราะห์ถึงผลที่เกิดจากการยกเลิกการเก็บค่าพรีเมี่ยมข้าวและภาษีส่งออก

นอกจากนี้ ยังมีบทความอีกเรื่องหนึ่งว่าด้วย แบบจำลองของสินค้าใน LINK Model ก็เป็นที่หวังว่าท่านผู้อ่านคงได้รับประโยชน์เหมือนกับวารสารเล่มที่แล้ว

วารสารวิจัยสังคม

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สารบัญ

Econometric Estimates of Post-Harvest[1] Loss of Rice

Barry Thomas Coyle,

Warin Wonghanchao,

Wisoot Wiseschinda

1. Estimates of Harvesting Loss Functions.

Harvesting loss functions were estimated in order to provide further explanation of the variation in losses within data for field experiments and, in turn, in order to provide necessary input to farm simulation models and policy analysis. The data on harvest losses is summarized in Table 1. The field work for the present study was conducted in 1982. Total harvest losses for the two regions with the largest number of samples (Central and Northeast regions) are identical to the average loss of 2.9% across all regions, with a minimum of 2.0% and a maximum of 4.3% for the less extensively sampled regions (North and South, respectively). At the provincial level, average total losses varied from 1.7%-4.3%; average shattering losses varied from 1%-3%; average unharvested grains varied from 0.2%-1.7%, and average laying losses varied from 0.2%-0.6%

The variables used in the regression analyses of harvest loss data are listed in Table 2. Most of the explanatory variables are "dummy" (binary) variables, and of course one variable (the "base" variable) for each set of dummy variables must be deleted from the statistical analysis in order to avoid perfect collinearity with the included intercept.

In addition, for our particular data base, the provincial dummies are P1-P8 and varietal dummies are RD-6-RD 23. L1-L31 were also perfectly collinear; so it was necessary to aggregate provincial dummies or varietal dummies in our loss-function models. Table 6. summarizes test results concerning the choice between

[1] This article is a result of a research project funded by the National Economic and Social Development Board. The project was directed by Warin Wonghanchao. Field survey of the project was led by Prajoed Sinsup and the laboratory work was supervised by Vichitr Benjasil and Prasoot Sittisong. The main contributors to the present article are Barry Thomas Coyle, Warin Wonghanchao, and Wisoot Wiseschinda.

aggregation of provincial dummies and aggregation of varietal dummies. For linear models of harvest loss, the hypothesis that varietal dummies can be correctly aggregated to two dummies (RD, Local) cannot be rejected at the 95% level of confidence; whereas the hypothesis that provincial dummies can be correctly aggregated to regional dummies can be rejected at both the 95% and 99% level of confidence (see A, B of Table 6). Thus, for linear models, it is most appropriate to specify a set of provincial dummy variables (P1–P9) combined with two aggregated varietal dummy variables RD and Local.

For log-linear models of harvest loss, the hypothesis that provincial dummies and varietal dummies can be correctly aggregated are both rejected at the 99% level of confidence (see A, B of Table 6). Thus, the most appropriate aggregation procedure is less obvious for long-linear models than for linear models.

Harvest loss functions were estimated for all regions in aggregate and also for each region individually. Tables 3 and 4 summarize the estimated loss functions for all regions in aggregate, and Tables 7–10 summarize the loss functions estimated by region.

For linear models defined over all regions (Table 3), results for the case B utilizing dummies by province and aggregated varietal dummies are most important. For total losses and shattering losses, the effect of grain moisture content, harvesting method, overmaturity of grain and position of the stalk are statistically significant from 0 at the 99% level of confidence. A 1% increase in grain moisture content is estimated to lead to a reduction in total losses that is equivalent to 0.1% of the potential total yield for harvesting. The use of sickle rather than ani-ani is estimated to increase total harvesting losses/shattering losses by 3.9%/3.2% of potential total yield. Likewise overmaturity of grain (by 7 or more days) increases total harvesting/shattering losses. Dry field conditions reduce these losses, and bending of the stalk at time of harvest increase these losses. All of these results are as expected.

The dummy variables by province (P1–P8) are all strongly negative for these linear models (Table 3B). Estimated coefficients for these dummies range from–1.6% to–3.7% of total potential yield for the case of shattering losses, and from–3.3% to–5.1% of total potential yield for the case of total harvesting losses. Here the "base" province is Nakhon Si Thammarat. It is interesting to note that these coefficients are greater in magnitude than the difference in losses between Nakhon Si Thammarat and the respective other provinces. Thus it does not appear that differences in losses between Nakhon Si Thammarat and other provinces can be explained even partially in terms of differences in grain moisture content, harvesting method (sickle versus *ani-ani*), grain maturity, water conditions in the field, position of stalk, and varietal aggregates (RD, Local).

Aside from the inability of our variables to account for the difference in losses between Nakhon Si Thammarat and other provinces, the only surprise in our results (Table 3B) may be that the frequency of the varietal aggregate RD (relative to Local varieties) is not statistically significant at the 95% level in accounting for shattering losses. Based on the results for linear models disaggregated by variety and aggregated by region (Table 3B), it appears that only one of the varieties (RD 15) studied here has a significant effect on total harvesting/shattering losses.

In addition, linear models were also estimated for unharvested grains and losses by laying of stalks on the ground after cutting. Total harvest yield and the provincial dummies P1-P8 have a significant negative influence on the ratio of unharvested grains to harvested yield. Losses from laying down stalks are significantly higher for RD varieties (relative to Local varieties) and when the loose stalks are scattered on the ground rather than laying loose stalks in small piles, and are also partially accounted for by various provincial dummies.

Results for log-linear models defined over all regions are presented in Table 4. Our tentative conclusions above concerning the qualitative effects of variables on harvesting losses are also supported by results for log-linear models with varieties aggregated (Table 4B). Linear and log-linear models with varieties aggregated have similar explanatory power, and it is not clear whether log-linear models are more correctly specified with provinces aggregated or with varieties aggregated (Table 6).

Tables 7-10 present harvest loss functions estimated by region. Moisture content has a significant influence on total harvesting/shattering losses only in the Northeast, overmaturity has a significant influence in the Central and Northeastern regions, position of stalk has a significant influence only in the North, and method of harvesting has a significant influence in the South (during experiments in other regions sickles were always employed). In addition, dummies for various provinces are statistically significant in the regional models.

Perhaps the most important point about Tables 7-10 is that statistically significant results here do not contradict our conclusions based on Tables 3-4. Thus the generally higher levels of statistical significance for Tables 3-4 presumably reflect the greater variation of data and quantity of data arising from the pooling of data across regions, and apparently do not reflect mis-specifications of aggregate models relative to regional models.

Table 1 : Summary of Harvesting Losses (%)

A. losses by Region

	All regions (N=468)		Central (N=130)		Northeast (N=198)		North (N=84)		South (N=56)	
	mean	SD	mean	SD	mean	SD	mean	SD	mean	SD
total losses	2.932	2.28	2.970	2.13	2.903	2.31	2.093	1.24	4.283	2.98
shattering	1.989	1.96	1.989	1.92	2.183	2.15	1.413	1.04	2.171	2.28
unharvested	0.627	0.67	0.582	0.53	0.486	0.52	0.317	0.32	1.690	1.01
laying	0.316	0.31	0.399	0.31	0.234	0.20	0.309	0.25	0.422	0.57

B. losses by Province

	Supan Buri (N=42)		Lop Buri (N=34)		Prachin Buri (N=54)		Nakhon Ratchasima (N=80)		Surin (N=58)		Phitsanulok (N=42)		Chieng Rai (N=42)		Nakhon Si Thammarat (N=56)		Khon Kaen (N=60)	
	mean	SD	mean	SD	mean	SD	mean	SD	mean	SD	mean	SD	mean	SD	mean	SD	mean	SD
total	1.899	0.94	2.155	0.82	4.317	2.59	2.549	1.61	3.625	3.42	1.722	1.22	2.356	1.19	4.283	2.98	2.675	1.53
shattering	1.005	0.63	1.572	0.75	3.016	2.53	1.854	1.35	2.816	3.30	1.287	1.17	1.540	0.89	2.171	2.28	2.010	1.38
unharvested	0.324	0.41	0.359	0.22	0.924	0.57	0.448	0.47	0.549	0.36	0.204	0.11	0.431	0.41	1.690	1.01	0.475	0.38
laying	0.570	0.40	0.224	0.17	0.378	0.21	0.247	0.24	0.260	0.18	0.232	0.23	0.385	0.26	0.422	0.57	0.190	0.14

Table 2: Harvesting Variables in Regression Analysis.

1. Losses: % loss (= Kg loss/Kg yield × 100)
   - total-total harvesting loss (avg-2.93 %, SD-2.3 %)
   - shatter-shattering losses during harvest (avg-1.99 %, SD-2.0 %)
   - unhar-unharvested stalks (avg-0.63 %, SD-0.7 %)
   - laying-losses during laying of stalks (avg-0.32 %, SD-2.9 %)
2. MC: % moisture content of harvested grain (avg-19.5 %, SD-2.9 %)
3. YLD: Kg yield/constant unit area (4×4 m.) (avg-5.1 Kg, SD-1.8 Kg)
4. Harvesting Method
   - HARV-sickle (93 %)
   - base-ani-ani (7 %)
5. Crop Maturity
   - IM-immature (12 %)
   - OM-overmature (5 %)
   - base-mature (83 %)
6. Field Condition
   - Dry-dry field (35 %)
   - WET-wet field (1 %)
   - base-average (64 %)
7. Position of Stalk
   - POST 2-stalks bending, one direction (36 %)
   - POST 3-stalks bending, many directions (13 %)
   - POST 4-other (2 %)
   - base-stalks standing upright (49 %)
8. Region (aggregate)
   - R1-Central (28 %)
   - R2-Northeast (42 %)
   - R3-Northern (18 %)
   - base-South (12 %)
9. Variety (aggregate)
   - RD-RD varieties (36 %)
   - base-Local varieties (64 %)
10. Laying stalks on ground after harvest
    - BIND-binding stalks before laying (18 %)
    - PILE-laying loose stalks in small piles (13 %)
    - base-laying loose stalks on ground (no piles) (69 %)

Table 2 : (Continued)

11. Province (disaggregate)

P1-Suphan Buri	(9 %)	P5-Khon Kean	(13 %)
P2-Lop Buri	(7 %)	P6-Surin	(12 %)
P3-Prachin Buri	(12 %)	P7-Phitsanulok	(9 %)
P4-Nakhon Ratchasima	(17 %)	P8-Chieng Rai	(9 %)

base-(P9) Nakhon Si Thammarat (12 %)

12. Variety (disaggregate)

RD varieties :

RD6 (12 %) RD7 (13 %) RD10 (2 %) RD15 (6 %) RD23 (3 %)

Local varieties :

L1-Look Lai	(3)	L6-Kao Deng Nai	(1)	L10-Lueng Pra Tui	(4)
L2-Lep Mu Nang	(5)	L7-Check Chur Mao	(2)	L11-Tae Wa Da	(2)
L3-Daw Dok Pud	(0.5)	L8-Kao Pak Mo	(2)	L12-Kao Ta Haeng	(11)
L4-Kay Yai	(6)	L9-Hom Chan	(0.4)	L13-Kao Dok Mali105	(18)
L5-San Pa Tong	(2)				

base-Kao Luang (3 %)

Note : 4-12 defines sets of dummy variable (1=yes), (0=no), with frequencies listed in parentheses and "base" variable deleted from the set in order to accomodate an intercept.

Table 3A: Harvesting Losses: Linear Models (All Regions).

Losses	Constant	MC	YLD	HARV	IM	OM	DRY	WET	POST 2	POST 3	R1	R2	R3	RD	R^2
A. Varieties disaggregated (provinces aggregated)															
1. total	3.17	-0.03	-0.08	3.98	-0.25	2.04	-0.69	0.43	0.74	1.44	-4.71	-4.34	-4.25	-	.3704
		(0.4)	(1.0)	(18.9)	(0.1)	(21.9)	(9.6)	(0.1)	(6.6)	(14.6)	(60.4)	(54.1)	(36.6)		
2. shatter	1.55	-0.03	0.00	2.99	-0.23	1.77	-0.60	0.57	0.75	1.26	-3.29	-2.74	-2.85	-	.2962
		(0.7)	(0.0)	(12.9)	(0.7)	(19.8)	(8.6)	(0.2)	(8.2)	(13.3)	(35.4)	(25.9)	(19.8)		
3. unharv	1.53	0.01	-0.08	0.54	-0.03	0.18	-0.02	-0.26	0.02	0.17	-1.16	-1.20	-1.11	-	.5165
		(0.0)	(15.8)	(5.2)	(0.2)	(2.7)	(0.2)	(0.6)	(0.1)	(2.9)	(54.4)	(61.5)	(37.6)		
4. laying	0.59	-0.00	0.00	-	0.00	0.09	-0.07	0.13	-0.03	0.02	-0.31	-0.44	-0.34	-	.4773
		(0.0)	(0.0)	-	(0.01)	(2.6)	(6.6)	(0.6)	(0.8)	(0.2)	(10.0)	(24.6)	(9.4)		
B. Provinces disaggregated (varieties aggregated)															
5. total	5.01	-0.11	-0.13	3.87	-0.16	1.76	-0.51	0.21	0.86	1.28	-	-	-	0.63	.3646
		(6.5)	(3.8)	(41.6)	(0.3)	(17.4)	(5.2)	(0.4)	(12.4)	(14.4)				(5.2)	
6. shatter	2.81	-0.10	-0.13	3.19	-0.10	1.56	-0.49	0.05	0.84	1.13	-	-	-	0.44	.2927
		(7.0)	(0.2)	(35.8)	(0.6)	(16.5)	(5.8)	(0.0)	(14.3)	(13.3)				(3.1)	
7. unharv	2.00	0.00	-0.11	-0.12	0.05	0.14	0.00	0.20	0.07	0.14	-	-	-	0.05	.4690
		(0.01)	(37.1)	(0.6)	(0.4)	(1.5)	(0.0)	(0.0)	(1.0)	(2.5)				(0.5)	
8. laying	0.54	-0.01	0.00	-	-0.02	0.06	-0.01	0.11	-0.04	-0.00	-	-	-	0.17	.3300
		(0.7)	(0.1)		(0.3)	(1.1)	(0.1)	(0.6)	(1.0)	(0.0)				(15.2)	

Note : F - statistics are listed in parentheses below coefficients

* - denotes that the coefficient is statistically significant from υ at 99% level of confidence

$F_{.01;\ 1,\ 436-448}$ 6.80 $F_{.05;\ 1,\ 436-448}$ 3.90

Table 3B: Harvesting Losses: Linear Models (All Regions) (Concluded).

A. Varieties Disaggregated (provinces aggregated)

	Losses	BIND	PILE	RD6	RD7	RD10	RD15	RD23	L1	L2	L3	L4	L5	L6	L7	L8	L9	L10	L11	L12	L13
1.	total	-	-	1.15	0.61	-0.35	1.91	-0.42	0.42	1.37	0.77	0.85	1.08	1.48	1.50	-0.52	0.73	0.03	0.10	0.37	0.55
				(2.6)	(0.8)	(0.1)	(6.2)	(0.2)	(0.4)	(4.3)	(0.2)	(1.2)	(1.5)	(1.7)	(2.8)	(0.4)	(0.2)	(0.0)	(1.3)	(0.4)	(0.1)
2.	shatter	-	-	1.01	0.40	0.12	1.78	-0.17	-0.31	1.14	0.57	0.84	1.04	1.40	0.89	-0.48	0.80	0.13	0.61	0.56	0.71
				(2.4)	(0.4)	(0.0)	(6.5)	(0.0)	(0.3)	(3.6)	(0.1)	(1.4)	(1.7)	(1.9)	(1.2)	(0.4)	(0.4)	(0.0)	(0.5)	(1.0)	(1.5)
3.	unharv	-	-	-0.06	-0.25	-0.37	-0.06	-0.22	-0.78	-0.22	0.01	-0.07	-0.07	-0.15	0.26	-0.11	-0.23	-0.21	0.41	-0.29	-0.24
				(0.1)	(1.9)	(2.3)	(0.1)	(0.8)	(22.1)	(1.7)	(0.0)	(0.1)	(0.1)	(0.3)	(1.3)	(0.2)	(0.4)	(1.4)	(2.6)	(3.5)	(2.1)
4.	laying	-0.04	-0.50	0.20	0.44	-0.10	0.21	-0.02	-0.06	-0.00	0.18	0.57	0.09	0.22	0.34	0.06	0.14	0.10	0.07	0.09	0.08
		(0.6)	(14.2)	(4.7)	(25.1)	(0.7)	(4.3)	(0.0)	(0.5)	(0.0)	(0.8)	(25.1)	(0.6)	(2.5)	(9.0)	(0.3)	(0.6)	(1.4)	(0.4)	(1.2)	(1.1)

B. Provinces Disaggregated (varieties aggregated)

	Losses	BIND	PILE	P1	P2	P3	P4	P5	P6	P7	P8
5.	total	-	-	-5.12	-5.05	-3.29	-3.93	-3.58	-3.30	-4.32	-3.42
				(85.3)	(59.4)	(30.9)	(55.4)	(46.4)	(42.3)	(50.5)	(36.2)
6.	shatter	-	-	-3.68	-3.29	-2.27	-2.27	-1.91	-1.63	-2.61	-2.10
				(53.1)	(30.5)	(14.7)	(22.2)	(19.5)	(12.5)	(22.2)	(15.5)
7.	unharv	-	-	-1.05	-1.11	-0.75	-1.11	0.98	-1.00	-1.04	-0.86
				(49.5)	(29.5)	(21.9)	(59.4)	(48.0)	(53.0)	(40.0)	(29.5)
8.	laying	0.16	-0.25	0.01	-0.23	-0.07	-0.18	-0.20	-0.44	-0.33	-0.20
		(6.1)	(13.5)	(0.0)	(5.8)	(0.7)	(4.9)	(8.6)	(42.4)	(13.4)	(4.5)

Table 4 A : Harvesting Losses : Log Linear Models (All Regions)

Losses	Constant	MC	YLD	HARV	IM	OM	DRY	WET	POST 2	POST 3	R1	R2	R3	RD	R^2
A. Varieties Disaggregated (Provinces Aggregated)															
9. total	0.78	0.07	-0.99	-0.05	0.39	-0.17	0.13	0.17	0.17	0.31	-1.10	-1.15	-1.04	-	.4342
		(0.1)	(4.2)	(15.0)	(0.4)	(9.8)	(7.6)	(0.1)	(4.6)	(8.5)	(42.5)	(47.9)	(28.7)		
10. shatter	-0.05	-0.00	-0.17	1.57	-0.01	0.39	-0.21	0.21	0.30	-0.38	-1.41	-1.31	-1.29	-	.4405
		(0.00)	(1.6)	(24.3)	(0.0)	(6.7)	(7.0)	(0.2)	(9.0)	(8.3)	(45.0)	(40.3)	(28.8)		
11. unharv	0.07	0.25	-0.55	1.83	-0.63	0.34	0.01	0.20	-0.29	0.19	-2.11	-1.28	-2.04	-	.5229
		(0.6)	(12.7)	(26.1)	(0.3)	(3.9)	(0.4)	(0.2)	(6.6)	(1.6)	(78.5)	(95.9)	(55.8)		
12. laying	-1.48	0.25	-0.20	-	-0.05	0.36	-0.18	0.67	-0.10	0.11	-0.27	-0.84	00.41	-	.4710
		(0.7)	(2.1)		(0.2)	(5.3)	(5.0)	(2.2)	(0.8)	(0.7)	(1.0)	(11.0)	(1.8)		
B. Provinces Disaggregated (Varieties Aggregated)															
13. total	2.54	-0.48	-0.30	0.99	-0.01	0.25	-0.15	0.13	0.29	0.36	-	-	-	0.10	.3412
		(4.0)	(10.6)	(31.2)	(0.0)	(3.7)	(4.7)	0.2)	(15.5)	(12.2)				(1.4)	
14. shatter	1.67	-0.65	-0.25	1.83	-0.00	0.25	-0.20	-0.05	0.45	0.42	-	-	-	0.03	.3748
		(5.0)	(4.7)	(72.3)	(0.0)	(2.6)	(6.1)	(0.0)	(24.9)	(11.7)				(0.1)	
15. unharv	1.10	0.09	-0.09	0.29	0.11	0.24	0.01	0.32	0.04	0.27	-	-	-	0.03	.4551
		(0.1)	(48.8)	(1.4)	(0.9)	(0.8)	(0.0)	(0.6)	(0.2)	(3.7)				(2.1)	
16. laying	-1.12	-0.11	-0.11	-	-0.06	0.25	0.20	0.41	-0.06	-0.06	-	-	-	0.57	.3121
		(0.1)	(0.8)		(0.3)	(2.1)	(0.1)	(1.0)	(0.3)	(2.0)				(20.7)	

Note : F - statistics are listed in parentheses below coefficients

* - denotes that the coefficient is statistically significant from 0 at 99% level of confidence

$F_{.01;\ 1,\ 436-448}$ 6.80 $F_{.05;\ 1,\ 436-448}$ 3.90

Table 4 B: Harvesting Losses: Log Linear Models (All Regions)(Concluded)

A. Varieties disaggregated (Provinces aggregated)

Losses	BIND	PILE	RD6	RD7	RD10	RD15	RD23	L1	L2	L3	L4	L5	L6	L7	L8	L9	L10	L11	L12	L13
9. total	-	-	0.41	0.13	-0.78	0.66	-0.72	0.18	0.41	0.01	0.42	0.55	0.50	0.63	-0.22	0.42	0.00	0.40	0.19	0.22
			(4.4)	(0.5)	(0.4)	(9.3)	(7.6)	(1.0)	(4.6)	(0.0)	(3.7)	(5.0)	(2.5)	(6.3)	(0.9)	(1.0)	(0.0)	(2.1)	(1.3)	(1.5)
10. shatter	-	-	0.59	0.02	-0.62	0.89	-0.71	-0.48	0.59	-0.18	0.64	0.79	0.68	0.58	-0.23	0.53	0.20	0.44	0.40	0.45
			(5.7)	(0.0)	(3.5)	(11.0)	(4.7)	(4.4)	(6.2)	(0.0)	(5.8)	(6.6)	(2.9)	(3.4)	(0.6)	(1.0)	(0.7)	(1.6)	(3.6)	(4.2)
11. unharv	-	-	-0.49	-1.51	-1.82	-0.30	-1.65	0.48	-0.01	-0.21	-0.39	-0.54	-0.45	-0.23	-0.44	-0.71	-0.60	0.12	0.73	-0.74
			(3.1)	(32.3)	(23.5)	(1.0)	(20.1)	(3.6)	(0.0)	(0.1)	(1.7)	(2.4)	(1.0)	(0.4)	(1.8)	(1.5)	(5.1)	(0.1)	(9.4)	(8.7)
12. laying	-.24	-1.76	0.57	1.05	-0.83	0.78	-0.08	-0.48	-0.22	0.45	1.85	0.21	0.60	0.99	0.04	0.72	0.09	-0.20	0.06	0.16
	(2.4)	(22.1)	(5.0)	(18.2)	(5.9)	(7.3)	(0.1)	(4.3)	(0.8)	(0.6)	(33.3)	(0.4)	(2.1)	(9.5)	(0.0)	(1.8)	(0.1)	(0.3)	(0.1)	(2.0)

B. Provinces Disaggregated (varieties aggregated)

Losses	BIND	PILE	P1	P2	P3	P4	P5	P6	P7	P8
13. total	-	-	-1.13	-1.25	-0.79	-1.05	-0.79	-0.77	-1.27	-0.91
			(62.2)	(38.8)	(19.6)	(44.1)	(24.9)	(25.2)	(50.4)	(28.1)
14. shatter	-	-	1.68	-1.28	-0.88	-1.04	-0.66	-0.62	-1.32	-0.90
			(68.9)	(22.7)	(16.5)	(29.3)	(11.6)	(10.9)	(36.6)	(18.7)
15. unharv	-	-	-1.73	-1.50	-1.02	-1.67	-1.22	-1.20	-1.61	-1.04
			(56.3)	(29.0)	(17.0)	(57.7)	(30.9)	(31.7)	(41.8)	(19.1)
16. laying	0.31	-0.63	0.53	-0.05	0.39	-0.05	-0.09	-0.62	-0.35	-0.10
	(2.7)	(10.3)	(5.3)	(0.0)	(2.6)	(0.1)	(0.2)	(10.3)	(2.0)	(0.2)

Table 5: Harvesting Losses: R^2 for Other Regressions (All Regions)

17. total = f (Constant, MC, YLD, SICKLE, IM, OM, DRY, WET, POST 2-3; R1-3, RD)
    R^2 (linear) = .3321 R^2 (log-linear) = .2982   K = 14

18. total = f (Constant, MC, YLD, SICLKE, IM OM, DRY, WET, POST 2-3; RD)
    R^2 (linear) = .2296 R^2 (log-linear) = .2198   K = 11

19. total = f (Constant, MC, YLD, SICKLE, IM, OM, DRY, WET, POST 2-3; R1-3)
    R^2 (linear) = .3239 R^2 (log-linear) = .2946   K = 13

Note: K = number of independent variable (including constant)

Table 6 : F – Tests for Joint Hypotheses Concerning Aggregates of Provincial and Varietal Dummies (Total Losses, All Regions).

A. H^A : Provincial Dummies (P1–P9) (viz. correctly aggregate to) Regional dummies (R1–4) (given aggregation of varieties to RD, Local)

linear case (see regression 5, 17):

$$F = \frac{.3646-.3321}{1-.3646} \cdot \frac{468-19}{5} = 4.56$$

log-linear case (see regressions 13, 17):

$$F = \frac{.3412-2982}{1-3412} \cdot \frac{468-19}{5} = 5.82$$

$F_{.01;5,449} = 3.02$ => H^A rejected at 99% level of confidence for linear and log-linear models

B. H^B : varietal dummies (RD6–23, L1–14) <=> (viz. correctly aggregate to) RD, Local dummies (given aggregation of provinces to R1–4)

linear case (see regressions 1, 17):

$$F = \frac{.3704-.3321}{1-.3704} \cdot \frac{468-31}{17} = 1.55$$

log-linear see regressions 9, 17):

$$F = \frac{.4342-3321}{1-4342} \cdot \frac{468-31}{17} = 4.61$$

$F_{.01;17,437} = 2.00$ => H^A rejected at 95/99% levels of confidence in case of log-linear model; but H^B

$F_{.05;17,437} = 1.70$ not rejected at 95/99% levels of confidence in case of linear model

Note : Give that the constraints $\underset{r \times k}{A} \times \underset{r \times k}{B} = o$ (in matrix form) on the vector of coefficients B are satisfied and given standard assumptions in ordinary least squares, then

$$\frac{R_u^2 - R_c^2}{1 - R_u^2} \cdot \frac{n-k}{r} \sim F_{r,n-k}$$

where $R_u^2 \equiv R^2$ for unconstrained regression, $R_c^2 \equiv R^2$ for the constrained regression, $n \equiv$ number of observations, and $K \equiv$ number of explanatory variables (including contant) (e.g., P. Dhrymes, Econometrics, 1978, pp. 58–9)

Table 7: Harvesting Losses: Central Region.

Losses	Constant	MC	YLD	IM	OM	DRY	WET	POST 2	POST 3	P1	P2	RD	R^2
LINEAR MODELS													
total	5.26	-0.03	-0.15	-0.63	1.58	-0.42	-0.17	-0.07	0.17	-1.52	-1.75	-0.37	.3508
		(0.2)	(1.4)	(1.1)	(6.6)	(0.4)	(0.0)	(0.0)	(0.1)	(5.93)	(5.90)	(0.1)	
shatter	4.28	-0.08	-0.00	-0.48	1.16	-0.46	-0.12	-0.06	0.16	-1.39	-1.38	0.74	.2639
		(1.0)	(0.0)	(0.7)	(3.9)	(0.5)	(0.0)	(0.0)	(0.1)	(5.3)	(4.0)	(0.6)	
unharv	0.63	0.04	-0.17	-0.17	0.33	-0.09	-0.14	0.15	-0.14	-0.03	-0.10	0.05	.5653
		(6.4)	(41.4)	(1.9)	(6.9)	(0.5)	(0.5)	(1.1)	(1.0)	(0.1)	(0.5)	(0.1)	
laying	0.35	0.01	0.02	0.02	0.09	0.14	0.09	-0.17	-0.13	-0.10	-0.27	0.31	.4431
		(0.2)	(1.35)	(0.09)	(1.1)	(2.5)	(0.5)	(3.0)	(1.9)	(1.5)	(8.1)	(5.4)	
LOG-LINEAR MODELS													
total	1.08	0.18	-0.23	-0.22	0.41	-0.03	0.02	-0.06	-0.03	-0.42	-0.50	-0.25	.4641
		(0.4)	(3.3)	(2.1)	(7.2)	(0.0)	(0.0)	(0.1)	(0.0)	(7.3)	(7.8)	(1.1)	
shatter	0.95	-0.01	-0.09	-0.29	-0.40	-0.11	-0.03	0.07	0.06	-0.59	-0.46	-0.52	.4361
		(0.0)	(0.3)	(2.0)	(3.6)	(0.2)	(0.0)	(0.1)	(0.1)	(7.6)	(3.5)	(2.6)	
unharv	-2.61	1.16	-0.95	-0.27	0.60	-0.00	0.11	0.00	0.11	0.16	-0.30	-1.30	.7297
		(9.8)	(35.7)	(2.0)	(9.8)	(0.0)	(0.1)	(0.0)	(0.2)	(0.6)	(1.5)	(19.4)	
laying	-1.57	0.17	0.23	0.04	0.32	0.15	0.37	-0.47	-0.37	-0.25	-0.71	0.55	.4683
		(0.2)	(2.4)	(0.0)	(3.1)	(0.6)	(1.6)	(4.9)	(3.2)	(1.8)	(11.1)	(3.9)	

Note F - statistics are listed in parentheses below coefficients

* - denotes that the coefficient is statistically significant from 0 at 99% level of confidence

$F_{.01;\ 1,\ 118}{}^{6.85}$ $F_{.05;\ 1,\ 118}{}^{3.92}$

Table 8 : Harvesting Losses : Northeastern Region.

Losses	Constant	MC	YLD	IM	DRY	POST 2	POST 3	BIND	PILE	P4	P5	P6	RD	R^2
LINEAR MODELS														
total	5.20	-0.18	0.46	0.43	3.89	-0.19	0.23	1.00	0.29	0.39	-0.01	-0.15	0.89	.2666
		(5.7)	(1.6)	(0.8)	(17.4)	(0.3)	(0.4)	(2.7)	(0.1)	(0.4)	(0.0)	(0.0)	(4.6)	
shatter	2.83	-0.13	0.21	0.16	3.88	-0.20	0.43	0.82	0.80	0.27	0.37	0.34	0.73	.2611
		(3.4)	(3.1)	(0.1)	(19.9)	(0.5)	(1.4)	(2.0)	(0.6)	(0.2)	(0.1)	(0.1)	(3.5)	
unharv	1.51	-0.04	-0.06	0.18	-0.04	0.05	-0.19	0.14	-	-	0.03	0.05	0.04	.1625
		(7.2)	(5.4)	(4.0)	(0.1)	(0.6)	(6.6)	(1.4)			(0.1)	(0.4)	(0.3)	
laying	0.64	-0.01	0.01	0.09	0.05	-0.03	0.03	0.02	0.02	0.02	-0.13	-0.21	-0.09	.1582
		(4.0)	(0.2)	(4.0)	(0.4)	(1.2)	(0.5)	(0.2)	(4.1)	(0.1)	(1.6)	(4.2)	(5.5)	
LOG-LINEAR MODELS														
total	4.83	-1.36	0.03	0.22	0.27	-0.11	0.04	0.29	-0.04	0.19	-0.13	-0.08	0.25	.2171
		(10.6)	(0.0)	(2.9)	(1.1)	(1.6)	(0.2)	(3.2)	(0.0)	(1.2)	(0.2)	(0.1)	(5.0)	
shatter	3.74	-1.22	0.11	0.17	0.30	-0.15	0.17	0.32	0.22	0.19	0.02	0.14	0.27	.2044
		(6.9)	(0.4)	(1.4)	(1.2)	(2.7)	(2.1)	(3.1)	(0.5)	(1.1)	(0.0)	(0.2)	(4.7)	
unharv	4.98	-1.67	-0.51	0.37	0.01	0.13	-0.63	0.20	-	-	0.01	0.13	0.03	.2188
		(7.1)	(4.9)	(3.6)	(0.0)	(1.1)	(17.0)	(0.7)			(0.0)	(0.5)	(0.0)	
laying	0.63	0.75	0.12	0.29	0.29	-0.04	-0.18	0.16	-0.54	0.10	-0.22	-0.53	0.46	.2088
		(2.5)	(0.5)	(1.0)	(1.0)	(0.2)	(2.4)	(0.1)	(2.7)	(0.3)	(0.4)	(2.4)	(13.4)	

Note : F - statistics are listed in parentheses below coefficients

* - denotes that the coefficient is statistically significant from 0 at 99% level of confidence

$F_{.01;\ 1,\ 184}\ 6.80$ $F_{.05;\ 1,\ 184}\ 3.90$

Table 9 : Harvesting Losses : Northern Region.

Losses	Constant	MC	YLD	OM	DRY	POST 2	BIND	P7	RD	R^2
LINEAR MODELS										
total	2.43	0.01	-0.10	0.38	-0.19	1.19	-0.67	-0.59	0.28	.3053
		(0.0)	(1.2)	(0.2)	(0.3)	(7.0)	(1.6)	(2.0)	(0.3)	
shatter	2.08	-0.00	-0.06	0.22	-0.23	0.69	-0.61	-0.26	-0.14	.2517
		(0.0)	(0.5)	(0.1)	(0.6)	(3.1)	(1.8)	(0.5)	(0.1)	
unharv	-0.31	0.03	-0.02	0.09	0.06	0.38	0.11	-0.27	0.11	.2961
		(1.7)	(0.4)	(0.1)	(0.4)	(10.6)	(0.6)	(6.3)	(0.6)	
laying	0.66	-0.02	-0.03	0.07	-0.01	0.12	-0.16	-0.06	0.31	.1892
		(0.8)	(1.7)	(0.1)	(0.0)	(1.4)	(1.8)	(0.4)	(6.2)	
LOG-LINEAR MODELS										
total	0.52	0.22	-0.39	0.48	0.00	0.61	-0.78	0.30	0.10	.3341
		(0.0)	(0.9)	(0.8)	(0.0)	(4.6)	(6.1)	(1.3)	(0.1)	
shatter	-0.36	0.32	-0.26	0.61	0.04	0.60	-1.13	-0.31	-0.12	.3254
		(0.1)	(0.3)	(0.8)	(0.0)	(2.7)	(1.7)	(0.9)	(0.1)	
unharv	-1.31	0.21	-0.42	-0.07	-0.07	0.78	0.08	-0.67	0.16	.2550
		(0.0)	(0.9)	(0.0)	(0.1)	(6.0)	(0.1)	(5.5)	(0.2)	
laying	1.19	0.54	-0.81	0.41	-0.01	0.40	-0.41	-0.19	0.83	.1670
		(0.2)	(3.1)	(0.5)	(0.0)	(1.5)	(1.3)	(0.4)	(4.0)	

Note: F - statistics are listed in parentheses below coefficients

* denotes that the coefficient is statistically significent from 0 at 99% level of confidence

$F_{.01;\ 1,\ 74}$ 7.05 $F_{.05;\ 1,\ 74}$ 4.00

Table 10 : Harvesting Losses : Southern Region.

Losses	Constant	MC	YLD	HARV	IM	OM	DRY	POST 2	R^2
LINEAR MODELS									
total	3.56	0.10	-0.85	4.62	0.11	1.30	-4.21	1.74	.7197
		(0.7)	(8.2)	(80.1)	(0.0)	(1.0)	(10.1)	(2.7)	
shatter	1.24	0.01	-0.19	2.77	-0.03	0.81	-2.75	1.25	.7100
	(0.0)	(0.7)	(87.3)	(0.0)	(0.6)	(7.1)	(2.3)		
unharv	2.27	0.09	-0.67	-0.14	0.13	0.47	-0.78	0.55	.3169
		(2.2)	(18.1)	(0.2)	(0.2)	(0.5)	(1.26)	(0.6)	
laying	0.05	-0.00	-0.01	0.98	0.01	0.02	-0.68	0.05	*.6784
		(0.0)	(0.0)	(85.4)	(0.0)	(0.0)	(6.2)	(0.1)	
LOG-LINEAR MODELS									
total	-0.68	0.99	-1.12	1.06	-0.05	0.25	-0.84	0.28	.7488
		(3.7)	(25.3)	(79.1)	(0.2)	(0.7)	(7.6)	(1.3)	
shatter	2.26	-0.60	-0.86	1.92	0.04	0.34	-0.91	0.78	.7797
		(0.7)	(7.3)	(127.3)	(0.1)	(0.7)	(4.4)	(5.1)	
unharv	-2.33	1.55	-1.48	0.03	-0.13	0.29	-0.46	0.15	.3884
		(4.7)	(23.0)	(0.0)	(0.6)	(0.5)	(1.2)	(0.2)	
laying	-3.55	1.09	-1.68	2.38	-0.26	0.13	-0.88	-0.18	.6202
		(0.6)	(7.7)	(54.1)	(0.7)	(0.0)	(1.1)	(0.1)	

Note: F - statistics are listed in parentheses below coefficients

* denotes that the coefficient is statistically significant from 0 at 99% level of confidence

$F_{.01;\ 1,\ 48}$ 7.20 $F_{.05;\ 1,}$ 4.05

2. Estimates of Threshing Loss Functions.

Raw data on threshing losses is summarized in table 11*. Average threshing losses vary by region from 0.94% (Northern region) to 0.26% (Southern region) and vary by province from 1.32% (Chieng Rai) to 0.17% (Suphan Buri, Phitsanulok). Losses average 0.55% across all observations. Average threshing losses also show a large variation by threshing method: 0.95% for handbeating on floor or in basket; 0.61% for use of tractors; 0.36% for mechanical threshers; and 0.21% for trampling.

Given that paddy is threshed at a low moisture content (mean 16.3%), these low estimates of threshing losses are not surprising. Threshing losses can be broken down into unthreshed grains and scattered grains, and at low moisture contents unthreshed grains should be minimal. Therefore, trampling of paddy by feet, which tends to minimize scattering losses, shows the lowest threshing losses. Scattering losses. tend to be higher for handbeating than for trampling, but scattering losses are easily regulated by proper management techniques (e.g. choice of a suitably large mat or enclosed cage for handbeating). Therefore, given the low moisture contents of grain at time of threshing, we would expect that total threshing losses would be low for all methods of threshing.

The variables used in the regression analyses of threshing loss data are listed in Table 4.12. In contrast to the analysis of harvesting loss data, the list of explanatory variables is limited to grain moisture content, yield per trial, threshing method, variety and location.

Table 13 and 14 summarize our regression results using data for all provinces (excluding Khon Khaen). BEAT 2 (beating on floor is the base omitted) variable for threshing methods, and RD7, P9 (Nakhon Si Thammarat) are the base variables for varieties and provinces here these are employed. For our particular data set it is also necessary to aggregate either varieties or provinces in order to avoid perfect collinearity (as in the case of data accounting for harvesting losses. In addition, it was also necessary to delete a further variable from these models in order to avoid perfect collinearity (MACH2, denoting the Southern mechanical thresher, was deleted from the models in Table 13 and 14).

For linear models of threshing loss (Table 13), losses are more adequatedly accounted for by equation 1 (varieties disaggregated, provinces aggregated) than by equation 2 (provinces disaggregated, varieties aggregated) or equation 3 (varieties and provinces both aggregated) : see Table 4.15. On the other hand, for log-linear models (Table 14), losses are more adequately accounted for the equation 5 (provinces dis-

* Table 11 and our subsequent analysis of threshing losses excludes data from Khon Khaen, which appeared to be in error.

aggregated, varieties aggregated) than by equation 4 (varieties disaggregated, provinces aggregated) or equation 6 (varieties and provinces both aggregated): see Table 4.15. Thus we focus on regression equations 1 and 5 of Table 13 and 14. respectively.

In contrast to the case for harvesting losses, regression results from threshing losses are highly dependent on the functional from for the regression equation. For the linear equation 1 (Table 13), TRAC (threshing by tractor) and MACH 1 (threshing by axial flow thresher) are statistically significant from 0 at 99% level of confidence, and MC (grain moisture content) is significant from 0 at the 95% level. On the other hand, for equation 5, which is log-linear and is aggregated for varieties rather than provinces, YLD (threshing yield/trial) is significant at the 99% level and TRAMP (threshing by foot trampling) is significant at the 95% level. Thus more flexible functional forms will be deployed for estimating threshing loss functions in the Final Report. The deletion of MACH 2 as well as BEAT 2 from the equations also greatly complicates the interpretation of regression results in Tablet 4.13 and 4.14.

Tables 16-19 presents threshing loss functions estimated by region. Moisture content has a significant influence on threshing losses in the Northeast and to a lesser extent in the Southern and Central regions. Losses for MACH 1 (axial flow thresher) are substantially lower than losses for TRAC (tractor) in the Central region, and losses for MACH 2 (Southern mechanical thresher) are significantly higher than losses for TRAMP (foot trampling) in the Southern region. In several cases, differences in province and variety also have a significant influence on threshing losses within a region.

Table 11: Summary of Threshing Losses (%)

A. % losses by Region :

	All Regions (N = 255)	Central (N = 79)	Northeast (N = 57)	North (N = 42)	South (N = 77)
mean	0.6528	0.5078	0.7253	0.9356	0.2625
S.D.	0.75	0.62	0.89	0.10	0.25

B. % losses by Province :

	Suphan Buri (N = 21)	Lop Buri (N = 27)	Prachin Buri (N = 31)	Nakhon Ratchasima (N = 36)
mean	0.1659	0.6743	0.5943	0.8042
S.D.	0.11	0.60	0.76	1.07

	Surin (N = 21)	Phitsanulok (N = 14)	Chieng Rai (N = 28)	Nakhon Si Thammarat (N = 77)
mean	0.5901	0.1658	1.3205	0.2625
S.D.	0.39	0.19	1.17	0.25

C. % losses by Threshing Method :

	beating in basket (n = 6)	beating on floor (N = 74)	trampling (N = 55)	tractor (N = 37)	axial flow thresher (N = 61)	Southern thresher (N = 22)
mean	1.0364	0.9453	0.2139	0.6120	0.3599	0.3842
S.D.	0.80	1.06	0.18	0.78	0.45	0.34

*Note : excludes data from Khon Khaen

Table 12: Variable in Regression Analysis of Threshing Losses.

1. Losses : total threshing losses (%) (avg-0.55 %, SD-0.7 %)
2. MC : % moisture content of threshed grain (avg-16.34 %, SD-3.6 %)
3. YLD : Kg threshed grain/trial (avg-24.76 %, SD-47.4 %)
4. Threshing method
   - BEAT 1 - beat in basket (2 %)
   - BEAT 2 - beat on floor (29 %)
   - TRAMP - trampling (22 %)
   - TRAC - tractor (15 %)
   - MACH 1 - axial flow thresher (24 %)
   - MACH 2 - Southern thresher (9 %)
5. Region (aggregate)
   - R1 - Central (31 %)
   - R2 - Northeast (23 %)
   - R3 - North (16 %)
   - base - South (30 %)
6. Province (disaggregate)
   - P1 - Suphan Buri (8 %)
   - P2 - Lop Buri (11 %)
   - P3 - Prachin Buri (12 %)
   - P4 - Nakhon Ratchasima (14 %)
   - P6 - Surin (8 %)
   - P7 - Phitsanulok (5 %)
   - P8 - Chieng Rai (11 %)
   - base - Nakhon Si Thammarat (30 %)
7. Variety (aggregate)
   - RD - RD varieties (45 %)
   - base - local varieties (55 %)
8. Variety (disaggregate)
   - RD varieties -
     - RD6 (6 %) RD7 (23 %) RD10 (5 %)
     - RD13 (7 %) RD15 (3 %) RD23 (1 %)
   - Local Varieties -

L1	Look Lai	(6)	L9	Hom Chan	(0.4)
L2	Lep Mu Nang	(6)	L10	Lueng Pra Tui	(5)
L6	Kao Deng Noi	(0.4)	L12	Kao Ta Haeng	(15)
L7	Check Chur Mao	(2)	L13	Kao Dak Mali 105	(13)
L8	Kao Pak Mo	(2)	L14	Kao Luang	(3)

Table 13 A: Threshing Losses: Linear Models (All Regions)

Losses	constant	MC	YLD	BEAT 1	TRAMP	TRAC	MACH 1	R1	R2	R3	RD	R^2
A. Varieties disaggregated, provinces aggregated												
1.	-0.26	0.03	0.00	0.26	-0.19	-1.26*	-1.36*	1.33*	0.04	0.79	-	.3869
		(5.6)	(0.0)	(0.7)	(1.0)	(11.5)	(19.4)	(12.2)	(0.0)	(2.7)		
B. Provinces disaggregated, varieties aggregated												
2.	-0.39	0.04*	-0.00	-0.46	-0.17	-0.44	-0.78	-	-	-	-0.02	.2764
		(8.8)	(0.0)	(2.3)	(1.0)	(1.0)	(6.2)				(0.0)	
C. Provinces and varieties aggregated												
3.	-0.22	0.04*	-0.00	-0.38	-0.18	-0.86*	-1.04*	1.29*	0.38	1.17*	-0.08	.2465
		(7.0)	(2.8)	(1.5)	(1.1)	(9.9)	(18.8)	(22.0)	(3.9)	(32.1)	(0.4)	

Note : I. BEAT 2 - base variable for threshing methods; and MACH 2 also is deleted in order to avoid perfect collinearity for the specific data sets

II. F - statistics are listed in parentheses below coefficients

* - denotes statistical significance from 0 at 99% level of confidence

$F_{.01;\ 1,\ 230-244} \approx 6.80$ $F_{.05;\ 1,\ 230-244} \approx 3.90$

Table 13 B : Threshing Losses : Linear Models (All Regions) (Concluded)

A. Varieties disaggregated, provinces aggregated

	RD6	RD7	RD10	RD13	RD15	RD23	L1	L2	L6	L7	L8	L9	L10	L12	L13	L14
1.	-0.33	base	1.16	0.08	0.11	0.44	-0.00	0.62	0.20	0.56	1.12*	0.55	-0.06	0.39	0.41	-0.00
	(0.4)		(6.3)	(0.2)	(0.1)	(1.0)	(0.0)	(3.7)	(0.1)	(2.7)	(11.1)	(0.7)	(0.0)	(3.0)	(2.8)	(0.0)

B. Provinces disaggregated, varieties aggregated

	P1	P2	P3	P4	P6	P7	P8
2.	0.69	1.26*	0.89	0.48	0.32	0.57	1.21*
	(3.1)	(10.3)	(3.2)	(4.9)	(2.1)	(1.8)	(35.2)

Table 14 A : Threshing Losses : Log Linear Models (All Regions)

Losses	constant	MC	YLD	BEAT 1	TRAMP	TRAC	MACH 1	R1	R2	R3	RD	R^2
A. Varieties disaggregated, provinces aggregated												
4.	0.31	0.29	-0.46*	0.89	-0.68	-0.47	-0.76	1.26	0.28	0.85	-	.3917
		(1.3)	(16.6)	(3.1)	(5.6)	(0.7)	(2.5)	(4.6)	(0.4)	(1.1)		
B. Provinces disaggregated, varieties aggregated												
5.	0.25	-0.21	-0.58*	0.76	-0.61	1.07	-0.34	-	-	-	-0.06	.3775
		(0.7)	(28.1)	(2.6)	(6.4)	(2.8)	(0.6)				(0.1)	
C. Provinces and varieties aggregated												
6.	0.17	-0.21	-0.48*	0.62	-0.63*	-0.73	-0.67	1.31	0.33	1.32	-0.10	.3346
		(0.7)	(41.4)	(1.8)	(6.7)	(3.4)	(3.5)	(12.0)	(1.4)	(20.5)	(0.3)	

Note : I. BEAT 2 = base variable for threshing methods; and MACH 2 also is deleted in order to avoid perfect collinearity for the specific data sets

II. F - Statistics are listed in parentheses below coefficients

* - denotes statistical significance from 0 at 99% level of confidence

$F_{.01;\ 1,\ 230-244} \approx 6.80$ $\quad$ $F_{.05;\ 1,\ 230-244} \approx 3.90$

Table 14 B : Threshing Losses : Log Linear Models (All Regions) (Concluded)

A. Varieties disaggregated, provinces aggregated

	RD6	RD7	RD10	RD13	RD15	RD23	L1	L2	L6	L7	L8	L9	L10	L12	L13	L14
4.	0.15	base	0.84	0.18	-0.40	1.10	0.03	-0.01	0.23	0.55	0.62	0.58	-0.84	0.11	0.23	0.37
	(0.0)		(1.2)	(0.3)	(0.6)	(2.6)	(0.0)	(0.0)	(0.1)	(1.0)	(1.5)	(0.3)	(3.3)	(0.1)	(0.3)	(0.8)

B. Provinces disaggregated, varieties aggregated

	P1	P2	P3	P4	P6	P7	P8
5.	1.32	1.25	-0.57	0.44	0.34	0.94	1.38*
	(5.0)	(5.2)	(0.7)	(1.9)	(1.3)	(2.4)	(23.2)

Table 15: F-Tests for Joint Hypotheses Concerning Aggregates of Provincial and Varietal Dummies (All Regions)

A. H_0^A : provincial dummies (P1-4, P6-9)

<=> (Viz. correctly aggregate to) regional dummies (R1-4) (given aggregation of variety to RD. Local)

linear case (see regressions 2,3):

$$F = \frac{.2764-.2465}{1-.2764} \cdot \frac{255-15}{4} = 2.48$$

log-linear case (see regressions 5, 6):

$$F = \frac{.3775-.3346}{1-.3775} \cdot \frac{255-15}{4} = 4.13$$

$F_{.01;\,4,\,255} \sim 3.35$ $\quad$ $F_{.05;\,4,\,255} \sim 2.40$

=> H_0^A rejected at 95/99 % levels of confidence for log-linear case : but H_0^A rejected only at 95% level of confidence for linear case

B. H_0^B : varietal dummies (RD6-23, L1-L4)

<=> (Viz. correctly aggregate to) RD, Local dummies (given aggregation of provinces to R1-4)

linear case (see regressions 1, 3):

$$F = \frac{.3869-2465}{1-3869} \cdot \frac{255-22}{13} = 4.05$$

log-linear case (see regressions 4, 6):

$$F = \frac{.3917-3346}{1-3917} \cdot \frac{255-25}{13} = 1.66$$

$F_{.01;\,13,\,255}$ 2.20 $\quad$ $F_{.05;\,13,\,255}$ 1.75

=> H_0^B rejected at 95/99% levels of confidence for linear case; but H_0^B not rejected at either 95% or 99% level of confidence for log-linear case.

Table 17 : Threshing Losses : Northeastern Region.

Losses	constant	MC	YLD	MACH 1	P4	RD15	L6	L7	L8	L9	L10	L12	L13	R^2
9. Linear model	-1.94	0.13*	-0.03	0.88	0.55	0.47	0.11	-0.21	0.65	0.28	-0.27	-0.16	0.54	.5789
		(15.6)	(3.3)	(1.3)	(1.9)	(0.6)	(0.0)	(0.2)	(1.4)	(0.1)	(0.2)	(0.7)	(0.9)	
10. Log-linear model	-5.21	2.17	-1.43*	1.63	0.16	0.21	0.99	0.23	1.07	0.63	0.44	0.85	0.59	.6092
		(7.2)	(17.8)	(3.9)	(0.1)	(0.1)	(0.8)	(0.1)	(2.1)	(0.3)	(0.3)	(1.5)	(0.6)	

Note : I. BEAT 2 = base variable for threshing methods

RD7 = base variable for varieties

II. F - statistics are listed in parentheses below coefficients

* - denotes statistical significance from 0 at 99% level of confidence

$F_{.01;\ 1,\ 45} \approx 7.30$ $F_{.05;\ 1,\ 45} \approx 4.05$

Table 18 : Threshing Losses : Northern Region

Losses	constant	MC	YLD	BEAT 1	TRAC	MACH 1	P7	RD	RD6	RD10	RD23	L13	R^2
11. Linear model (A)	1.41	-0.01	-0.00	-0.45	-0.50	-0.86	-0.21	0.29	-	-	-	-	.3095
		(0.0)	(0.1)	(0.9)	(0.3)	(1.8)	(0.0)	(0.1)					
12. Linear model (B)	1.76	0.02	-0.00	0.28	-1.45	-1.74*	-	-	-1.24	0.24	-0.05	-0.25	.5437
		(0.1)	(0.1)	(0.4)	(2.8)	(9.2)			(1.2)	(0.0)	(0.0)	(0.1)	
13. Log-linear model (A)	-1.14	0.26	-0.70	0.95	0.92	-0.46	1.23	1.64*	-	-	-	-	.7020
		(0.1)	(5.8)	(2.5)	(1.6)	(0.9)	(1.1)	(8.2)					
14. Log-linear model (B)	-0.25	0.50	-0.33	0.71	0.25	-1.00	-	-	-0.95	-0.12	-0.17	-1.38	.7376
		(0.4)	(0.9)	(1.4)	(0.1)	(3.5)			(0.5)	(0.0)	(0.0)	(2.4)	

Note : I. BEAT 2 = base variable for threshing methods

RD7 = base variable for varieties

PD7 also dropped from equations 12 and 14 in order to avoid perfect collinearity

II. F - statistics are listed in parentheses below coefficients

* - denotes statistical significance from 0 at 99% level of confidence

$F_{.01;\ 1,\ 67\text{-}69} \approx 7.05$ $F_{.05;\ 1,\ 67\text{-}69} \approx 4.00$

Table 19 : Threshing Losses : Southern Region

Losses	Constant	MC	YLD	MACH2	RD13	L1	R^2
15. Linear model	-0.01	0.01	0.03*	0.28*	0.14	0.09	.2774
		(0.7)	(17.4)	(15.2)	(2.9)	(1.4)	
16. Log-linear model	-0.69	-0.78*	0.54*	1.16*	0.67	0.52	.3243
		(10.2)	(8.4)	(22.8)	(6.5)	(4.0)	

Note : I. TRAMP = base variable for threshing mothods
RD7 = base variable for varieties

II. F - statistics are listed in parentheses below coefficients
*denotes statistical significance from 0 at 99 % level of confidence
$F_{.01;\,1,\,71} \approx 7.05$ $F_{.05;\,1,\,71} \approx 4.00$

3. Estimates of Drying Loss Functions.

Drying losses by region, province and drying method are summarized in Table 20. Recorded losses are extremely low for all provinces, averaging 0.14%, and show very small variation by drying method.

Regression results for drying loss functions are summarized in Table 22. In contrast to the cases for harvesting and threshing, the data set designed to account for drying losses permitted simultaneous disaggregation of region and variety (equations 1, 4). Log-linear models show greater explanatory power (higher R^2's) than do linear models.

For log-linear models, both grain moisture content after drying (MC) and drying yield per trial (YLD) show significant negative relations to percent of drying loss. Since grains are more easily threshed/detached from panicles as grain and stalk moisture content decreases, the negative relation between variable MC and drying losses is as expected. The negative relation between yield of dried grain and dryiug losses is less obvious. This may imply that percent of drying losses decrease with scale of operation (over the small range observed), or this may simply mean that drying losses are underestimated and that the relative errors $\frac{\text{true drying loss} - \text{recorded drying loss}}{\text{drying yield}}$ increases with drying yield.

Table 20 : Summary of Drying Losses (%)

A. % losses by Region :

	All regions (N=402)	Central (N=130)	Northeast (N=194)	North (N=66)	South (N=12)
mean	0.1364	0.1703	0.1132	0.1324	0.1663
S.D.	0.15	0.19	0.09	0.15	0.21

B. % losses by Province

	Suphan Buri (N=42)	Lop Buri (N=34)	Prachin Buri (N=54)	Nakhon Ratchasima (N=74)	Khon Kaen (N=58)
mean	0.2031	0.1309	0.1696	0.1361	0.0812
S.D.	0.25	0.08	0.19	0.11	0.04
	Surin (N=62)	Phitsanulok (N=36)	Chieng Rai N=30	Nakhon Si Thammarat (N=12)	
mean	0.1159	0.0574	0.2223	0.1663	
S.D.	0.10	0.05	0.18	0.21	

C. % losses by Drying Method

	laying loosely in field (N=274)	binding and drying in field (N=59)	laying loosely in small piles (N=68)
mean	0.1296	0.1442	0.1571
S.D.	0.15	0.15	0.14

Table 21 : Variables in Regression Analysis of Drying Losses

1. Losses : total drying losses (%) (avg-0.14 %, SD-0.1 %)
2. MC : % moisture content of grain after drying (avg-16.29 %, SD-3.7 %)
3. YLD : Kg grain dried/trial (avg-8.3 Kg, SD0.6Kg)
4. Drytime : number of days drying in field (avg-3.9 days, SD-2.9 days)
5. Drying Method

DM3-binding and drying harvested stalks in field	(15 %)
DM4-laying harvested stalks loosely in small piles	(17 %)
base-laying harvested stalks loosely in field	(68 %)

6. Region (aggregate)

R1-Central	(32 %)
R2-Northeast	(48 %)
R3-North	(16 %)
base-South	(4 %)

7. Province (disaggregate)

P1-Suphan Buri	(10 %)
P2-Lop Buri	(8 %)
P3-Prachin Buri	(13 %)
P4-Nakhon Ratchasima	(18 %)
P5-Khon Khaen	(14 %)
P6-Surin	(15 %)
P7-Phitsanulok	(9 %)
P8-Chieng Rai	(7 %)
base-Nakhon Si Thammarat	(4 %)

8. Variety (aggregate)

RD-RD varieties	(27 %)
base-local varieties	(73 %)

9. Variety (disaggregate)

RD varieties -

RD6 (10 %) RD10 (2 %) RD23 (3 %)

Local varieties -

L2-LepMu Nang	(5)	L9-Hom Chan	(1)
L4-Kao Yai	(6)	L10-Lueng Pra Tui	(5)
L5-San Pa Tong	(3)	L11-Tae We Da	(2)
L6-Kao Deng Noi	(1)	L12-Kao Ta Haeng	(13)
L7-Check Chur Mao	(2)	L13-Kao Dak Mali 105	(21)
L8-Kao Pak Mo	(1)	L14-Kao Luang	(3)

base-RD7 (13 %)

Table 22 A : Regression Results : Drying Losses.

Losses	Constant	MC	YLD	DRYTIME	DM3	DM4	R1	R2	R3	RD	R^2
A. Linear models											
1.	0.11	0.01	-0.01*	0.01	0.00	-0.05	-	-	-	-	.2342
		(5.8)	(8.0)	(0.0)	(0.0)	(2.0)					
2.	0.10	0.01*	-0.01*	0.00	0.01	-0.03	0.08	0.01	-0.03	-	.1969
		(8.6)	(10.4)	(0.1)	(0.1)	(0.9)	(2.0)	(0.0)	(0.3)		
3.	0.00	-0.01	-0.01*	-0.00	0.09	0.02	-	-	-	0.03	.1605
		(5.8)	(11.3)	(0.4)	(4.2)	(0.4)					
B. Log-linear models											
4.	-0.21	-0.42*	0.43*	0.02	0.19	-0.16	-	-	-	-	.3436
		(9.9)	(12.7)	(0.1)	(0.5)	(0.6)					
5.	-0.14	-0.38*	-0.55*	0.02	0.04	-0.03	0.36	0.15	-0.41	-	.3080
		(7.6)	(24.1)	(0.1)	(0.1)	(0.0)	(0.9)	(0.1)	(1.2)		
6.	-0.69	-0.41*	-0.42*	-0.04	0.50	0.15	-	-	-	0.22	.2766
		(9.0)	(14.4)	(0.4)	(4.0)	(0.7)				(4.1)	

Note: F - statistics are listed in parentheses below coefficients

* denotes statistical significance from 0 at 99% level of confidence

$F_{.01;\ 1,373-387}$ 6.80 $F_{.05;\ 1,373-387}$ 3.90

Table 22 B : Regression Results : Drying Losses. (Concluded)

	P1	P2	P3	P4	P5	P6	P7	P8	RD6	RD10	RD23	L2	L4	L5	L6	L7	L8	L9	L10	L11	L12	L13	L14
A. Linear models																							
1.	0.08	0.05	0.16	0.03	0.42*	-0.01	-0.07	0.40	-0.44*	-0.18	-0.08	-0.10	-0.47*	-0.46*	-0.11	0.06	-0.07	-0.02	-0.05	-0.14	-0.04	-0.05	-0.05
	(1.3)	(0.5)	(4.2)	(0.1)	(7.9)	(0.0)	(0.9)	(8.3)	(9.2)	(1.5)	(2.3)	(2.9)	(9.6)	(9.2)	(2.2)	(1.0)	(1.2)	(0.1)	(0.8)	(4.7)	(1.1)	(3.1)	(1.0)
2.									-0.01	0.24*	-0.12	-0.03	-0.05	-0.05	-0.09	0.08	-0.04	0.00	0.00	-0.08	-0.02	-0.07*	-0.03
									(0.1)	(15.0)	(0.1)	(0.7)	(1.8)	(1.1)	(1.6)	(2.0)	(0.5)	(0.0)	(0.0)	(2.2)	(0.6)	(9.0)	(0.6)
3.	0.18	0.12	0.15	0.12	0.08	0.01	-0.01	0.12															
	(6.3)	(3.3)	(5.2)	(2.9)	(1.2)	(0.0)	(0.0)	(3.5)															
B. Log-Linear models																							
4.	0.37	0.28	1.12	0.44	0.78	-0.07	-0.58	0.66	-0.85	0.32	0.00	-1.12*	-0.91	-0.76	-0.72	0.15	-0.72	-0.15	-0.60	-1.16*	-0.42	0.31	-0.13
	(0.6)	(0.4)	(5.2)	(0.8)	(0.9)	(0.0)	(1.6)	(0.7)	(1.1)	(0.2)	(0.0)	(12.2)	(1.1)	(0.8)	(3.0)	(0.2)	(3.0)	(0.1)	(4.7)	(20.0)	(3.8)	(4.1)	(0.3)
5.									-0.01	1.24*	-0.23	-0.42	-0.21	-0.07	-0.42	0.40	-0.39	0.18	-0.07	-0.98*	-0.14	-0.38*	-0.06
									(0.0)	(13.1)	(0.7)	(3.9)	(1.0)	(0.1)	(1.1)	(1.7)	(1.4)	(0.1)	(0.1)	(10.7)	(0.8)	(8.7)	(0.1)
6.	0.65	0.35	0.40	0.56	0.32	-0.12	-0.34	0.32															
	(2.0)	(0.6)	(0.8)	(1.5)	(0.4)	(0.1)	(0.6)	(0.6)															

4. Estimates of Binding Loss Functions.

Binding losses by region and province are summarized in Table 4.23. Recorded losses are very low (average 0.27 %), and are somewhat higher in the Central region (average 0.41 %) than in the Northeastern and Northern regions (average 0.20 %).

Regression results for binding loss functions are summarized in Table 25. In contrast to the cases for harvesting and threshing, the data set designed to account for binding losses permitted simultaneous disaggregation of region and variety (equations 1, 4). Log-linear models show substantially greater explanatory power (higher R^2's) than do linear models.

For log-linear equation 5, immaturity of crop (IM) and adverse solar conditions at the time of binding (SOL 2' SOL 3) are positively related to percent of binding losses. The positive relation between binding losses and adverse solar conditions (clouds or intermittent sunshine is not surprising; but the positive relation between binding losses and immaturity of crop was not expected). Note that coefficients for the variable IM are not significant for any other equation, and that these coefficients are believed to control the effect of grain moisture content on losses, which includes the effect of crop immaturity on binding losses via high grain moisture contents.

Table 23: Summary of Binding Losses (%)

A. % losses by Region:

	All Regions (N=309)	Central (N=130)	Northeast (N=192)	North (N=68)
mean	0.2712	0.4104	0.1971	0.2142
S.D.	0.38	0.52	0.28	0.17

B. % losses by Province:

	Suphan Buri (N=42)	Lop Buri (N=34)	Prachin Buri (N=54)	Nakhon Ratchasima (N=74)
mean	0.4281	0.2660	0.4875	0.3124
S.D.	0.61	0.11	0.59	0.40
	Khon Khaen (N=58)	Surin (N=60)	Phitsanulok (N=36)	Chieng Rai (N=32)
mean	0.1784	0.0730	0.0908	0.3531
S.D.	0.12	0.05	0.05	0.15

Table 24: Variables in Regression Analysis of Binding Losses

1. Losses : total binding losses (%) (avg–0.27 %, SD–0.4 %)
2. MC : % moisture content of grain during binding (avg–16.56 %, SD–3.1%)
3. YLD : Kg grain bound/trial (avg–8.5 Kg, SD–3.6 Kg)
4. DRYTIME : number of days drying in field (avg–4.0 days, SD–2.7 days)
5. Crop Maturity

IM	–	immature	(4 %)
OM	–	overmature	(5 %)
base	–	mature	(91 %)

6. Solar Conditions

SOL 2	–	Cloudy	(7 %)
SOL 3	–	intermittent sunshine	(39 %)
base	–	strong sun	(54 %)

7. Region (aggregate)

R1	–	Central	(33 %)
R2	–	Northeast	(49 %)
base	–	North	(17 %)

8. Province (disaggregate)

P1	–	Suphan Buri	(11 %)
P2	–	Lop Buri	(9 %)
P3	–	Prachin Buri	(14 %)
P4	–	Nakhon Ratchasima	(19 %)
P5	–	Khon Khaen	(15 %)
P6	–	Surin	(15 %)
P7	–	Phitsanulok	(9 %)
base	–	Chieng Rai	(8 %)

9. Variety (aggregate)

RD	–	RD varieties	(32 %)
base	–	local varieties	(68 %)

10. Variety (disaggregate)

RD varieties –

RD6 (11 %) RD15 (7 %) RD23 (3 %)

Local varieties –

L4	–	Kao Yai	(7)	L10	–	Lueng Pra Tui	(5)
L5	–	San Pa Tong	(4)	L11	–	Tae Wa DA	(3)
L6	–	Kao Deng Noi	(1)	L12	–	Kao Ta Haeng	(13)
L7	–	Check Chur Mao	(2)	L13	–	Kao Dak Mali 105	(22)
L8	–	Kao Pak Mo	(2)	L14	–	Kao Luang	(4)
L9	–	Hom Chan	(1)				
base	–	RD7 (9 %)					

Table 25 A: Regression Results: Binding Losses.

Losses	constant	MC	YLD	DRYTIME	IM	OM	SOL2	SOL3	R1	R2	RD	R^2
A. Linear models												
1.	0.63	-0.02	0.00	0.01	0.15	0.05	-0.03	-0.04	-	-	-	.2362
		(3.7)	(0.3)	(2.6)	(1.8)	(0.3)	(0.1)	(0.6)				
2.	0.36	-0.01	0.00	0.02	0.02	0.08	0.03	0.04	0.13	-0.06	-	.2017
		(1.2)	(0.2)	(4.0)	(3.7)	(0.9)	(0.1)	(0.8)	(2.8)	(0.7)		
3.	0.44	-0.01	-0.01	0.00	0.09	0.10	0.03	0.04	-	-	0.02	.1569
		(1.0)	(0.5)	(0.4)	(0.7)	(1.4)	(0.1)	(0.8)			(0.1)	
B. Log-linear models												
4.	-0.07	-0.33	-0.01	0.09	0.38	0.25	0.25	0.13	-	-	-	.5349
		(1.5)	(0.0)	(1.4)	(3.3)	(2.5)	(2.2)	(1.9)				
5.	-1.08	-0.18	-0.06	0.02	0.71*	0.28	0.45*	0.37*	0.47*	-0.25	-	.4710
		(0.5)	(0.3)	(0.1)	(12.0)	(2.8)	(7.4)	(19.7)	(9.2)	(2.5)		
6.	-0.86	-0.11	-0.08	0.00	0.31	0.35	0.20	0.72	-	-	0.04	.4800
		(0.2)	(0.6)	(0.0)	(2.5)	(4.7)	(1.7)	(0.7)			(0.2)	

Note: F - statistics are listed in parentheses below coefficients

* denotes statistical significance from 0 at 99% level of confidance

$F_{.01;\ 1,\ 361-374} \approx 6.80$ $F_{.05;\ 1,\ 361-374} \approx 3.90$

Table 25 B : Regression Results : Binding Losses. (Concluded)

	P1	P2	P3	P4	P5	P6	P7	RD6	RD15	RD23	L4	L5	L6	L7	L8	L9	L10	L11	L12	L13	L14
A. Linear models																					
1.	0.07	-0.35	-0.07	-0.34	-0.16	-0.50*	-0.45*	-0.14	0.08	0.10	-0.04	-0.15	0.86*	0.46*	-0.07	-0.06	0.14	-0.17	0.07	0.12	-0.29
	(0.3)	(4.4)	(0.2)	(4.4)	(1.4)	(8.7)	(7.7)	(1.0)	(0.4)	(0.5)	(0.0)	(0.6)	(19.0)	(8.5)	(0.2)	(0.1)	(1.8)	(1.4)	(0.6)	(1.5)	(6.3)
2.								-0.04	-0.23	-0.25	-0.00	-0.10	0.69*	0.26	-0.25	-0.21	0.05	-0.20	-0.11	-0.17	-0.19
								(0.2)	(5.9)	(3.2)	(0.0)	(0.9)	(13.2)	(3.2)	(2.3)	(0.7)	(0.3)	(2.3)	(2.3)	(6.6)	(3.3)
3.	0.12	-0.07	0.14	-0.02	-0.07	-0.23	-0.23														
	(1.6)	(0.4)	(1.8)	(0.0)	(0.4)	(6.5)	(6.5)														
B. Log-Linear models																					
4.	-0.12	-0.74	-0.28	-0.96*	-0.52	-2.00*	-1.62*	-0.50	-0.04	-0.10	-0.23	-0.98*	0.84	0.90*	-0.31	-0.51	-0.16	-0.26	0.11	0.09	-0.42
	(0.2)	(5.8)	(1.0)	(10.1)	(3.7)	(38.2)	(28.7)	(3.3)	(0.0)	(0.1)	(0.5)	(7.2)	(5.2)	(9.7)	(1.0)	(1.1)	(0.7)	(1.0)	(0.4)	(0.3)	(3.9)
5.								0.07	-1.01*	-1.16*	0.22	-0.50	0.67	0.59	-0.56	-0.66	-0.31	-0.13	-0.11	-0.71*	-0.26
								(0.2)	(29.1)	(22.2)	(1.3)	(5.3)	(3.2)	(4.3)	(3.2)	(1.8)	(2.6)	(0.2)	(0.6)	(30.0)	(1.6)
6.	0.13	-0.16	0.17	-0.32	-0.60*	-1.52*	-1.20*														
	(0.4)	(0.5)	(0.7)	(2.4)	(7.6)	(62.6)	(47.8)														

5. Estimates of Transport Loss Functions.

Transport losses by region and province are summarized in Table 26. Recorded losses average only 0.33%, and are highest in the Central region (average 0.53 %) and lowest in the Southern region (average 0.15 %). Average losses by province vary from 0.74 % (Prachin Buri) to 0.15 % (Nakhon Si Thammarat).

Regression results for transport loss functions are summarized in Table 4.28 As in the case of drying and binding, the data set designed to account for transport losses permitted simultaneous disaggregation of region and variety (equations 1, 4). Log-linear models show somewhat greater explanatory power than do linear models.

For log-linear models, grain moisture content and transport yield are negatively related to transport losses, and crop immaturity is positively related to transport losses. The negative relation between transport losses and grain moisture content is as expected. On the other hand the estimated relations between percent of transport loss and transport yield and crop immaturity were unexpected.

Table 26 : Summary of Transport Losses (%)

A. % losses by Region:

	All Regions (N=422)	Central (N=130)	Northeast (N=194)	North (N=68)	South (N=30)
mean	0.3289	0.5258	0.2719	0.1939	0.1509
S.D.	0.30	0.35	0.23	0.22	0.11

B. % losses by Province:

	Suphan Buri (N=42)	Lop Buri (N=34)	Prachin Buri (N=54)	Nakhon Ratchasina (N=76)	Khon Khaen (N=58)
mean	0.3241	0.4299	0.7429	0.3050	0.1582
S.D.	0.19	0.25	0.37	0.31	0.09

	Surin (N=60)	Phitsanulok (N=36)	Chieng Rai (N=32)	Nakhon Si Thammarat (N=30)
mean	0.3399	0.1648	0.2267	0.1509
S.D.	0.17	0.09	0.31	0.11

Table 27 : Variables in Regression Analysis of Transport Losses

1. Losses : total transport losses (%) (avg-0.33 %, SD-0.3 %)
2. MC : % moisture content of grain at transport (avg-16.58 %, SD-3.7 %)
3. YLD : Kg grain transported/trial (avg-8.6 Kg, SD-4.9 Kg)
4. Drytime : number of days drying in field (avg-3.3 days, SD-3.0 days)
5. Crop Maturity
   - IM - immature (6 %)
   - OM - overmature (5 %)
   - base - mature (89 %)
6. Region (aggregate)
   - R1 - Central (31 %)
   - R2 - Northeast (46 %)
   - R3 - North (16 %)
   - base - South (7 %)
7. Province (disaggregate)
   - P1 - Suphan Buri (10 %)
   - P2 - Lop Buri (8 %)
   - P3 - Prachin Buri (13 %)
   - P4 - Nakhon Ratchasima (18 %)
   - P5 - Khon Khaen (14 %)
   - P6 - Surin (14 %)
   - P7 - Phitsanulok (9 %)
   - P8 - Chieng Rai (8 %)
   - base - Nakhon Si Thammarat (7 %)
8. Variety (aggregate)
   - RD - RD varieties (30 %)
   - base - local varieties (70 %)
9. Variety (disaggregate)
   - RD varieties -
     RD6 (10 %) RD13 (30 %) RD15 (70 %)
   - Local varieties -

L1 - Look Lai	(4)	L8 - Kao Pak Mo	(2)
L2 - Lep Mu Nang	(5)	L9 - Hom Chan	(0)
L4 - Kao Yai	(6)	L10 - Lueng Pra Tui	(5)
L5 - San Pa Tong	(3)	L12 - Kao Ta Haeng	(12)
L6 - Kao Deng Nai	(1)	L13 - Kao Kak Mali 105	(20)
L7 - Check Chur Mao	(2)	L14 - Kao Luang	(4)

base - RD7 (9 %)

Table 28 A: Regression Results: Transport Losses

Losses	Constant	MC	YLD	DRYTIME	IM	OM	R1	R2	R3	RD	R^2
A. Linear models											
1.	0.43	-0.01	-0.01	-0.00	9.16*	0.10	-	-	-	-	.4596
		(2.8)	(2.3)	(0.0)	(7.7)	(3.2)					
2.	0.42	-0.01	-0.01	0.02*	0.21*	0.12	0.80	-0.15	-0.19	-	.3599
		(1.5)	(3.4)	(19.5)	(12.0)	(4.3)	(0.2)	(0.7)	(1.1)		
3.	0.20	-0.00	-0.01	0.01	0.16*	0.15	-	-	-	0.01	.4016
		(0.7)	(4.7)	(2.7)	(8.7)	(7.1)				(0.0)	
B. Log-linear models											
4.	0.89	-0.40*	-0.42*	-0.03	0.45*	0.16	-	-	-	-	.4880
		(8.6)	(19.9)	(0.2)	(7.8)	(1.0)					
5.	0.96	-0.35	-0.46*	0.14	0.45*	0.35	-0.33	-0.88	-1.47*	-	.4346
		(6.1)	(24.6)	(5.4)	(7.6)	(5.2)	(0.4)	(3.0)	(8.3)		
6.	-0.03	-0.40*	-0.40*	0.01	0.22	0.29	-	-	-	-0.04	.4125
		(12.2)	(23.9)	(0.0)	(2.1)	(3.6)				(0.2)	

Note: F - statistics are listed in parentheses below coefficients

* denotes statistical significance from 0 at 99% level of confidence

$F_{.01;\ 1,\ 393\text{-}407} \approx 6.80$ $F_{.05;\ 1,\ 393\text{-}407} \approx 3.90$

Table 28 B : Regression Results : Transport Losses (Concluded)

	P1	P2	P3	P4	P5	P6	P7	P8	RD6	RD13	RD15	L1	L2	L4	L5	L6	L7	L8	L9	L10	L12	L13	L14
A. Linear models																							
1.	0.03	0.08	0.59*	0.02	-0.16	0.01	-0.19	-0.14	0.08	-0.23	0.03	-0.16	-0.29*	0.09	-0.00	0.04	0.15	-0.27*	-0.21	-0.16	0.00	0.09	0.02
	(0.0)	(0.2)	(10.6)	(0.0)	(0.6)	(0.0)	(1.2)	(0.5)	(0.8)	(1.7)	(0.2)	(0.7)	(12.8)	(0.6)	(0.0)	(0.1)	(2.2)	(7.3)	(0.8)	(4.6)	(0.0)	(2.4)	(0.1)
2.									0.07	-0.24	0.05	-0.21	0.14	0.02	-0.09	0.13	0.21	-0.22	-0.11	0.14	0.08	0.08	-0.10
									(1.2)	(4.8)	(0.1)	(1.3)	(1.0)	(4.3)	(4.7)	(0.2)	(4.3)	(4.8)	(0.2)	(4.3)	(2.2)	(3.4)	(2.1)
3.	0.20*	0.30*	0.57*	0.16*	0.59	0.19*	0.01	0.10															
	(9.9)	(22.7)	(89.9)	(8.5)	(1.0)	(8.9)	(0.0)	(1.9)															
B. Log-linear models																							
4.	-0.21	-0.41	0.67	-0.67	-0.49	-0.37	-1.26	-1.19	0.03	-0.90	0.29	-1.14	0.22	-0.04	-0.53	0.69	0.32	-0.97*	-0.58	-0.06	0.34	0.43*	0.25
	(0.2)	(0.7)	(1.7)	(1.8)	(0.8)	(0.5)	(6.5)	(5.1)	(0.0)	(3.3)	(1.7)	(4.9)	(1.0)	(0.0)	(2.3)	(3.8)	(1.3)	(12.1)	(0.8)	(0.1)	(3.7)	(7.0)	(1.6)
5.									0.09	-0.91	0.31	-1.22	0.47*	0.06	-0.51	0.55	0.16	-1.14*	-0.70	0.29	0.24	0.31*	0.02
									(0.4)	(3.1)	(3.2)	(5.3)	(7.7)	(0.1)	(5.7)	(2.5)	(0.4)	(18.0)	(1.1)	(2.8)	(3.1)	(6.8)	(0.0)
6.	0.74*	0.81*	1.44*	0.38	0.22	0.83*	-0.18	-0.23															
	(12.8)	(17.1)	(50.4)	(3.8)	(1.1)	(13.7)	(0.8)	(1.2)															

6. Estimates of Cleaning Loss Functions.

Cleaning losses by region, province and method are summarized in Table 4.29. Recorded losses average only 0.35 %, ranging by region from 0.47 % (Northeast) to 0.22% (Central), and ranging by province from 0.76 % (Surin) to 0.10 % (Phitsanulok). Losses by cleaning method range from 0.41 % (bamboo tray was by far the most common method of cleaning in our data sample) to 0.05 % (winnowing).

Regression results for cleaning loss functions are summarized in Table 4.31. As in the case of harvesting and threshing, region and variety could not be disaggregated simultaneously without leading to perfect collinearity of explanatory variables. Moreover, disaggregation of regions to provinces also required elimination of other variables in order to avoid perfect collinearity; so two cleaning methods (MAN, CLEAN), in addition to the base variable TRAY, were deleted from equations 2 and 4. The log-linear models show much higher explanatory power than do the linear models.

For log-linear model 3, cleaning loss is positively related to mechanical cleaners (CLEAN), (relative to the use of trap for cleaning) and negatively related to cleaning yield (YLD). The first relation is as expected (percent of cleaning losses may decrease over the scale of operation observed); but the negative coefficient for CLEAN is surprising.

Table 29: Summary of Cleaning Losses (%)

A. % losses by Region:

	All Regions	Central	Northeast	North	South
	(N=402)	(N=114)	(N=170)	(N=58)	(N=60)
mean	0.3509	0.2167	0.4694	0.2946	0.3243
S.D.	0.89	0.29	0.89	1.47	0.90

B. % losses by Province:

	Suphan Buri	Lop Buri	Prachin Buri	Nakhon Ratchsima	Khon Khaen
	(N=26)	(N=34)	(N=54)	(N=72)	(N=56)
mean	0.2386	0.2665	0.1749	0.4261	0.3046
S.D.	0.38	0.24	0.26	0.61	0.27
	Surin	Phitsanulok	Chieng Rai	Nakhon Si Thammarat	
	(N=42)	(N=22)	(N=36)	(N=60)	
mean	0.7634	0.1023	0.4121	0.3243	
S.D.	1.55	0.25	1.86	0.90	

C. % losses by Cleaning Method:

	winnowing	pouring from basket	bamboo tray	bamboo fan	man-powered machine	mechanical cleaner
	(N=12)	(N=3)	(N=267)	(N=44)	(N=22)	(N=54)
mean	0.0486	0.1989	0.4095	0.4279	0.1023	0.1749
S.D.	0.06	0.31	0.84	1.67	0.24	0.26

Table 30 : Variables in Regression Analysis of Cleaning Losses

1. Losses : total cleaning losses (%) (avg-0.35 %, SD-0.9 %)
2. MC : % moisture content of grain during cleaning (avg-11.58 %, SD-8.2 %)
3. YLD : Kg grain cleaned/trial (avg-7.8 Kg, SD-20.2 Kg)
4. Cleaning method

WINN	- winnowing	(3 %)
POUR	- pouring from basket	(1 %)
TRAY	- bamboo tray	(66 %)
FAN	- bamboo fan	(11 %)
MAN	- man-powered machine	(6 %)
CLEAN	- mechanical cleaner	(13 %)

5. Region (aggregate)

R1	- Central	(28 %)
R2	- Northeast	(42 %)
R3	- North	(14 %)
base	- South	(16 %)

6. Province (disaggregate)

P1	- Suphan Buri	(6 %)
P2	- Lop Buri	(8 %)
P3	- Prachin Buri	(13 %)
P4	- Nakhon Ratchasima	(18 %)
P5	- Khon Khaen	(14 %)
P6	- Surin	(10 %)
P7	- Phitsanulok	(5 %)
P8	- Chieng Rai	(9 %)
base	- Nakhon Si Thammarat	(16 %)

7. Variety (aggregate)

RD	- RD varieties	(28 %)
base	- local varieties	(72 %)

8. Variety (disaggregate)

RD varieties -

RD6 (10 %) RD10 (3 %) RD13 (4 %) RD15 (4 %)

Local varieties -

L1 - Look Lai	(8)	L 7 - Check Chur Mao	(2)
L2 - Lep Mu Nang	(8)	L 8 - Kao Pak Mo	(1)
L4 - Kao Yai	(6)	L10 - Lueng Pra Tui	(4)
L5 - San Pa Tong	(3)	L12 - Kao Ta Haeng	(13)
L6 - Kao Deng Nai	(1)	L13 - Kao Dak Mali 105	(20)

base - RD7 (10 %)

Table 31 A: Regression Results: Cleaning Losses

Losses	Constant	MC	YLD	WINN	POUR	FAN	MAN	CLEAN	R1	R2	R2	RD	R^2
A. Linear models													
1.	-0.23	0.04*	-0.00	-1.13	-0.33	-0.18	-1.68*	0.16	0.06	0.56	1.71*	-	.1716
		(36.0)	(2.5)	(6.7)	(0.4)	(0.6)	(15.4)	(0.4)	(0.0)	(2.7)	(12.0)		
2.	-0.28	0.04*	-0.00	-0.38	-0.25	-0.11	-	-	-	-	-	.0.20	.1310
		(31.9)	(1.7)	(1.0)	(0.3)	(0.2)						(1.8)	
B. Log-linear models													
3.	-0.55	0.04	-0.63*	-0.57	-0.58	-0.33	-0.88	0.75*	0.14	0.82	1.40*	-	.5665
		(0.4)	(82.2)	(1.9)	(1.4)	(2.1)	(4.3)	(8.3)	(0.2)	(5.5)	(7.9)		
4.	-1.03	-0.02	-0.56*	0.14	-0.63	-0.33	-	-	-	-	-	-0.12	.5308
		(0.1)	(67.0)	(0.1)	(1.6)	(2.0)						(0.7)	

Note: I. TRAY = base variable for cleaning methods; and MAN and CLEAN also are deleted from equations 2 and 4 in order to avoid perfect collinearity for the specific data sets

II. F - statistics are listed in parentheses below coefficients

* denotes statistical significance from 0 at 99% level of confidence

$F_{.01;\ 1,\ 377-387} \approx 6.80$ $F_{.05;\ 1,\ 377-387} \approx 3.90$

Table 31 B: Regression Results: Cleaning Losses. (Concluded)

	P1	P2	P3	P4	P5	P6	P7	P8	RD6	RD10	RD13	RD15	L1	L2	L4	L5	L6	L7	L8	L10	L12	L13
A. Linear modely																						
1.	-	-	-	-	-	-	-	-	-0.59	-1.79*	0.16	-0.35	-0.35	-0.04	-0.8*	-0.58	-0.36	-0.37	-0.53	-0.04	-0.15	0.13
									(3.5)	(14.6)	(0.2)	(1.4)	(1.2)	(0.0)	(7.5)	(3.0)	(0.6)	(1.2)	(1.3)	(0.0)	(0.5)	(0.3)
2.	0.41	0.08	0.24	0.41	0.02	0.84*	0.21	0.64														
	(3.1)	(0.2)	(1.7)	(8.5)	(0.0)	(21.3)	(0.7)	(3.8)														
B. Log-Linear models																						
3.	-	-	-	-	-	-	-	-	-0.47	-1.81*	-0.56	-0.31	-0.74	-0.14	-0.21	-0.01	-0.32	-0.31	-0.53	0.04	-0.33	0.04
									(2.0)	(15.3)	(2.7)	(1.2)	(5.6)	(0.2)	(0.5)	(0.0)	(0.5)	(0.9)	(1.3)	(0.0)	(2.2)	(0.0)
4.	0.90*	0.42	1.21*	1.19*	1.09*	1.27*	0.98*	0.78														
	(14.3)	(5.0)	(44.6)	(58.4)	(33.0)	(50.8)	(16.2)	(5.8)														

Taxation of Rice Exports in Thailand: A Tax Simulation Analysis

*Kitti Limskul**

1. Introduction

Thailand is basically an agricultural economy. Rice is not only the main staple for most of the Thais but has also been an important source of foreign exchange earnings from post WW II up to the present. The Thai government introduced a taxation of rice exports through the export premium called the 'rice premium' during the 1955-1970's. It was a specific tax on rice export for most of the period. It has been claimed by the government (the Ministry of Commerce) to be a stabilization policy instrument for the domestic market prices and quantities of rice vis-a-vis the world market. In addition, it was also an important source of tax revenue, especially during the 1955-1960's. Nevertheless, the revenue has steadily declined, from 15 per cent during 1955-1958, to less than 10 per cent in the 1960's, and less than 1.5 per cent during 1970-1973. Since the tax has a direct effect on lowering both the domestic consumer and producer prices of rice, its economic impact on trade, welfare, as well as on development policy has been a highly controversial subject of debate.

One of the economic implications the rice premium has on trade, claim the opponents of the tax, is a disincentive effect on production of paddy. Given an inelastic domestic consumption, the derived shortage of rice supply will induce domestic prices and thereby cause the export prices of rice to increase. Since foreign demand for Thai rice is very elastic, this will decrease the export potentials of rice. Hence, an abolishment of the tax, as claimed by the opponents, will be necessary. Supporters of the tax, on the other hand, argue that the foreign

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demand for Thai rice is not highly elastic but is subject to various interventions for instance, government policy and other imperfections in the world and the domestic rice market. The elimination of the tax will not increase exports but the loss in tax revenue will be an instability in the domestic prices of rice. Furthermore, they even claim that the farmers do not respond to the farm-gate price of paddy thereby production does not decrease despite the suppressed domestic prices by the tax.

In regards to the welfare implication of the tax, it is denounced by the opponents to be an unfair in-come transfer from the rural to urban dwellers who are relatively well off. Supporters, on the other hand, argue that the burden is caused partly by foreign consumers of Thai rice and partly by the middle man in the domestic rice market. Hence, the elimination of the tax will serve those who are not farmers. Moreover, the suppressed farm-gate price is compensated for by government investment in agriculture.

In terms of the development policy implication of the tax, supporters claim that industrialization needs a cheap supply of labor. This can be achieved through the cheap domestic prices of rice. Opponents on the other hand, argue that the abolishment of the tax will increase the income of the farmers and thereby the demand for the nonagricultural sector's goods and services. Industrialization can be achieved as well.

We see that the debates on the tax are to some extent empirical questions both on micro-and macro economics aspects. A brief survey of the literature that will be helpful for our study are as follows :

In the early 1960's, the rice export tax, namely the rice export premium was a hot issue among the Thai economists, the government circle, and foreigners who were interested in the Thai economy. One of the pioneered studies was by Sura Sanittanont (12). He hypothesised that the rice export tax was a major disincentive factor to rice production and export. According to his study, the foreign demand for Thai rice was highly elastic. Moreover, the domestic rice and paddy markets were highly competitive and that the domestic supply of paddy was significantly price responsive. Therefore, the elimination of the rice export tax would, in the short run, increase the supply of export and paddy output, after time lags. A higher domestic price would increase the farmers' income but would not generate any serious inflationary pressure on the economy. In the short run he stated that the 90 per cent of the rice export tax would go to the farmers in higher paddy prices and the rest was an exporting margin. However, his estimation of the price elasticity of demand for Thai rice by the rest of the world is only tentative since the numerical values used in the calculation were only assumed values.

E. V. Roy (11) cited Usher's study (14) for his calculation of the deflationary impact on the domestic price of rice and paddy by the rice premium. He came to the conclusion that the abolishment of the tax would raise the retail price of rice, the urban cost of living and the farm gate paddy prices. For example, it would raise the retail price of rice by 60% and would raise the Bangkok wholesale prices of various grades of white rice by 72 to 90 per cent, and the paddy price by 85 per cent.

Another investigation by N. V. Lam (5, 6) found a much lower deflationary effect of the tax. He figured an abolishment of the tax would increase the paddy price, the wholesale and retail rice price by 30-40 per cent less than calculated by Roy.

A study by Bertrand M. Renaud and Phiphit Suphaphiphat (9) tried to determine the magnitude of the increase in the domestic rice price and paddy price for separate types of rice and paddy as a consequence of the reduction or the abolishment of the rice export tax. The results of the study were in line with Sura's conclusion. The rice export tax (rice premium, export tax, and a municipal tax) suppressed the farm gate price of paddy and has a disincentive effect on production. Moreover, as a stabilization tool it was not effective.

Hiroshi Tsujii (13) pointed out that those who opposed or supported the rice premium policy had different assumptions about the international rice market. The opponents assumed the international rice market to be perfectly competitive, while the latter assumed it to be imperfectly competitive. He further pointed out that the assumption of perfectly competitive was not supported according to his analysis.

Another study by Chung Ming Wong (17) under the title of "A Model for Evaluating the Effects of Thai Government Taxation of Rice Exports on Trade and Welfare" applied simultaneous equations to investigate the effects of rice export tax. The four equations are : a domestic supply equation, a domestic consumption, equation, an export price equation, and a domestic consumption equation, an export price equation, and a price transmission equation; with two identities: a market clearing identity and the export price net of rice premium. He used the model to estimate various prices and income elasticities. For instance, the price elasticity of foreign demand for Thai rice was-4, which was not as high as usually assumed. Furthermore, an increase in rice premium would depress the net exporter's price and subsequently the domestic producers price by 80 per cent. Finally, the welfare effect of the tax was also calculated in his study.

A macroeconometric model by Virabongsa Ramangkura (15) on the Thai economy applied a simulation analysis of the elimination of the rice export tax. The abolishment of the tax had a favorable effect on the economy in terms of various endogeneous variables e.g. rice production, rice export, and GNP etc. The model had not taken into account directly the rice market clearing condition or identity in the sense of a micro-econometric model approched by Wong (17) above. The model had, however, incorporated the monetary sector and was able to link the government budget deficit and the increase in the money supply.

The Bank of Thailand's model of the Thai economy by Olan Chaipravat, Kanitta Meesook, Siri Garnjarerndee (8) is a macroeconometric model and has been used for short run forecasting and policy simulation. In this model, prices and interest rates are assumed to be determined jointly by demand and supply interaction through market equilibrium conditions. In addition, the linkage between the real and the financial sectors are achieved through interest rates and the rate of return on financial assets. The model does not take into account directly the rice market equations in the sense of Wong above.

The NESDB (National Economic and Social Development Board) model by Virabongsa Ramangkura, Piyasavasti Amranand and Associates (16) was constructed for long term planning for economic development for 1980-1990. The model has details in the real sector while assuming that equilibria in the real and financial sectors occur independently. An equilibrium in the product market is reached through changes in import flows, implying that the saving-investment gap in the domestic market is cleared by the adjusted change in foreign savings. The model does not directly take into account the rice market equations in the sense of Wong above.

We see that the review of the literature has three points which are related to this paper : Firstly, We are interested in the deflationary effect of the rice export tax or the rice premium during 1960-1979 on the rice production and export through its lowering of producer prices. Consequenty, a microeconometric approach to the rice market by Wong (17) may be suitable for this purpose. Secondly, we are interested to know how the economy would respond to an inflationary potential after the abolishment of the tax and that the government would have to rely on deficit financing (and others) through the central bank's channels. On this aspect, although it had been refered to in Sura's (12) and Usher's (14) studies, a simulation analysis should be tried with a more complete macroeconometric model. Thirdly, the adjustment process* of the BOT and the NESDB models are without doubt suitable for the modellers' purposes there, but may not be compatible with our purpose here. That is, the equilibrium between the aggregate supply of goods and services (or rice, in particular), and the aggregate demand for goods and services (or rice, in particular) may occur independently. The disequilibrium in the product market may imply a build-up of inventory stock (of rice, in particular). The build-up of inventory stock may induce price adjustments in the respective markets.

* See a comparision of the adjustment mechanism in the BOT and the NESDB model in S. Kinoshita (4)

The objective of this paper is to link those three points mentioned above together. In addition we will test a hypothesis where an abolishment of the tax will have favorable effects on the economy in terms of production (paddy, in particular), trade (rice export, in particular), and development policy. In other words, the elimination of the rice export taxes may induce an increase in the economic activities in the non-agricultural sector due to an implied change in the effective demand component i.e. real consumption level after the overall households' real disposable incomes have been increased. In order to test the hypothesis, with the data base from the Bank of Thailand (BOT), the National Economic and Social Development Board (NESDB) the Ministry of Agriculture and Co-Operatives, the Ministry of Commerce and other available sources, we made an extension of the real sector of the BOT model (8) to suit our purpose here. It should be stressed here that we are only a user of the estabished model and we have no intention in making any deprivation of the original model. With this tool, we do a simulation analysis of the abolishment of the taxes, namely the rice export premium, and the rice export duty. The simulation analysis will be done for the period between 1963-1976.

The organization of the paper is as follows: the second part provides a short description of the rice export taxes in various forms of taxation both before and during the period of study. The third part is a summary of the model used in this study together with its evaluation. The fourth part is a simulation analysis of the elimination of the rice premium, and the rice export duty. The results of the simulation are shown in terms of figure and percentage changes after periods of time due to sustained change in the policy variables. The last part includes the hypothesis testing, discussion of the results, and conclusion. The estimated results of the equations in the real sector are shown in appendix A for reference.

2. Description of the Rice Taxation in Thailand

Thailand inaugurated her free trade era after signing a Bowring Treaty with the British in 1856. In the beginning of the era, export especially rice was free from government interventions. Even in 1926, when she resumed her fiscal autonomy from the treaty with the West, rice export was still trading through a free market mechanism. Nevertheless, at the end of the World War II, in 1946, according to the Formal Agreement signed with Great Britain and India, Thailand had to surrender 1.5 million tons of rice, free of charge as war reparations. This demand of reparations coupled with the excess foreign demand for Thai rice forced the government to intervene into the rice market for fear of a domestic shortage of supply. The government decided to ban private trade in rice and set up a "Rice Office" that had a sole right to export rice. Although Thailand was permitted by the Allies to be free from all obligations as such in 1948, she has never resumed a pre-war free trade in rice. The government still retained in name the monopoly power through the "Rice Office" while in fact a great deal of the rice trade was conducted by private exporting firms. At the time, marketing of Thai rice overseas, excluding government-to-government sales by private exporters, had to obtain an export license from the Ministry of Commerce who would send officials from the Rice Office to check the firm's stock and the grades to be exported. The Rice Office collected the licence fee after that. This nominal fee or "premium" that exporters paid in order to obtain an export license during 1950-1954 was not considered from an administrative point of view as tax, the Ministry of Commerce had the power to impose, repeal or modify the premium rates by itself until 1974 when the Farmer Aid Fund was estabished. Since then, any change in rice premium rates have to be approved by the cabinet. In economic terms, it was in fact a special kind of export tax on rice exports.

There was also another form of taxation on rice exports by means of an exchange control system. During 1947-1954, the Thai government established a multiple exchange rate system to cope with the problem of black market in the foreign exchange. Thus, traders of non-traditional export goods were permitted to sell foreign exchange in the free market. But for rice, exporters were supposed to surrender the entire export proceeds to the Bank of Thailand in exchange for the local currency quoting at lower rate than the free market. This was in effect a tax on rice exports, and amounted to about $33\frac{1}{3}$ per cent of the export proceeds.

An export duty is another kind of tax on rice export in Thailand. It is an ad valorem tax which is imposed by the Department of Customs. The rate of export duty was charged as a percentage of the standard price estimated by the Department of Customs. For example in 1956, the rate of export on white rice 5 per cent was 4.2 per cent of the standard price. In 1974, and 1976 they were 10, and 5 per cent respectively.

There were also other kinds of policy instruments that were used to accompany the taxation mentioned above. These were a rice reserve requirement, and a quantitative restrictions on rice export. The former policy required exporters to surrender a fixed proportion of rice for every ton of rice exported. The latter policy included an outright ban on rice exports due to a rice shortage crisis, and export quota measures according to the rice situation.

Some details of rice export and rice premium are shown in Table 1 below. During 1960-1975, the rice premium was more than 20 per cent of rice export value except for some years, in the 1970's. Moreover it was one of important sources of revenue for the government in the 1960's (as well as from 1955-1959). As a source of revenue in 1970's, the rice premium revenue has declined in terms of the percentage share in total revenue.

Table 1

Rice Export and Rice Premium: 1960–1975

Year	Rice Export Volume (1000 metric tons) (1)	Rice Export Value (million baht) (2)	Average Price (baht/ton) (3)	Total Premium (million baht) (4)	Average Premium (baht/ton) (5)	Total Gov't Revenue (million baht) (6)	(4) % (2)	(4) % (6)
1960	1204.5	2570	2133.7	745	618.51	6792	29	10.97
1961	1574	3598	2281.6	872	552.95	7449	24.23	11.71
1962	1271.7	3240	2547.8	753	592.12	8002	23.24	9.41
1963	1417.3	3424	2415.8	819	577.36	8819	23.92	9.29
1964	1896.3	4389	2314.5	1238	622.85	9957	28.21	12.43
1965	1896.3	4334	2285.5	1192	639.72	11,344	27.50	10.51
1966	1507	4001	2655	995	660.25	12,901	24.87	7.71
1967	1481.8	4653	3140.2	995	671.48	14,777	21.38	6.73
1968	1070	3775	3528	1268	1185.05	16,889	33.59	7.51
1969	1022.4	2945	2880.5	1037	1014.28	18,296	35.21	5.67
1970	1064.4	2517	2364.7	540	507.33	18,793	21.45	2.87
1971	1577	2909	1844.6	225	142.67	19,355	7.73	1.16
1972	2112	4437	2100.9	158	74.81	21,535	3.56	0.09
1973	848.7	3593	4239.4	333	392.35	26,950	9.27	0.01
1974	1030.8	9778	9485.9	3123	3029.68	38,959	31.94	0.08
1975	952.36	5852	6144.7	371	389.56	39,568	6.34	0.09

Source : Data on export volumes, export values, and prices are from NESDB (National Economic and Social Development Board), and IMF (International Monetary Fund), *International Financial Statistics*, Yearbook, 1984.
Data on the rice premium, and government revenue are from the BOT (Bank of Thailand), *Monthly Bulletin* various issues.

3. Structure of the Model

The model in this paper is an extended version of the BOT model (8). The model comprises real and financial sectors. In order to be able to explain the real side of the economy, the model takes into account both the influences of demand and supply in the product market. On the supply side outputs in both agricultural and non-agricultural sectors are determined by the producers' profit maximization subject to the technology constraint. These together determine the aggregate supply of goods and services in the economy. On the demand side, aggregate demand consists of the demand for goods and services of private, government, and the rest of the world sectors respectively the private consumption demand captures a larger share compared with the private investment demand. In total, private demand is derived from households' utility maximization subject to budget constraint (disposable income level) given the corresponding relative prices of goods and services. In addition, private demand for investment in the agricultural sector is assumed to be the demand determined, while that in the non-agricultural sector takes into account both demand and supply potentials i.e., the availability of capital stock and investable funds of private business. The government demand for consumption and investment in this model are assumed to be exogeneously given. This may reflect the situation that the fiscal policies are to some extent at the disposal of the policy makers in Thailand. Finally, demand for goods and services from Thailand by the rest of the world netted demand for goods and services from the rest of the world or, in other words, export and import demand respectively are assumed to be fully demand determined. This is based on a 'small country' assumption and that exports from Thailand have to face with tough competition from other exporters. This is not to mention imports which is cleary demand determined.

The extension that has been made in this model compared with the original BOT model are as the following :

a. on the supply side, the determination of output in the agricultural sector is extended to cope with productions of agricultural cash crops, namely paddy, maize, cassava, sugar cane, and rubber. Outputs are determined from the availability of factors of production say, labor, capital, and land. The planted area of land of each crop is determined from the producers' profit maximization given the relative price of each crop at farm-gate or at boarder prices.

The model also takes into consideration the determination of the farm-gate price of paddy, the price of which is suppressed by the so called 'rice premium' in the exportation of rice.

b. On the demand side, the private consumption demand is extended to cope with more details like those categorized in the National Income and expenditure

System used in Thailand. Some consumption categories are further divided into durable and non-durable components respectively. Still, like the BOT model, the expected real rate of return of assets is considered as one of the arguments in the consumption function.

The demand from the rest of the world towards Thai exports, especially, the agricultural products is further diversified into rice, maize, tapioca products, sugar rubber, tin, and tobacco respectively.

c. In our model, unlike the BOT model where the general price level is determined from the equilibrium condition, the general price level is determined partly by external factors i.e., world price, and partly by "internal factors i.e., the relative influences of real output and money" supply. The former reflects the assumption that inflation is an imported inflation while the latter takes into account the consequence of the government's budget deficit.

d. On the aggregate level, equilibrium in the product market is determined by the equality of effective demand and supply. When the equilibrium condition is not realized, i.e., excess supply (demand) may occur at the end of the period (e.g., the end of the year), it may imply that the consumption (production) plan of a representative household (firm) is not realized. In our model, the household is assumed to make an instantaneous change in his consumption plan at the beginning of the next period e.g., the beginning of the year, and firms will do likewise. In addition, firms will try to dispose (hoard) a build-up of inventory stock due to an unintended investment (inventory investment) by taking on more sale promotion and advertising expenses, or cutting (raising) prices until equilibrium is restored. In our model, since such transaction cost is not directly estimated, we have to rely on the price adjustment mechanism that finally equilibrates effective demand with supply.

In Thailand, an excess supply may occur more likely than excess demand. This is due to deficiencies in the effective demand component, especially in the short run. There is demand for Thai exports by the rest of the world, and the government's investment expenditure are assumed to be the main causes of demand deficiency in our model. Since export activities occur in the non-agricultural sector, the gross and net producer price in this sector are consequently assumed to respond to the build-up of inventory stock that resulted from a disequilibrium in the product market through the mechanism described above.

The supply side of the model can be summarized in terms of equations' systems as follows :

Production :

Agriculture

Cash crops $$Q_j = f(N_{1j}, K_{1j,-1}, A_j, E^*)$$
$$j = 1, 2, \ldots\ldots, 5$$

	Y_{1j}	$= Q_j \cdot q_j$
		$j = 1, 2, \ldots\ldots, 5$
Non-crops	Y_{16}	$= f\,(N_{16},\ K_{16},\ t^*)$
	N_{1j}	$= N_1 \cdot Y_{1j}/Y_1$
		$j = 1, 2, \ldots\ldots, 6$
	K_{1j}	$= K_1 \cdot Y_{1j}/Y_1$
		$j = 1, 2, \ldots\ldots, 6$
	A_j	$= f\,(P_{fj}/P_{f\theta},\ A_{j,-1},\ X_{-1})$
		$j = 1, 2, \ldots\ldots, 5$
		$\theta = 1, 2, \ldots\ldots, 5;\ j \neq \theta$
	Y_1	$= \sum_{j=1}^{5} Y_{1j} + Y_{16}$
Non-agriculture	Y_2	$= f\,(N_2,\ K_2,\ t^*)$
	N_2	$= f\,(K_{2,\,-1},\ W_2/P_n)$
	W_2	$= f\,(P_{-1},\ Y_{2,\,-1}/N_{2,\,-1})$
	N_1	$= N^* - N_1$
Aggregate supply :	Y^S	$= Y_1 + Y_2$

The demand side of the model can be summarized in terms of the equations' system as follows :

Consumption :		
Private		
Non-durable	CNS_j	$= f\,(YDV/P,\ P_{c_j}/P_{c_\theta})$
		$j = 1, 2, \ldots\ldots, 14;\ \theta = 1, 2, \ldots\ldots, 1;\ \theta \neq j)$
Durable	CNS_j	$= f\,(YDV/P,\ P_{c_j}/P_{c_\theta},\ r)$
		$;\ \theta = 1, 2, \ldots\ldots, 14;\ \theta \neq j)$
	CNS	$= \sum_{j=1}^{14} CNS_j$
Government	CG	$= CGV^*/P$
Investment :		
Private		
Agriculture	IF_1	$= f\,(Y_1,\ IF_{1,\,-1})$
Non-agriculture	IF_2	$= f\,(Y_2,\ K_{2,\,-1}\ i,\ UBP)$

Government $IG = IGV^*/P = (IGV_1^* + IGV_2^*)/P$

Public enterprises $IBS = IBSV^*/P = (IBSV_1^* + IBSV_2^*)/P$

Import :

$$M_j = f\,(CNS,\ Y^S,\ IF_1 + IF_2 + IG + IBS,\ P_{m_j}\,(1 + t_{m_j})/P)$$

$$j = 1,\ 2,\ 3,\ 4$$

$$M = \sum_{j=1}^{4} M_j$$

Export :

Agriculture

$$X_{1j} = f\,(YW,\ P_{xwj}/(P_{x_j}/qx_j \,.\, Z^*))$$

$$j = 1,\ 2,\ \ldots,\ 6;$$

$$X_1 = \sum_{j=1}^{6} X_{1j} \,.\, (P_{x_j}/P_{dx_j})$$

Non-agricultural products and nonfactor services

$$X_{2j} = f\,(YX,\ P_{xw_j}/P_{x_j})$$

$$j = 7,\ 8$$

$$X_2 = \sum_{j=7}^{8} X_{2j}$$

$$X = X_1 + X_2$$

Aggregate demand for domestic products :

$$Y^d \equiv CNS + CG + IF_1 + IF_2 + INV + IBS + X - m$$

Inventory investment (INV) is determined from the equilibrium condition :

$$INV = Y^S - Y^d$$

Total real fixed capital stock :

Agriculture

$$K_1 = (1 - 0.035) \,.\, K_{1,-1} + IF_1 + (IGV^* + IBSV_1^*)/P$$

Non-agriculture

$$K_2 = (1 - 0.035) \,.\, K_{2,-1} + IF_2\ (IFV_2^* + IBSV_2^*)/P$$

Stock of inventory :

$$KIV = KIV_{-1} + INV$$

Price determination :

General price	P	$= f(P_w \cdot Z^*, FM/Y^S)$
Non-agriculture :		
Gross producer price	P_{g2}	$= f(P, KIV/Y_2)$
Net producer price	P_n	$= P_{g2} - t_n^* - TN/Y_2$
Agriculture :		
Gross producer price	P_{gl}	$= f(P)$
Net producer price of rice	P_{nr}	$= f(T_{x^*}, P_{xl}, \triangle SR)$
	$\triangle SR$	$= 0.66 \cdot Q_1 - CNS_1 \cdot q_{21} - X_{11}$
Farm-gate prices of rice	P_{f_1}	$= f(P_{nr})$
other cash crops	P_{f_j}	$= f(P_{x_j})$
		$j = 2, 3, \ldots, 5$
Export prices :		
Agriculture	P_{x_j}	$= f(P_{gl})$
		$j = 1, 2, \ldots, 6$
Non-agriculture	P_{x_j}	$= f(P_{g2}, P_{ml} \cdot (1 + t_{ml})/P_{g2})$
		$j = 7, 8$
Consumer prices	P_{c_j}	$= f(P)$
		$j = 1, 2, 3, \ldots, 13, 14$

where

A_j $j = 1, 2, \ldots, 5$	= planted area of paddy, maize, cassava, sugar cane, and rubber in 1000 rai
CNS_j; $i = 1, 2, \ldots, 12$	= real private consumption of non-durable goods is in B-million at 1972's constant price
CNS_1	= real private consumption of rice plus input (in terms of rice equivalent value) of next crop year, in B-million.
CNS_j; $j = 13, 14$	= real private consumption of durable goods is in B-million at 1972's constant price

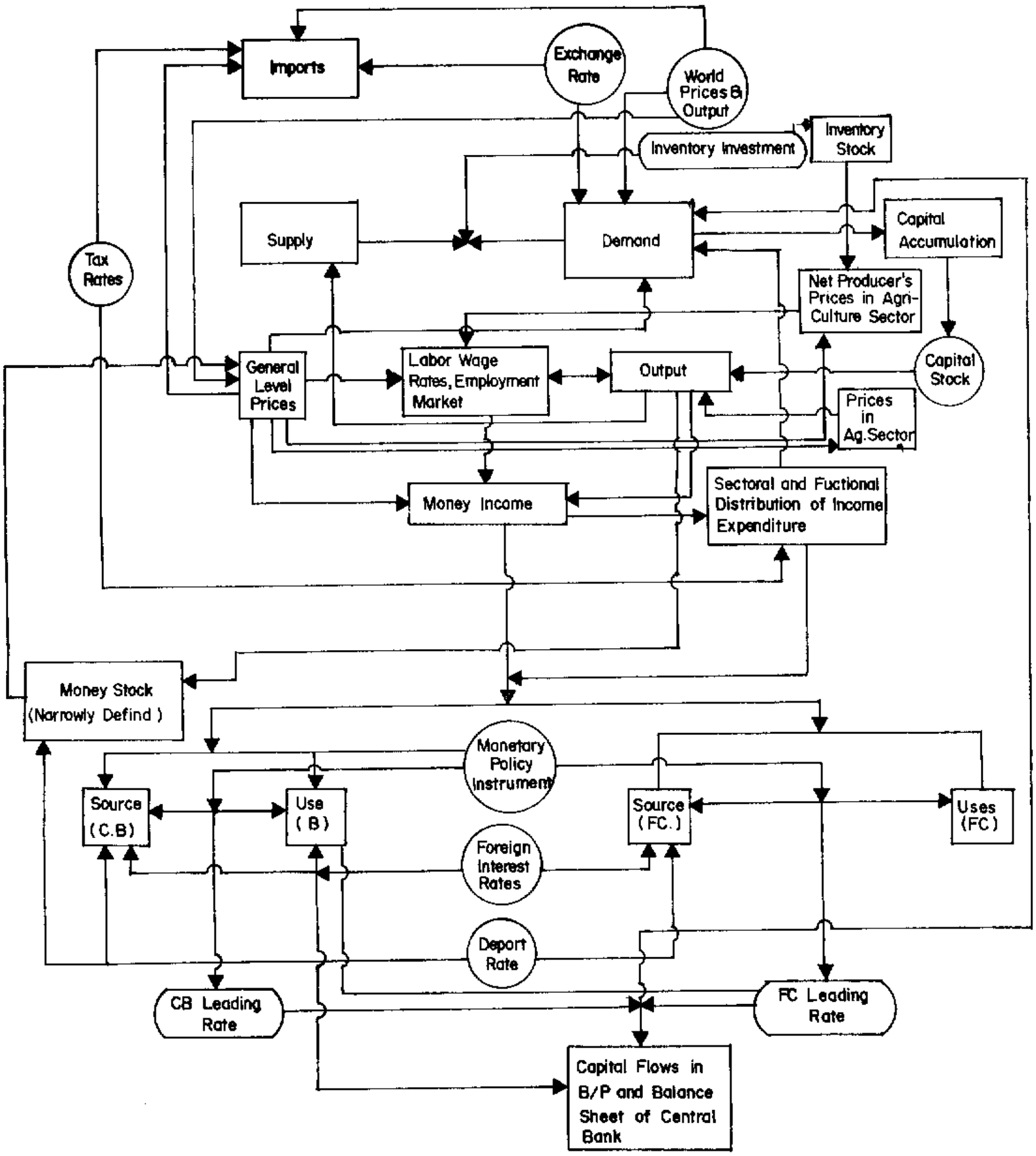
CG, CGV*	= real and nominal value of government sector's consumption, in B-million at 1972's constant price and in B-million respectively
E*	= quantity of rain fall after planting
FM	= narrowly defined money stock in B-million
i	= rate of interest
$IBSV_1$*, $IVSV_2$*	= nominal value of gross fixed investment in agricultural and non-agricultural sector in B-million
IBSV*, IBS	= total nominal and real gross fixed investment in agricultural and non-agricultural sector in B-million and B-million at 1972's constant price
IF_1, IF_2	= real gross fixed investment of private business in agricultural and non-agricultural sector in B-million at 1972's constant price
IGV_1*, IFV_2*	= nominal value of government's gross fixed investment in agricultural and non-agricultural sector, in B-million
IGV*, IG	= total nominal and real value of government's gross fixed investment in B-million and B-million at 1972's constant price
INV	= real inventory investment in B-million
K_{1j} ; j = 1, 2, ..., 5	= fixed capital stock used in the production of cash crops valued in B-million at 1972's constant price
K_{16}	= fixed capital stock used in the production of non-crops in agricultural sector valued in B-million at 1972's constant price
K_1, K_2	= total real fixed capital stock in agricultural and non-agricultural sector valued in B-million at 1972's constant price
KIV	= stock of inventory in B-million at 1972's constant price
M_j ; j = 1, 2, 3, 4	= real value of import j in B-million at 1972's constant price
M	= total real value of import in B-million at 1972's constant price
N_{1j} ; j = 1, 2, ..., 5	= labor empioyed in the production of cash crops in 1000 persons
N_{16}	= labour employed in the production of non-crops in the agricultural sector of 1000 persons

N^*, N_1, N_2	= total labour supply, labour employed in agricultural and non-agricultural sector of 1000 persons
P	= general price level 1972's price = 1
P_{f_1}, P_{f_j}, P_{f_θ} ; j, θ = 1, 2, ..., 5 ; $j \neq \theta$	= producer price of farm-gate price of cash crop j and other cash crop θ, 1972's price = 1, j = 1 indicated paddy
P_{gl}	= gross producer price in agricultural sector, 1972's price = 1
P_{nr}	= net producer price of rice in B per metric ton
P_{g2}, P_n	= gross and net producer price in non-agricultural sector 1972's price = 1
P_{c_j}, P_{c_j} ; j, θ = 1, 2 3, ..., 14 ; $j \neq \theta$	= consumer price index of good j, and θ, 1972's price = 1
P_{x_1}, P_{x_1} ; j = 1, 2, ... 7, 8	= export price of agricultural products (j = 1, 2, ..., 6) and non-agricultural products and nonfactor services (j = 7, 8) for j=i indicates export price of rice, in B per metric ton
P_{m_1}, P_{m_1} ; j = 1, 2, 3, 4	= import price of goods j in B, 1972's price = 1, j = 1 indicates raw material import
P_{dx_j} ; j = 1, 2, ..., 8	= export price deflator of product j, 1972's price = 1
P_{wx_j} ; j = 1, 2, ..., 8	= world price of export of product j, in $ U.S., 1972's price = 1
Q_1, Q_j ; j = 1, 2, ..., 5	= production quantities of cash crops j, in 1000 metric tons, for j=1 indicates paddy
q_j ; j = 1, 2, ..., 5	= value-added/output conversion ratio of crop j
q_{21}	= quantity/value-added conversion ratio of rice consumption plus those used for next crop year's input in terms of rice equivalent
qx_j ; j = 1, 2, ..., 6	= unit value at 1972 of export quantity of agricultural product j, in B per metric ton
r	= rate of return of financial assets
$\triangle SR$	= change in stock of rice in 1000 metric ton
t^*	= time trend
t_n^*	= business tax rate on non-agricultural sector

Tx^*	= tax on rice export or 'rice premium' and 'rice export duty' in B-million
t_{m_1}, t_{m_j} ; j = 1, 2, 3, 4	= tax rate on import j, for j=1 indicates import of raw material
TN	= total import tax revenue in B-million
UPS	= retained income of private business in B-million
W_2	= nominal wage rate in non-agricultural sector in B per man-day
X_{11}, X_{1j} ; j = 1, 2, ..., 6	= export quantity of agricultural product j in 1000 metric tons, j=1 indicates rice export
X_1, X_3	= real value of export of agricultural products and non-agricultural products and nonfactor service in B-million at 1972's constant price
X	= total real value of export of goods and services in B-million at 1972's constant price
Y_{1j} ; j = 1, 2, ..., 5	= real value of gross domestic product from agricultural cash crops j, in B-million at 1972's constant price
Y_{16}	= real value of gross domestic product from agricultural non-crops, in B-million at 1972's constant price
Y_1, Y_2	= real value of gross domestic product from agricultural and non-agricultural sector in B-million at 1972's constant price
$Y,^s Y^d$	= aggregate supply and demand of goods and services in B-million at 1972's constant price
YDV	= disposable income of all households in B-million
YW	= world GDP or real income index, 1972's s=1
Z^*	= real exchange rate B per $U.S., 1972's exchange rate=1
*	= the superscripted variables are exogeneously given or policy instrument
0.035 ; 0.66	= rate of fixed capital's depreciation, and paddy-rice milling ratio respectively

It should be noted that the foregoing equations system are shown only for a short summary of the real sector in the model. The complete estimated equations in the real sector are shown in the appendix A. The complete financial sector are shown in the BOT model (8). The interaction of real and financial sectors are simply depicted in terms of flow-chart. The detail of the flow-chart is shown in Diagram 1 below.

Diagram 1. Diagrammatic Representation of the Model: The Real and the Financial Sectors.



3.2 Evaluation of the Estimated Model

The model is able to capture the historical path of major endogeneous variables such as the real output (GDPR), private consumption (CONHHR), government consumption (CONGVR), total investment (IFTR), total capital stock (KFTR), imports (MGSR), exports (XGSR), etc., the details of which are shown in Table 2 below. Model's evaluation is done in terms of %RMSP (root mean square percentage error).

Table 2 Error Statistics of Selected Endogeneous Variables

Endogeneous Variables	% RMSE
1. Real government consumption (CONGVR)	4.32
2. Real private consumption (CONHHR)	6.86
3. Real consumption value of rice (CRCR)	3.05
4. Money stock (FM 1)	2.47
5. Quantity of paddy output (GAPADYQ)	6.98
6. Real output of non-agricultural sector (GDPNAR)	8.01
7. Real output of agricultural sector (GDPAGR)	4.11
8. Real output of agricultural cash crops (CACOPR)	6.66
9. Real output of agricultural non-cash crops (GANCOPR)	5.37
10. Real gross domestic product (GDPR)	4.72
11. Total real gross fixed investment (IFTR)	12.98
12. Real gross fixed investment of government sector (IFGR)	4.32
13. Total real fixed capital stock (KFTR)	3.65
14. Employment in agricultural sector (NEMAG)	4.14
15. Employment in non-agricultural sector (NEMNA)	12.93
16. Total real imports (MGSR)	9.73
17. General price level (PD)	4.45
18. Gross producer price in non-agricultural sector (PGDNA)	3.65
19. Gross producer price in agricultural sector (PGDAG)	8.36
20. Net producer price in non-agricultural sector (PTXNA)	3.77
21. Net producer price in agricultural sector (PTXAG)	10.04
22. General consumer price index (PCI)	4.54
23. Consumer price index, rice (PCIR)	2.80
24. Government net revenue, less transfer (TAX)	4.63
25. Wage rate in non-agricultural sector (WGRNA)	11.08
26. Export of agricultural products (XGAGR)	6.08
27. Total real exports (XGSR)	11.67

Table 2 (Cont.)

Endogeneous Variables	% RMSE
28. Gross labor income in non-agricultural sector (YLBNA)	7.84
29. Capital income accrued to non-agricultural products (XGAGR)	13.68
30. Disposable household income (YDSHHR)	5.96

Note : %RMSE is defined as follow :

$$\% \text{ RMSE} = \sqrt{\frac{1}{14} \cdot \sum_{t=4}^{17} \left(\frac{S_t^s - X_t^a}{X_t^a} \right)^2}$$

where

X_t^a = simulated value of X_t

X_t^a = actual value of X_t

14 = no. period in the simulation, t_4 (1963)* – t_{17} (1976)

4. Simulation Analysis

We perform a simulation analysis by making a hypothetical change in the 'rice premium' and see how major economic variables responded to the assumed situation. In order to do that, it is helpful to recall the corresponding system of equations that are specific for our purpose here.

Planted area and harvested area of paddy:

$$\text{UPRC} = \underset{(2.079)}{6799.8} + \underset{(8.8120)}{0.73273}\ (\text{UPRC}_{-1}) - \underset{(3.4515)}{8318.6}\ (\text{D67*}) +$$

$$\underset{(2.3333)}{5760.2}\ (\text{D78*}) + \underset{(2.90177)}{9043.4}\ (\text{PFRC/PFOC})$$

R^2 = 0.91134 SE = 2324.5 DW = 2.6757 (1960–1981)

$$\log(\text{UHRC}) = -\underset{(1.094)}{0.51862} + \underset{(23.628)}{1.0408}\ \log(\text{UPRC})$$

R^2 = 0.96369 SE = 0.032081 DW = 2.1357 (1960–1981)

Production of paddy:

$$\log(\text{GAPADYQ}) = \underset{(0.8720)}{-1.9357} + \underset{(0.65564)}{0.12635}\ \log+(\text{GAPADYR : NEMAG/GDPAGR}) +$$

$$\underset{(2.0002)}{0.94856}\ \log(\text{UHRC/UPRC}) + \underset{(4.9072)}{0.96415}\ \log(\text{ER2*}) +$$

$$0.30197 \log(UFRC_{-1})$$
$$(11.421)$$
$$R^2 = 0.91859 \quad SE = 0.067832 \quad DW = 2.4804 \ (1960-1979)$$

Farm gate price, and net producer price of paddy and rice respectively :

$$PFRC = \underset{(2.490)}{0.23380} + \underset{(10.487)}{0.65362} \ (PTXRI/1908.6)$$
$$R^2 = 0.85153 \quad SE = 0.19382 \quad DW = 2.0285 \ (1960-1979)$$

$$PTXRI = \underset{(3.858)}{468.28} - \underset{(8.5158)}{0.75270} \ (TRICEP^* + TRICED^*) + \underset{(25.656)}{0.77074} \ (PXRI) - \underset{(1.3992)}{0.17372} \ (DELST)$$
$$R^2 = 0.97204 \quad SE = 227.69 \quad DW = 1.2927 \ (1960-1979)$$

Change in stock of rice, rice consumption, and rice export ,

$$DELST = 0.66.GAPADYQ - CRCR.Q21 - XRICQ$$

$$\log(CRCR) = \underset{(22.12)}{3.2304} + \underset{(42.131)}{0.53645} \log(YDSHHR) - \underset{(3.4753)}{0.21507} \log(PCIFR/PCI)$$
$$R^2 = 0.99164 \quad SE = 0.017145 \quad DW = 1.2976 \ (1962-1979)$$

$$XRICQ = \underset{(10.93)}{1574.1} + \underset{(5.3738)}{1285.7} \ (D77^*) + \underset{(4.1414)}{717.21} \ (D6772^*) - 0.27923 \ (UIA^*) + 0.028464 \ (UDV^*) - \underset{(3.7315)}{323.57} \ (PXRI\$/PXWHI\$^*) + \underset{(3.3665)}{729.84} \ (GDPWR3^*)$$
$$R^2 = 0.86319 \quad SE = 213.51 \quad DW = 1.6850 \ (1960-1979)$$

It is clear that net producer price and subsequently farm-gate price are being suppressed by taxation on the exportation of rice, namely the 'rice premium' (TRICEP*) and export duty on rice (TRICED*). The hypothetical abolishment of the taxes will be tried as in our simulation analysis. The results of the simulation in terms of percentage change of some selected variables are shown in Table 3 and Figures 1-4 below.

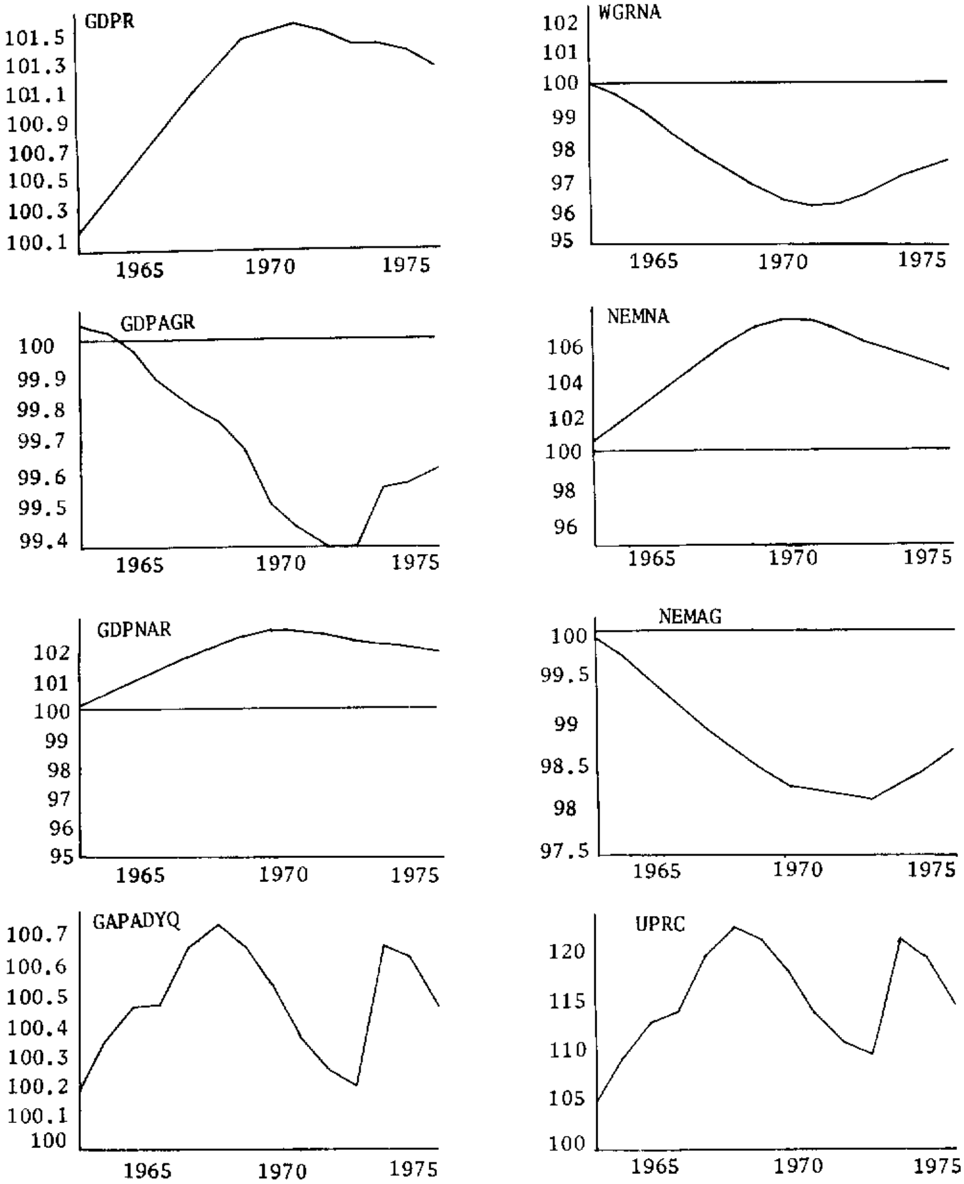


Figure 1.

Simulation Results of Some Major Variables Compared With Base (Controlled) Solution : Real Gross Domestic Product (GDPR), Real Gross Domestic Product in Agricultural (GDPAGR), in Non-Agricultural (GDPNAR) Sector, Production Quantity of Paddy (GADADYQ), Area Planted of Paddy (UPRC), Wage Rate in Non-Agricultural Sector (WGRNA), Employment in Agricultural (NEMAG) and Non-Agricutural (NEMNA) Sector. (Base (Controlled) = 100; 1963-1976)

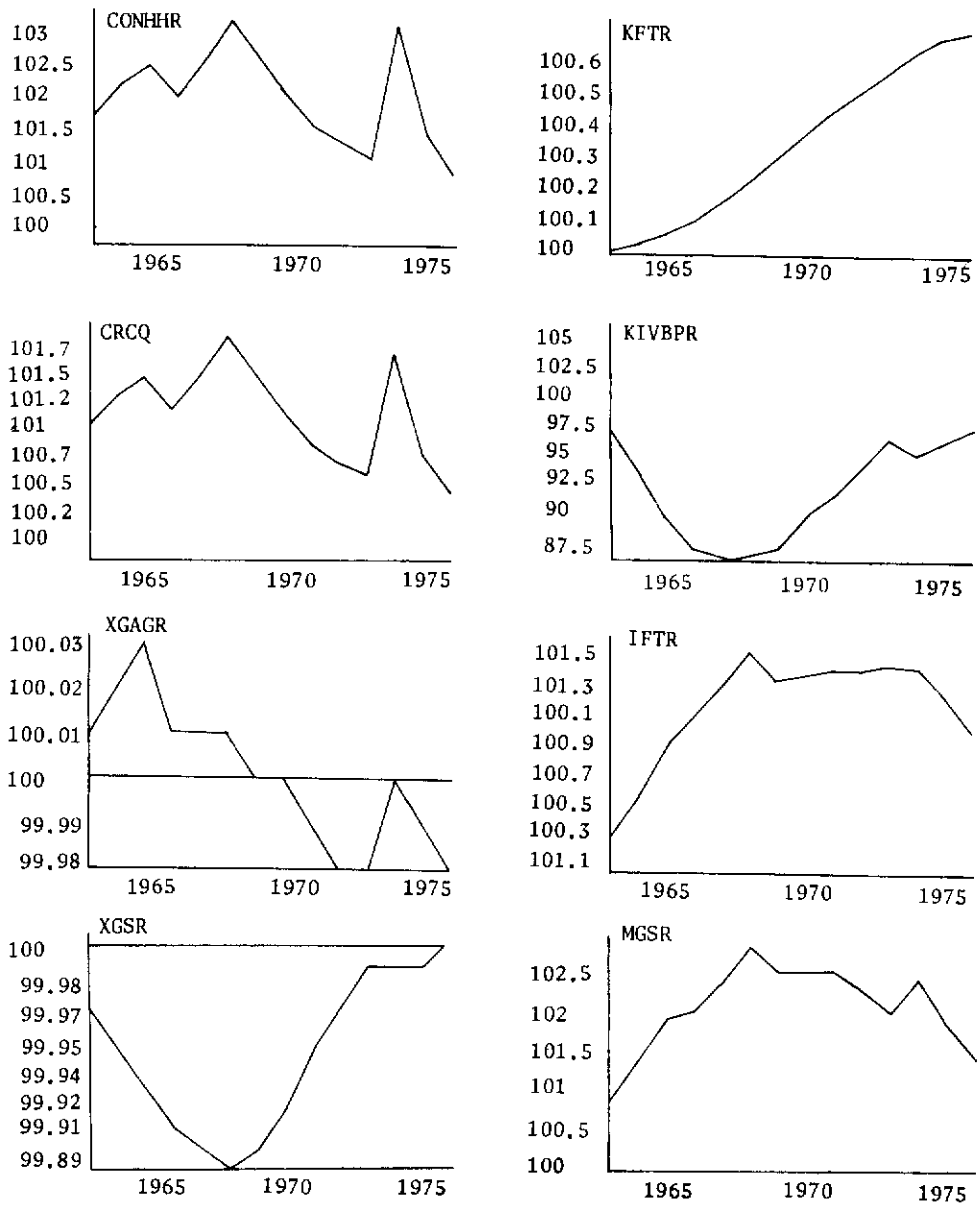


Figure 2.

Simulation Results of Some Major Variables Compared With Base (Controlled) Solution : Real Private Consumption (CONHHR), Real Consumption of Rice (CROQ), Real Export of Agricultural Products (XGAGR), Total Real Export (XGSR), Total Real Fixed Capital Stock (KFTR), Inventory Stock (KIVBPR), Total Real Fixed Investment (IFTR), Total Real Import (MGSR). (Base (Controlled) = 100; 1963-1976)

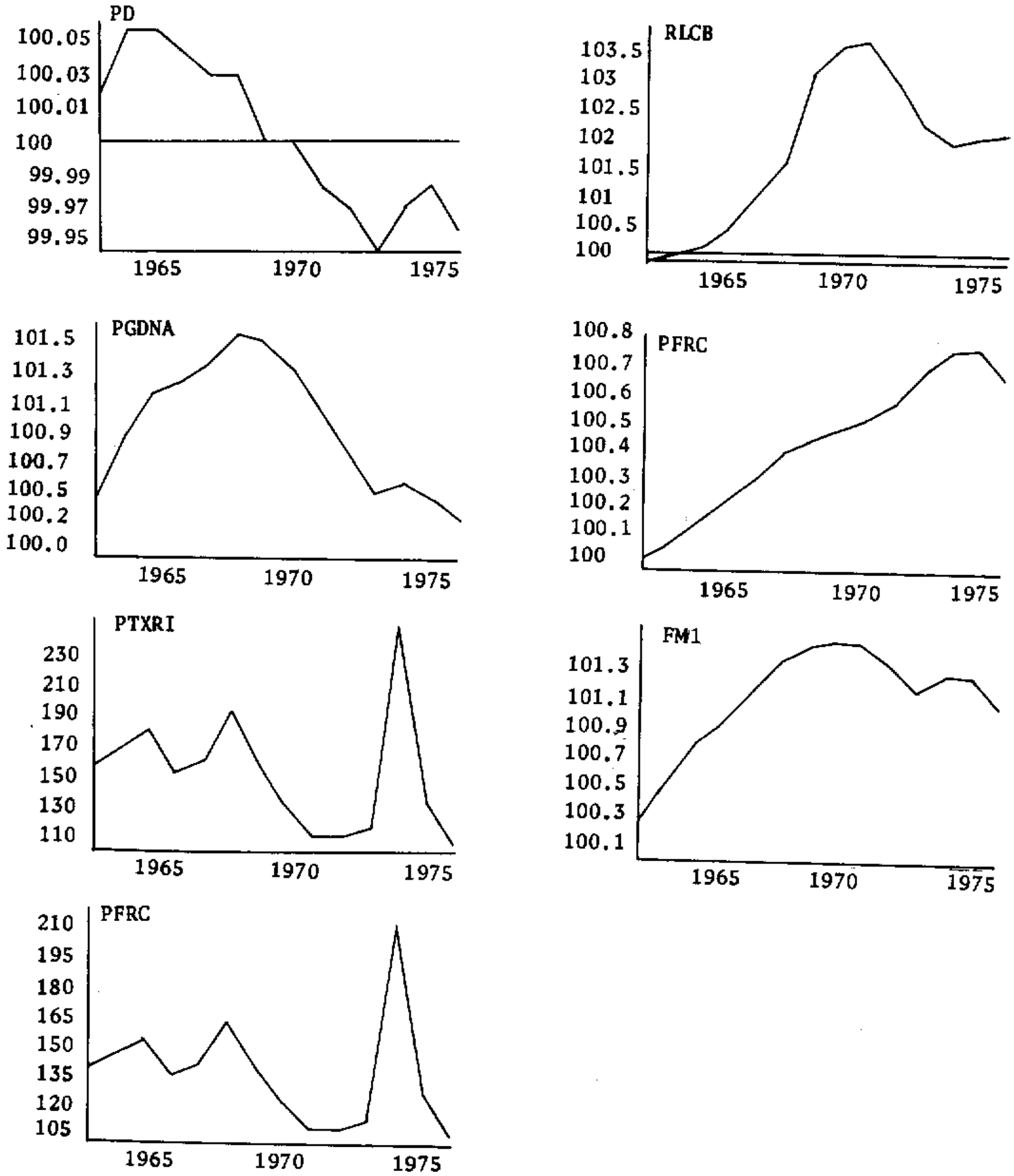


Figure 3.

Simulation Results of Some Major Variables Compared With Base (Controlled) Solution : General Price Level (PD), Gross Producer Price in Non-Agricultural Sector (PGDNA), Net Producer Price of Rice Production (PTXRI), Farmgate Price of Paddy (PFRC), Commercial Bank Loan Rate of Interest (RLCB), Financial Company Loan Rate of Interest (RLFC), Money Stock, Narrowly Defined (FM1). (Base (Controlled) = 100; 1963-1976)

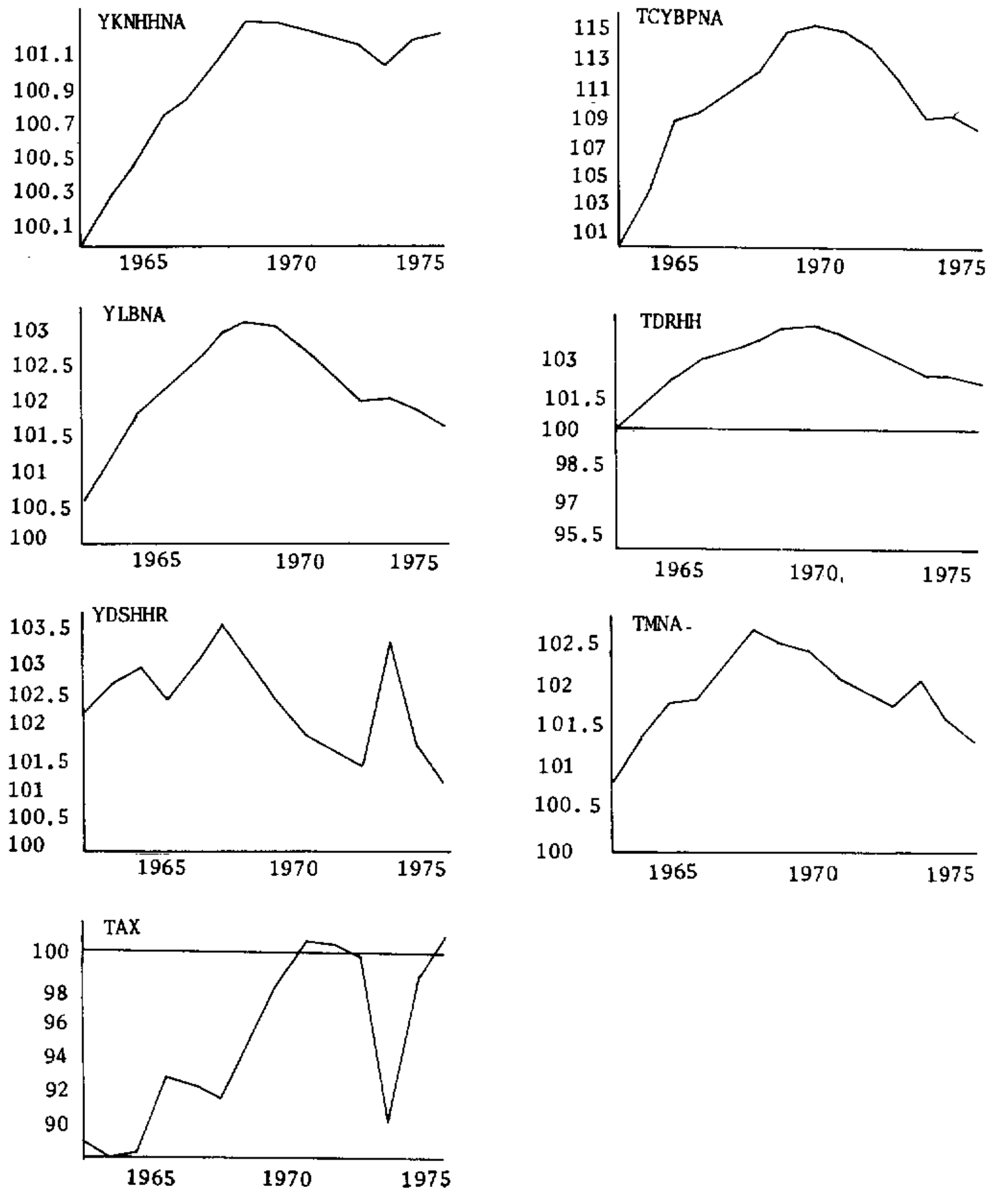


Figure 4.

Simulation Results of Some Major Variables Compared With Base (Controlled) Solution : Capital Income Accrued to Non-Agricultural Households (YKNHHNA), Gross Labor Income to Non-Agricultural Households (YLBNA), Real Disposable Income of All Households (YDSHHR), Government Net Revenue (Less Transfer) (TAX), Corporate Income Tax (TCYBPNA), Income Tax on Households (TDRHH), Total Import Tax Revenue (TMNA).

(Base (Controlled) Solution = 100; 1963-1976)

Table 3 Simulation Results of the Hypothetical Abolishment of the Rice Export Tax. Rice Premium (TRICEP*), and Rice Export Duty (TRICED*); 1963–1976.

Endogeneous Variables	Percentage Change After 1963-1970	1971-1976	1963-1976
Total disappearance of rice (rice consumption plus seed input in rice-equivalent quantity) (CROQ)	11.59 * (1.45)	5.74 (0.96)	17.33 (1.24)
Total private consumption (CONHHR)	20.66 (2.58)	10.7 (1.78)	31.36 (2.24)
Paddy production (GAPADYQ)	3.94 (0.4925)	2.47 (0.41)	6.41 (0.46)
Real value added in agriculture (GDPAGR)	-1.4 (-0.17)	-3.1 (-0.52)	-4.5 (-0.32)
Real value added in non-agriculture (GDPNAR)	12.02 (1.50)	13.72 (2.29)	25.74 (1.84)
Total real value added in economy or real gross domestic product (GDPR)	7 (0.87)	8.42 (1.40)	15.42 (1.10)
Total gross fixed investment (IFTR)	8.2 (1.02)	7.76 (1.29)	15.96 (1.14)
Inventory stock (KIVBPR)	-88.67 (-11.08)	-31.62 (-5.27)	120.29 (-8.59)
Total imports (MGSR)	15.82 (1.98)	12.06 (2.01)	27.88 (1.9)
Employment in agriculture (NEMAG)	-7.66 (-0.96)	-10.14 (-1.69)	-17.8 (-1.27)
Employment in non-agriculture (NEMNA)	32.82 (4.10)	33.02 (5.50)	65.84 (4.70)
General price level. (PD)	0.19 (0.02)	-0.19 (-0.03)	0.0
Farm-gate price of paddy (PFRC)	327.84 (40.98)	166.5 (27.75)	494.34 (35.31)
Gross producer price in non-agriculture (PGDNA)	9.7 (1.21)	3.55 (0.59)	13.25 (0.94)
Net producer price of rice (PTXRI)	480.35 (60.04)	210.84 (35.14)	691.19 (49.37)
Planted area of paddy (UPRC)	118.94 (14.87)	86.18 (10.77)	205.12 (14.65)
Export of rice (XRICQ)	-0.01	0.07	0.06
Export of agricultural products (XGAGR)	0.08	-0.08	0.0
Export of non-agricultural products (XGNAR)	-7.37 (-0.92)	-0.76 (-0.126)	-8.13 (-0.58)
Money stock (FM1)	7.9 (0.99)	7.44 (1.24)	15.34 (1.09)
Disposable income accrued to agricultural households (YDSHHAG)	30.21 (3.78)	7.06 (1.17)	32.27 (2.66)
Disposable income accrued to non-agricultural householde (YDSHHNA)	16.63 (2.08)	12.25 (2.04)	28.88 (2.06)
Real disposable income of all households	21.75 (2.72)	10.74 (1.79)	32.49 (2.32)

Note: numerical values in brackets are simple average of percentage change per periods.

The hypothetical abolishment of the rice export taxes, namely the 'rice premium' and the 'rice export duty' will have favorable expansionary effects on the economy as a whole. This is shown in terms of percentage increase in real GDP throughout the periods of the simulation analysis (1963–1976) by an accumulated value of 15.42 per cent or on average 1.10 per cent accordingly. The increase in the real GDP is in fact caused by an expansion of the non-agricultural sector netted by a shrinkage in the agricultural sector's real GDP. The former increases by 25.74 (or 1.84 on average) per cent while the later decreases by 4.5 (or 0.32 on average) per cent respectively. A mechanism of the change in major endogeneous variables is as follows. The elimination of the taxes induces an increase in the net producer price of rice by 691.19 (or 49.37 on average) per cent throughout the period. The rice growers respond to this by increasing their planted area of paddy by 205.12 (or 14.65 on average) per cent. The production of paddy is there by increased by 6.41 (or 0.46 on average) per cent. On the other hand, the production of other cash crops decrease (not shown in the table) together with a decline in the agricultural sector's employment, the percentage of which decreased by 17.8 (or 1.27 on average) per cent. This is because in our model labor supply is assumed to be exogeneously given, therefore an increase in the non-agricultural sector's employment will also imply a decline in the employment level in the agricultural sector. The reason why there is an increase in the non-agricultural sector's employment will be explained below.

The elimination of the taxes will raise a disposable income of paddy growers' households while other cash crops' growers may not benefit from the tax abolishment. Since in Thailand the agricultural sector is overwhelmed by paddy growers' households, the tax elimination will raise the disposable income of all the agricultural households rather than lower them. This is shown in our simulation result that the disposable income accrued to agricultural households increase by 37.27 (or 2.66 on average) per cent. In our model, gross producer price increases by 13.25 (0.94 on average) per cent due to a decline in the build-up of the inventory stock by 120.29 (or 8.59 on average). This implies a decrease in real wage rates in the non-agricultural sector and consequently the real GDP in the sector. In addition, this also implies an increase in a disposable income accrued to the non-agricultural sector and the real disposable income accrued to all households by 28.88 (or 2.06 on average) per cent and 32.49 (or 2.32 on average) per cent respectively. It is noted that employment in this sector increase by 65.84 (or 4.70 on average) per cent throughout the period. The increase in real disposable income induces an increase in real consumption by 31.36 (or 2.24 on average) which in turn induces a decline in the build-up of inventory stock.

Even though paddy production is increased after the elimination of tax, rice export does not increase so much only by 0.06 per cent. Exports of total agricultural exports and exports from the non-agricultural sector do not change and even decrease by 8.13 per cent This may be due to an inflationary effect of deficit financing or the increase in money stock during 1963–1970 by 7.9 per cent. After 1971–1976, exports decreased but by a small percentage. This may mean exports from Thailand can resume their competive position to some extent. During 1971–1976, even though money stock increased by 7.44 per cent, the general price level shows a decreasing sign of 0.19 per cent. This is because of an increase in the effective demand component i.e., private consumption after the tax abolishment induces an increase in both production and employment in the non-agricultural sector. This increase in aggregate supply relative to money stock pulls back an influence of the government deficit financing or the inflationary potential in the whole economy. Figure 4 clearly depicts that the government net tax revenue after the abolishment of the export taxes can resume its base (controlled) position after a certain lapse of time, though it becomes worse again during 1973–1975. Moreover, the government can also seek other sources of tax revenues, like direct tax on households' gross labor income tax, import tariff revenues, etc.

5. Hypothesis Testing, Discussion, and Conclusion

In this paper we can not reject a hypothesis that the abolishment of the rice export tax namely the 'rice premium' and the 'rice export duty' in general would have favorable effects on the Thai economy during 1963–1976 according to our simulation results. In the simulation, the production of paddy increases though it is balanced by a decline in the production of other cash crops namely maize, cassava, sugar cane, and rubber to a small extent. This may imply that an agricultural productions' diversification scheme shifted back to paddy production. In addition, production and employment in the non-agricultural sector expanded satisfactorily as has been hypothesized. There is no sign of severe inflationary pressure in the economy due to the deficit financing of the government budget. The hypothesis that trade or export of rice will be increased after the elimination of tax is not strongly confirmed. This may be due to our assumption concerning the demand determined export function of rice and export price determination.

Concerning the issue of development policy, it is clear that the elimination of the tax will work in the direction that is desired by policy makers i.e., a cheap supply of labor or real wage in the non-agricultural sector faced by producers is not increased but decreased. Had the tax elimination been implemented by the government during the period, there might have been a structural adjustment in the Thai economy. This means the abolishment of the rice premium and the export duty is in fact consistent with the primary aim of the policy makers according to our simulation results.

One interesting point that should be noted from our simulation analysis is that the role of effective demand should be studied rather carefully. Especially, if an effective demand component like private consumption demand is to be raised, the abolishment of the rice premium and the like should be recommended. It is not beyond this study to say that any income distribution scheme towards the agricultural households is also valid for raising such effective demand component.

At present, although the rice export taxation has declined, the tax revenue is tranferred back to the agricultural sector in terms of government investment and loans. We cannot help but conclude that the policy was not consistent with the development aim during the period. Despite various shortcomings in the study according to assumptions, data and the relevancy of the adjustment mechanism of the rice market and the macroeconometric model as a whole, we would like to recommend that such kind of taxation should not be implemented again. We would like to repeat Sura's proposal to tax urban land as well as property instead.

Appendix

List of selected variables used in the Real Sector.
(Variables with* sign denote exogeneous variables).

1. Comsumption Expenditure

Nominal	Real	Associated Price Deflator	
CRC	CRCR	PDRC	Private consumption expenditure on rice, million-baht
	CRCQ		Private consumption on rice in 100 metric tons.
		Q21	Conversion factor between rice consumption value and quantity

2. Dummy Variables and Some Exogeneous Variables

D67*	Dummy Variable (1967 = 1, otherwise = 0)
D77*	Dummy Variable (1977 = 1, otherwise = 0)
D6772*	Dummy Variable (1967, 72 = 1, other wise = 0)
D78*	Dummy Variable (1978 = 1, otherwise = 0)
ER2*	Average rainfall between the time of planting and harvesting

UIA*		U.S. Public Law 480 rice export plus net rice export of Japan in 1000 metric tons.	
UDV*		Deviation from trend of World rice paddy production in crop year (t-1)/t, 1000 metric tons.	

3. Output

Nominal	Real	Associated Price Deflator, or Value-Added/ Output Conversion Factor	
GAPADY	GAPADYR	PDPAD*	GDP originating from agricultural cash crops, paddy in million baht.
	GDPADYQ	QII	GDP originating from agricultural cash crops, paddy in 1000 metric tons.
GDPAG	GDPAGR	PGDAG	GDP originating from agriculture, million baht.
	GDPWR 3*		World GDP at 1972's constant price

4. Prices Per Unit, Price Deflators, and Price Indices (at 1972's constant price)

PCIFR	Consumer price index, rice.
PCI	Consumer price index, all items, weighted average.
PERC	Producer price of paddy.
PFOC	Weighted average (by planted area) producer price of maize, cassava, rubber, and sugar cane.
PXRI,	Price of export of rice, B/ton.
PXRI $	Price of rice export in $ U.S.
PTXRI	Net producer price of rice excluding rice export premium, rice export duty
PXWH $*	World price of wheat it $ U.S.

5. Variable hitherto Unspecified

DELST	Change in stock of rice, 1,000 metric ton
XRICQ	Export of rice in 1,000 metric tons
NEMAG	Available supply of labor in agricultural sector
UPRC	Planted area of rice production, in 1,000 rai
UHRC	Harvested area of paddy production, in 1,000 rai
UFRC*	Fertilizers used in paddy production, in metric tons.
TRICEP*	Rice export premium
TRICED*	Export duty or rice
YDSHHR	Disposable income of household

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Commodity Models in the LINK Model : A Summary

*F. Gerard Adams**

Introduction

Primary commodity exports--the quantities and prices of sugar, rice rubber exports, for example--are an important source of earnings for the less developed countries. Models of commodity markets and of the linkages from these markets to the producing and consuming countries have an important place in econometric models of the world economy and of the Asean country region.

The swings of the business cycle and the associated sharp inventory movements dominate the variation of demand for fuels and industrial raw materials. In turn, on the supply side, natural phenomena like droughts or plant disease epidemics, as well as labor disputes, mine disasters, military actions and the formation of cartels cause wide variations in the quantities of primary commodities which reach the market. Since elasticities of demand and supply of these commodities are low and since adjustments in quantities consumed or produced occur only with long time delays, large price movements are often required to achieve market clearing. The resulting instability of commodity prices and export earnings has been a source of inflation and depression in the industrial words--as the experience of the 1970s illustrates--and a barrier to the growth aspirations of less developed countries, like Thailand, which rely heavily on exports of primary commodities for their foreign exchange resources. Integrating commodity models into a world model system allows us to trace out the impact of policy in the industrial countries and the impact of shocks in commodity markets on the consuming and the producing country economies. It is also a basis for evaluating alternative policy measures to stabilize these markets or to offset market fluctuations.

This paper describes how commodity market models have been introduced into the Asean Link System, ELSA.

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Econometric Approach to World Modeling

International economic interrelations have come increasingly into the foreground as internationally linked economic instability has mounted since the early 1970s. It is fortunate that economists are also increasingly better able to handle global econometric systems and to integrate commdity price impacts into these models. How far have econometric approaches been developed to deal with commodities in international economic linkages?

It has been more than twenty years since econometric models, originally oriented toward description of the economies of separate countries, have been extended to the linkage between country economies and to coverage of the global world economy. Typically,[1] such systems begin with models describing the economies of the underlying countries using, as appropriate, Keynesian or growth model structures. Then linkages are provided between the countries reflecting trade flows, price linkages, commodity price determination, and most recently capital flows and current financial flows. The objective is a comprehensive model system which will give solutions for economic activity within countries which are consistent with the relationships between them. The aim is also to provide a useful multipurpose system, one which can be applied to a variety of problems affecting the global economy.

Primary Commodity Linkages--In recent years, we have become increasingly aware of the potential for disturbance to the world economy from abrupt changes in prices of primary commodities, the two "oil shocks" and the swings of the prices of other raw materials, for example. The impact of these developments has highlighted the differences between the industrial countries which are largely consumers of primary products, the petroleum producers, and the other less developed countries which are consumers of oil and producers of primary products. In the industrial countries, the increase of primary material and fuel prices has caused inflation and recession. In the economies of the producer countries increases in petroleum and other primary product prices have caused rapid expansion, and, frequently also inflation. Declines in primary product prices and increases of petroleum prices (in the case of the importing countries) have had disastrous impact on LDC growth. The changed terms of trade between fuels and prices of manufactures and the price volatility have been major contributors to international economic instability. Yet, the traditional linked international model system lacked the ability to recognize these phenomena.

The determination of primary commodity prices is best handled with a commodity market model which determines price as a reconciliation between forces

[1] The pioneering world model system is Lawrence Klein's Project LINK described in Ball (1973) and Sawyer (1979).

on the demand and on the supply side. The commodity prices are then introduced into the linked country model system using the trade matrix as a basis for allocating the prices to the importing countries. It is also important to note here that commodity exports serve as an important source of foreign exchange revenues to the producing countries and that the growth of many of the less developed countries depends on their earning of foreign exchange which are closely tied to the price of primary commodities. This linkage must, of course, be recognized in the model system.

Integration of Commodities Models Into ELSA

The integration of commodity models into ELSA (ELSA-Comlink) poses some new challenges.[1] The ELSA system does not disaggregate trade flow into various classes of commodities or even into broad categories as in Project LINK. Instead constant value shares from a base year trade matrix are applied to total imports and exports. There is also no disaggregation of prices between different import or export product categories. The challenge was then how to introduce the impact of commodities into the system.

A number of elements are involved:

- Commodity models in the country model system. The initial factor is to link commodity models into the country model system. The models of commodity markets call for data on economic activity as inputs on the demand side. This information can be provided from the economic activity variables of the ELSA models for Japan and the United States along with linkages to provide corresponding informational inputs for other consuming countries considered in the commodity models. The commodity models also require information on world price indexes and on exchange rates. Appropriate linkage equations have been developed for this purpose.

Given economic activity, general price indexes, and exchange rates, the commodities models can operate to generate commodity prices corresponding to the economic environment computed by the ELSA system.

- Price feedbacks into the ELSA system. Price feedbacks are necessary to transmit the information from the commodity models into the ELSA countries both from the perspective of imports and from the perspective of exports. In each case commodity prices have been introduced into the import and export price determination equations of the ELSA country models. This is the heart of the commodity linkage mechanism.
- Commodity earnings linkage. In a sufficiently detailed and structured country model, the price linkage above should, in principle, feed into the value of export

[1] An early example of international modeling along the lines proposed here is the Comlink version of Project LINK, Adams (1978).

earning for a producer country and that should have significant influence on the country's economic activity, price level, and growth. (Adams and Behrman (1982) found powerful effects from commodity export earnings on economic activity.) In practice the present versions of the ELSA models do not contain disaggregation of export broken down by commodities, so that export earnings from specific categories of commodities are captured only through the export price indexes.

- Quantity of commodity exports. The commodity models show quantity commodity production for the appropriate Asean countries. These figures could be modified to show exports as well as production and these data could be integrated into the country models, but that would require modification of country models.

The conceptual notion of integration of the commodity models into the ELSA system can best be described in a sequential approach to the solution of the entire system of models. While solution can begin at any point, we begin with the notion of a solution of ELSA without the commodity models. Such a solution would begin with exogenously set values for the commodity prices. Once the ELSA solution has been obtained, it is fed into commodity models. A solution of these produces commodity prices consistent with ELSA, what we term a one-way solution, from country models to commodity models. In turn the latter is fed back into the commodity models. Such a procedure continues until a stable and consistent solution for the country and commodity model systems has been obtained. This represents a simultaneous solution of both systems; we call this a two-way solution. In practice the process of solution need not go to equilibrium in one set of models before a transfer of information to the other is made. Rather we obtain equivalent results by carrying out an integrated iterative solution where the commodity models are fully integrated into the model system just like the country models.

The Commodity Models

A number of commodity market models, covering the principal commodities in Asean (and in world trade) have been constructed for use in the ELSA system.[1] The impact of commodities in the producing countries is considered in Adams and Behrman (1982).

The models developed here are, by choice, simple models designed to emphasize the demand, supply, and price in each of the commodity markets. They are designed to provide information for the producing countries and for the direct impact of commodity markets on major consuming countries.

[1] The literature on commodity market models in extensive: see for example, Labys (1973), Labys and Pollak (1984), Adams and Klein (1978), Adams and Behrman (1976), Adams and Behrman (1982). The models used here have been designed in the same pattern as models described in Adams and Behrman (1976).

Models have been constructed for:

-- cocoa[2]	-- wheat[1]
-- coffee	-- rice[2]
-- sugar	-- nickel
-- copper	-- lumber
-- tin	-- rubber[2]
-- maize	

The essentials of the structural equations for each of these model systems is summarized as follows:

- demand functions which relate consumption of the commodity to income or industrial activity (Y) on the consuming country and to price (P), relative to the price of alternatives (P_s).

  $D = f\ (Y, P, P_s).$

- supply functions based on the assumption of profit maximization by producers and consequently relating supply to price relative to production costs (C) usually with a long time lag and often time trends (T).

  $S = f\ (P, C, T).$

- inventory supply functions which are based on the identity relationship between production and consumption and official stockpile purchases ($\triangle I_o$).

  $I_s = I_{s-1} + S - D - \triangle I_o.$

- and finally, price functions which relate price to available stocks relative to consumption requirements for stocks, and to price expectations (P^e). The price function may reflect long run costs, (C), it may represent equilibrium in the market for inventories or it may take the form of a disequilibrium formulations based on the difference between supply and demand.

  $P = f\ (I_s, D, P^e, D).$

We summarize here some important judgments which can be reached on the basis of econometric modeling of commodity markets, specifically with reference to the implications for linked econometrio models of commodity markets and countries:

1. The elasticities of demand are generally less than one with respect to price. In most cases the elasticities with respect to income are also less than unity.
2. Elasticities of supply in many cases are also relatively low.
3. The important characteristic with respect to both supply and demand is that there are long time lags before the full response of changes in price and income are

[1] In the linkage calculations below, these models have not yet been fully integrated into the system.

felt. This means that adjustment periods to changes in demand or in supply are long and that swings in price as a result of changes in external conditions are likely to be large.

The Linkage Mechanisms

ELSA-Comlink integrates the CADE commodity models with the ELSA system. The commodity models draw on inputs from activity in the major ELSA model countries, specifically the United States and Japan. Production of commodities is determined endogenously in the commodity models. Prices determined in the commodity models are fed into the export prices and import prices of the ELSA models.

The necessary linkages fall into a number of categories:

- **Import and Export Price Linkages.** These involve the critical linkages between the price of primary commodities and the prices of the corresponding categories of imports and exports. Since the ELSA models do not provide disaggregation of imports and exports into appropriate categories, the effects of commodity prices are incorporated in the linkage equations by regression based relationships. Commodity export and import price variables were developed as trade weighted averages of commodity prices. To keep a close tie to the country models, our newly created commodity export and import price variables were introduced as an extra explanatory variable in the equations for export or import prices originally in the ELSA country models.
- **Linkages Between ELSA Country Models And Inputs Into Commodity Models.** Numerous variables about the world economy including industrial production, world commodity price indexes, and consumer prices and GDP deflators enter into the commodity models. These are available only to a limited extent from the ELSA country models. The requirement for input data into the commodity models has been met by providing linkage equations between variables present in the ELSA models and the required variables.
- **Exchange Rates.** Exchange rates to translate dollar prices into the prices of particular producing countries were necessary in the commodity models. In order to provide a systematic mechanism for linkage to the ELSA system, special equations, based on purchasing power parity notions were developed to explain exchange rates.
- **UN Commodity Price Indexes.** Since the commodity models operate with actual commodity prices in commodity markets and since the import and export prices are based on UN trade statistics, it was necessary to provide linkage equations between commodity prices and UN commodity price indices.

The linkage equations establish firm connections between the commodity models and the country models of ELSA, both in the direction of the consuming countries and in the direction of the commodity producers.

ELSA Comlink Simulation Results

Econometric models are only as good as their results. The ultimate test of econometric structures lies in how well they describe the behavior of the real world economy, either, over a historical period, or in multiplier or policy simulations. In this section we summarize the results obtained with ELSE-Comlink system. How well does the system describe what actually happened over the period 1976-1980? How does that system respond to exogenous changes in the policy variables for the industrial countries which are the principal consumers of primary commodities?

Two way linked simulation--the two way linked simulations are the ultimate test of the operation of the entire system. This is the stage of linkage which encompasses the feedbacks from the commodity models back to the country models. As we have noted earlier the predominant linkages from the commodity models to the country models are through the commodity prices affecting import prices for the importing countries and export prices for the commodity exporters. This approach tests the ability of the commodity prices to influence the economies of the consuming and the producing economies. Because this represents a complete simultaneous solution of the entire system, it provides a consistent view of the country and commodity market interactions.

The comparison of model simulations requires a base simulation. In order to facilitate comparison with real values, the baseline simulation used here is a simulation for the period 1976 to 1980, within the data period over which the models have been estimated. The baseline simulation can be compared with the actual values prevailing over this period. Such simulations are compared in Table 1. The results are quite satisfactory and indicate that the model system is performing properly.

The second form of simulation are so-called multiplier simulations. These involve as a starting point the same exogenous inputs over the 1976 to 1980 simulation period as in the baseline simulation except for a change that has been assumed in the exogenous inputs for government monetary and fiscal policies. The assumed changes are:

Monetary Policy-- A 10% increase (as compared to the base solution) in supply of money.

Fiscal Policy--A 10% increase in government expenditures.

The effects of these policy changes on the economies of the industrial countries, the United States and Japan are shown in Table 1.

The results reflect the monetarist orientation of the macro models for the US. and Japan used in this model system. The inflationary impulse is largely the result of monetary policy, rather than of the increase in commodity prices since the impact of rising commodity prices is likely to be more moderate than the overall inflation impact obtained here.

The principal conclusions of these simulations can be summarized as follows : The models clearly show the linkages from the movement of the industrial economies to the commodity markets, increases in economic activity and demand for primary commodities cause increases in the prices of the commodities in international markets. The impact on the producing countries does not appear to come through strongly, a fact which may reflect the relatively small role of each of these commodities in these countries or the structure of their models.

Table 1

Performance of Commodity Models

	Observed	Simulated	% Deviation	Multiplier Solution % Effect
Sugar c/lb				
1976	11.56	11.54	−0.2	+3.2
1977	8.09	11.03	+36.3	+8.1
1978	7.84	6.24	−20.4	+11.4
1979	9.65	7.65	−20.7	+13.5
1980	28.59	18.58	−35.0	+14.3
Absolute Percentage Error				
Coffee New York $/lb.				
1976	1.16	1.03	−10.9	+2.6
1977	1.74	1.68	−3.6	+2.8
1978	1.02	1.17	+14.8	+1.2
1979	0.97	0.76	−21.8	+0.8
1980	0.76	0.78	+3.5	
Absolute Percentage Error			10.9	
Timber Softwood US$/1000 bd. ft.				
1976	5.14	5.13	−0.2	+0.7
1977	5.29	5.37	+1.6	+0.7
1978	5.23	5.33	+1.9	+0.5
1979	5.43	5.42	−0.2	+0.5
1980	5.22	5.28	+1.3	+0.2
Absolute Percentage Error			1.0	

(table 1 continued)

	Observed	Simulated	% Deviation	Multiplier Solution % Effect
Nickel UK L/metric ton				
1976	2755.0	2591.1	-6.0	+2/8
1977	3169.3	2729.1	-13.9	+8.7
1978	2759.1	2326.2	-15.7	+12.2
1979	2848.7	2586.6	-9.2	+16.4
1980	3239.1	2703.9	-16.5	+17.0
Absolute Percentage Error			12.3	
Tin US $/metric ton				
1976	758.0	660.0	-12.9	+1.6
1977	1076.0	1049.7	-2.4	+4.3
1978	1291.0	1219.0	-5.6	+8.2
1979	1546.0	1367.4	-11.6	+10.3
1980	1678.0	1511.9	-9.9	+11.6
Absolute Percentage Error			8.5	
Copper US $/metric ton				
1976	1401.0	1376.9	-1.7	+1.4
1977	1310.0	1045.4	-20.2	+14.2
1978	1367.0	1239.4	-9.3	+6.0
1979	1985.0	1605.4	-19.1	+2.5
1980	2183.0	1816.2	-16.8	+1.6
Absolute Percentage Error			13.4	
Corn US $/metric ton				
1976	122.0	121.4	-0.5	0
1977	105.8	120.4	+13.8	0
1978	116.6	122.5	+5.0	0
1979	138.2	123.2	-10.8	0
1980	164.2	145.7	-11.2	0
Absolute Percentage Error			8.3	

Table 2

Effect of Policy Change on Industrial Economies
(Percent deviation from base solution)

	United States	*Japan*
Real GNP		
1976	6.5	1.2
1977	5.0	2.9
1978	1.9	2.3
1979	.1	2.1
1980	.9	1.8
GNP Deflator		
1976	2.4	1.5
1977	5.9	4.5
1978	8.8	5.2
1979	10.5	5.6
1980	11.2	5.9

Table 3

Effect of Policy Stimulus on Export Prices of Major Asean Countries
(percent deviation from base solution.)

Thailand	*Philippines*	*Malaysia*	*Indonesia*
0.1	0.5	0.1	0.5
0.3	1.4	0.2	2.7
0.3	2.1	0.2	4.6
0.4	2.6	0.2	5.6
0.3	2.9	0.2	6.1

The ELSA project represents a promising beginning. More work will be necessary to refine the linkages and to provide appropriate restructuring and disaggregation of the country models. Such efforts will lead to a model system with important potentials for policy analysis.

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บทคัดย่อ

Econometric Estimates of Post-Harvest loss of Rice

บทความนี้กล่าวถึงวิธีการประมาณการและปริมาณสูญเสียของข้าวหลังเก็บเกี่ยว ซึ่งการสูญเสียนี้รวมถึงการสูญเสียระหว่างการนวดข้าว การตากข้าว การผูกข้าวเพื่อเตรียมเคลื่อนย้ายและการขนส่งข้าว การสูญเสียข้าวนี้ยังได้จำแนกเป็นรายภาคด้วย

Taxation of Rice Exports in Thailand : A Tax Simulation Analysis

บทความนี้ พยายามจะชี้ให้เห็นว่า ถ้ามีการยกเลิกการเก็บค่าพรีเมี่ยมข้าวและภาษีส่งออกข้าวในช่วง พ.ศ. 2503 ถึง พ.ศ. 2517 แล้ว อาจจะมีผลดีต่อนโยบายพัฒนาประเทศที่เน้นการพัฒนาภาคนอกภาคเกษตร การศึกษาใช้แบบจำลองทางเศรษฐมิติ ทำการทดลองเพื่อทดสอบสมมติฐานในช่วงเวลาดังกล่าว

การยกเลิกภาษีของข้าวทำให้รายได้ของภาคเกษตรสูงขึ้น และทำให้อุปสงค์รวมเพิ่มขึ้น การผลิตนอกภาคเกษตรขยายตัวทำให้เศรษฐกิจโดยส่วนรวมขยายตัว การทดลองยังชี้ว่าการยกเลิกภาษีดังกล่าวไม่ก่อให้เกิดแรงกดดันทางด้านระดับราคา อันเนื่องมาจากการเพิ่มในปริมาณเงินแต่อย่างใด

Commodity Models in the LINK Model

บทความนี้ต้องการชี้ให้เห็นว่า สินค้าออกขั้นปฐมภูมิ อาทิเช่น ข้าว น้ำตาล ยางพารา ฯลฯ เป็นแหล่งรายได้ที่สำคัญสำหรับประเทศที่กำลังพัฒนา อย่างไรก็ตาม แบบจำลองของตลาดสินค้าเหล่านี้ก็มีความสำคัญในแบบจำลองเศรษฐมิติของเศรษฐกิจโลกด้วย เมื่อพิจารณาจากข้อเท็จจริงที่ว่า มีการเชื่อมโยงตลาดเหล่านี้เข้าด้วยกันทั้งในแง่ของประเทศผู้ผลิตและประเทศผู้บริโภค

จากผลการศึกษาครั้งนี้พอสรุปได้ว่า แบบจำลองข้างต้นนี้มีความเชื่อมโยงกันจากการเคลื่อนไหวของเศรษฐกิจประเทศอุตสาหกรรมไปสู่ประเทศที่ส่งสินค้าออกเหล่านี้ การที่กิจกรรมทางเศรษฐกิจและอุปสงค์ต่อสินค้าเหล่านี้เพิ่มขึ้น จะทำให้ราคาเหล่านี้สูงขึ้นในตลาดโลก

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