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REGIONAL INPUT-OUTPUT AND SOCIAL ACCOUNTING SYSTEMS
FOR AGRICULTURAL AND RURAL DEVELOPMENT PLANNING

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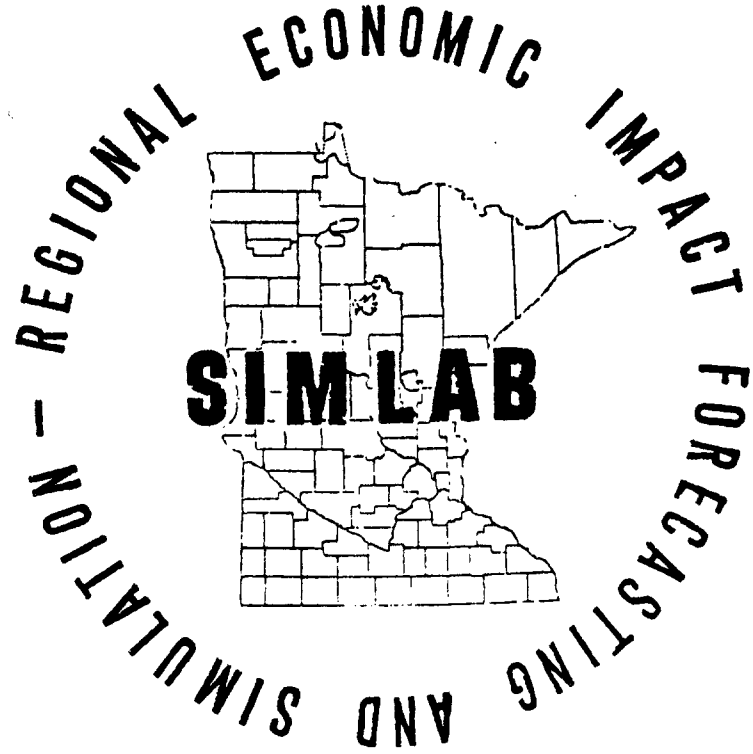

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CONTENTS

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This report is based, in part, on a current study of agribusiness development problems and prospects in Minnesota. This study is being conducted in cooperation with the Minnesota Department of Economic Development. It is funded by the Minnesota Agricultural Experiment Station. The related study of agribusiness development in Northeast Thailand, which demonstrates the use of a common analytical approach in regional development planning and provides comparable data in Part II of this report, was funded under the Agricultural Sector Analysis Program, Division of Agricultural Economics, Ministry of Agriculture and Cooperatives, Bangkok and the Center for Agricultural and Rural Development, Iowa State University, Ames.

Abstract

This report presents selected statistics of inter-industry interdependence which focus on the importance and role of agriculture and agriculture-related industry in regional economic development. Data for two vastly different regions -- the State of Minnesota and the Northeast Region of Thailand -- are presented to show the wide differences in regional economic relationships and activity levels which occur and which are amenable, nonetheless, to similar methods of economic accounting and analysis. These methods include use of regional input-output and socio-economic accounts for monitoring, assessing and comparing the effects of particular agricultural and agriculture-related industry development strategies on a total regional economy and, also, through its exports and imports, on the rest of the nation.

Summary and Conclusions

Detailed steps in the construction and use of regional input-output and social accounts in regional development planning and analysis must start with elements of a decision information system. Such a system for agriculture-related development planning is presented, first, for Minnesota and its role in state development strategy is discussed. This presentation and discussion is then extended to the building of a regional information system for agricultural and rural development in Northeast Thailand. The four changewats of Khon Kaen, Kalasin, Maha Sarakham and Rio Et, were selected for this purpose.

The Minnesota industry structure is represented by numerical entries in its 1972 input-output tables. These entries are summarized by estimated 1972 levels of industry output, sales and purchases as follows:

Industry Attribute	All Industry	Agriculture-Related		
		Farm	Off-Farm	Total
	(million dollars)			
Gross Output	38,623	3,280	4,501	7,781
Intermediate Local Sales	15,312	1,651	3,184	4,835
Final Local Sales	16,364	203	1,079	1,282
Exports to Rest of Nation	6,947	463	2,134	2,597
Intermediate Local Purchases	15,312	2,615	1,288	3,903
Value Added	18,763	1,236	778	2,014
Imports from Rest of Nation	4,548	393	540	933

The summary data show total industry output in Minnesota of $38.6 billion in 1972. Of this total, local intermediate sales were $15.3 billion, or 40 percent of gross output. Local intermediate purchases were $15.3 billion, also (given the balanced nature of the interindustry transaction table). Value added by these industries totaled $18.8 billion in 1972. Agriculture-related industries accounted for $2 billion, or 11 percent, of the state total.

The Northeast Thailand study area industry structure is represented by a comparable set of input-output accounts for 1976, as follows:

Industry Attribute	All Industry	Agriculture-Related		
		Farm	Off-Farm	Total
	(million baht)			
Gross Output	11,630	5,507	3,209	8,716
Intermediate Local Sales	5,601	3,866	843	4,709
Final Local Sales	4,805	1,419	1,374	2,793
Exports to Rest of Nation	1,224	222	992	1,214
Intermediate Local Purchases	4,350	893	2,574	3,467
Value Added	6,892	5,153	340	5,476
Imports from Rest of Nation	388	78	295	373

These data show a highly agriuclture-dependent area economy, with 75 percent of the total value added originating in agriculture-related industries. Also, local intermediate sales and purchases differ in the summary table, unlike the Minnesota data, which are in balance. This difference results from the lack of comparable estimates of industry sales and purchases for all industry, especially from agriculture-related trade and service activities.

While incomplete, the statistical series for the Northeast Thailand study area suggest important interindustry and interregional linkages which are a measure of the degree of economic interdependnece within the area and between the area and rest of nation. Because of these linkages, the planning of agricultural and rural development projects must take into account the inter-related and supporting activities, including both public and private investment in regional and community infrastructure. An integrated system of regional input-output and social accounts is presented for the purpose of providing the needed statistical and economic decision information for the area and regional development and planning.

Procedures for building an integrated input-output/social accounting system, which make use of farm and farm-related business surveys and published reports and documents, are presented. These procedures are used also in preparing a linked linear programming/input-output model for agricultural sector analysis. Regional economic effects of agricultural and rural development policies and programs are assessed with the regional analysis and forecasting system.

The computable regional model is available, also, for sector and project evaluation. An investment minimization criterion is identified which results in consistent project rankings with cost-benefit ratios weighted by the direct and indirect effects of the proposed investment. Residentiary activities are viewed as constraints on regional economic expansion. Less residentiary-dependent export-producing activities thus would outrank more residentiary-dependent activities. However, alternate development efforts favor import replacement rather than import substitution in a national strategy of regional industrial diversification. The computable regional model provides a framework for these and other approaches to investment planning as it takes into account critical resource scarcities in the prioritizing of investment alternatives.

Implementation of the linked linear programming/input-output model depends on the implementation of the regional input-output and social accounts. Once the two accounts are completely estimated for a base year, such as 1976, the next step is to incorporate the input-output tables and the expanded demands and primary inputs into the linear programming procedures. The inter-industry and inter-sectoral transactions of all local industries must be included in these tables. Use of partial and imcomplete analytical approaches, like the semi-input-output method, are avoided with the expanded linear programming/input-output model and related procedures.

REGIONAL INPUT-OUTPUT AND SOCIAL ACCOUNTING SYSTEMS FOR AGRICULTURAL AND RURAL DEVELOPMENT [1/]

Wilbur R. Maki

This paper focuses on the construction and use of regional input-output and social accounts in agricultural and rural development planning and analysis. It does so by building a set of regional accounts for tracing the impacts of agricultural and rural development policy from the agricultural production sector to other sectors of the economy and back again to agriculture. The purpose of this effort is to achieve a better understanding of agriculture-dependent regional economies and, thus, better predict and, prepare for, the consequences of various public and private actions.

Of critical importance to agricultural and rural development are the location, level and timing of public and private investment in productive activities, including supporting services. The two types of investment are interdependent and, also, competitive.

Private sector development, for example, requires large financial commitments from farmers, bankers, processors and distributors in the construction of the new agriculture-related facilities. To attain the full potential of this development, a host of related rural infrastructure investments are needed, ranging from farm-to-market roads and railarods to new or expanded water supply systems, wastewater treatment facilities and low-cost housing.

With high interest rates and capital rationing, adequate private financing is lacking for many promising investments among the small businesses which predominate in rural communities. This financing gap is bridged, in part, by various federal and state programs (e.g., Farmers Home Administration and its farm, business and industrial, rental and self-help housing loan programs). The private sector assistance is supplemented by assistance to local governments for the construction of basic community facilities.

Although existing federal and state loan programs follow a "worst-first" strategy, alternative strategies are available which favor different decision rules, such as a reduction in the rate of unemployment, or an increase in total "basic" (i.e., "export-producing" as contrasted with "residentiary") employment, or a maximization of "net return" on public investment. Use of the alternative decision rules would result in different patterns of investment "targeting" and "prioritizing". The impact of a federal loan program, for example, would vary among different communities and economic groups depending upon the decision rule.

1/ Paper prepared for Conference on Regional Input-Output Studies in Policy Analysis, First World Regional Science Congress, Harvard University, June 14-21, 1980.

PART I: DECISION INFORMATION FOR AGRICULTURE-RELATED DEVELOPMENT IN MINNESOTA [2/]

Decision information for agriculture-related development presented in Part I refers to statistical series like industry employment, capital stock, and value added. In addition, effects of different state policies on these variables must also be considered. For this purpose, Minnesota serves as a demonstration region for building, testing and interpreting the implications of different state policies on agriculture-related industry. The Minnesota data may be compared, in Part II, with corresponding statistical series in a regional accounting system for Northeast Thailand.

Study Region

Minnesota agriculture and agriculture-related manufacturing industries are compared with corresponding U.S. industry groups in a series of industry input and output flow tables based on the 1972 U.S. interindustry transactions tables (5). Industry input purchases and output disbursements from these tables are summarized for Minnesota in Table 1.1. This base year is used simply because it is the latest year for detailed comparisons between U.S. and Minnesota agriculture-related industry.

In 1972, agriculture and agriculture-related manufacturing in Minnesota accounted for total industry output of $7.8 billion, which was 20 percent of the gross output of all industry in Minnesota. Approximately $4.8 billion of the Minnesota gross output was disbursed to industry as intermediate inputs while approximately $1.3 billion was disbursed to final demand sectors in Minnesota. The agricultural industries thus demonstrated strong forward linkages to food products manufacturing industries in Minnesota, while the food products manufacturing industries demonstrated strong forward linkages to final demand sectors, including exports to other states.

A major part of the total outlays -- $3.9 billion -- of Minnesota agriculture-related purchases were from the input-supplying industries, like petroleum and chemical products; machinery; finance, insurance, and real estate; and business services. Primary inputs totaled $1.2 billion in value added in agriculture and $0.8 billion in food products manufacturing, while imports from other states totaled $0.4 billion in agriculture and $0.5 billion in food products manufacturing. Wholesale and retail trade margins involved in moving and transforming the agricultural products to food products are included in the food products manufacturing industry input purchases. Income payments to primary input suppliers (i.e., household, business and government) represent the value added (or gross state product) originiating in the specified industries. Thus, the agriculture-related industries are important markets for input-supplying industries in Minnesota,

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2/ This report is second in the series describing elements of the Minnesota Trade-Off Model (see, ref.10 in references cited on p. 27 of this report). Only the market economy and market-type public enterprise are included in this table, i.e., government activity, is excluded.

TABLE 1.1 OUTPUT DISBURSEMENTS AND INPUT PURCHASES OF SPECIFIED INDUSTRY, MINNESOTA, 1972.

Industry No.	Title	Input Purchases: Gross Output	Input Purchases: Intermediate	Input Purchases: Value Added	Input Purchases: Total Imports	Output Disbursements: Intermediate	Output Disbursements: Final: Local	Output Disbursements: Final: Exports: Allocated U.S. Net	Output Disbursements: Final: Exports: Ron	Output Disbursements: Final: Exports: Total
		($1000)	($1000)	($1000)	($1000)	($1000)	($1000)	($1000)	($1000)	($1000)
1	DAIRY FARM	503790.	259632.	213103.	31055.	405405.	2134.	0	96251.	96251.
2	POUL.,EGGS	131894.	96472.	15853.	19568.	110828.	21066.	267.	0	267.
3	MEAT AN.	1249891.	853445.	235311.	161135.	1197949.	19127.	-1749.	32815.	31066.
4	FOOD, FEED	885153.	290587.	466658.	127904.	606677.	70003.	36075.	208473.	244547.
5	VEGETABLES	64673.	14397.	40681.	6595.	23918.	37755.	-1160.	0	-1160.
6	SUGAR CROP	30338.	9369.	16131.	4838.	8750.	-195.	0	21783.	21783.
7	OIL-BEARIN	315335.	87028.	197725.	30581.	177269.	36159.	27368.	101908.	129276.
8	OTHER CROP	30128.	7411.	19477.	3240.	16117.	12663.	-359.	1348.	989.
9	FOR.,FISH.	5239.	1827.	2947.	465.	2953.	2286.	-1240.	0	-1240.
10	AGR.,FOR.,	67049.	31292.	27876.	7881.	64716.	2334.	200.	0	200.
11	MINING	666384.	275337.	275516.	115531.	74516.	18932.	-11949.	572935.	560987.
12	CONSTRUCTI	2965272.	1228134.	1359516.	377621.	474531.	2460416.	267.	30325.	30592.
13	MEAT PRODU	1781534.	1266113.	218057.	297364.	332422.	374886.	-10885.	1074226.	1063341.
14	DAIRY PROD	1200109.	1008549.	160477.	31083.	465588.	194607.	343.	539914.	540258.
15	FRUIT & VE	322699.	173811.	90382.	58505.	67140.	158816.	-2477.	96742.	94265.
16	GRAIN MILL	481105.	305687.	105159.	70259.	237956.	51894.	4338.	191254.	195592.
17	BAKERY	92484.	37222.	46896.	8366.	19855.	72629.	-46.	0	-46.
18	SUGAR PROD	89764.	41797.	26630.	21337.	33058.	56705.	-7036.	0	-7036.
19	SOYBEAN, V	240837.	199111.	24354.	17372.	80817.	21243.	9593.	138777.	148375.
20	ALCH. BEV.	292931.	151456.	105761.	35714.	51486.	148574.	-723.	92860.	92137.
21	MISC. FOOD	96659.	44258.	27982.	24413.	26182.	65553.	-866.	4924.	4058.
22	CHEM. & AL	482011.	211913.	158395.	111704.	261302.	175612.	15616.	45098.	60714.
23	PETR. REF.	372004.	91110.	85688.	195007.	190571.	181433.	-18360.	0	-18360.
24	FARM MACH.	190159.	75071.	77672.	37416.	40616.	102752.	1069.	46791.	47860.
25	OTHER MFG.	8682153.	3521628.	3433950.	1726575.	3842463.	2560647.	26546.	2279038.	2305585.
26	TRANSPORTA	1556393.	510981.	929220.	116193.	785716.	519870.	49324.	250808.	300132.
27	COMM., UTI	1475625.	489896.	805403.	180326.	823969.	617250.	1193.	34407.	35600.
28	WH. & RET.	5419457.	1384978.	3776623.	257856.	1328301.	3392572.	117537.	699584.	817121.
29	FIN.,INS.,	4263822.	1055677.	3092060.	116085.	1560898.	2615965.	28388.	86959.	115347.
30	SERVICES	4256506.	1450375.	2479068.	327063.	1703004.	2283826.	18522.	269676.	288198.
31	GOV'T ENT.	387541.	121486.	242068.	23988.	271012.	85886.	1890.	30644.	32534.
32	SCRAP	26617.	15504.	-0.	11114.	25556.	1062.	-994.	0	-994.
33	TOTAL	38622556.	15311555.	18762839.	4548163.	15311555.	16364460.	280696.	6946542.	7227238.
	FARM(1-10)	3280490.	1651461.	1235763.	393267.	2614580.	203332.	59402.	462578.	521980.
	AG.REL.(13-21)	4501462.	3183746.	777717.	540000.	1288333.	1079354.	-6889.	2133775.	2126886.

1/ Includes U.S. noncomparable imports allocated to Minnesota.

2/ Includes net U.S. exports (total competitive exports minus total competitive imports) allocated to Minnesota.

accounting for 32 percent of total intermediate sales of the Minnesota market economy in 1972. They also accounted for 37 percent of the net value of Minnesota exports to the rest of Nation. In six of the 19 agriculture-related industries, the Minnesota exports helped reduce a net deficit in the U.S. trade balance with other countries.

Net income of farm proprietors totaled nearly $0.9 billion in 1972, or $7,000 per farm proprietor. Farm-related and nonfarm earnings totaled $12.4 billion, or nearly $8,000 per worker.

Decision Information

In this section, production requirements of each industry are summarized and presented in several forms, starting with the total requirements of the Minnesota economy for specified industry output. Next, individual industry demand multipliers are presented. These are followed by estimates of so-called supply multipliers which relate changes in primary inputs and imports to changes in gross outputs.

Production Requirements

Production requirements are the intermediate and final purchases of goods and services of Minnesota industries (Table 2.1). These include purchases from other industries and, also, intra-industry transactions and purchases from primary input sectors -- household, business and government. Specifically, the gross output requirements show the purchases of industry output by the intermediate demand sectors and the regional final demand sectors. Total imports of each industry output are shown as a proportion of total requirements to represent the degree of import dependency of the Minnesota economy. These are the industry outputs which were in deficit supply in 1972. Import dependency varied from 100 percent in crude petroleum (included in mining industry) to no dependency, or excess supply, in 24 industries (indicated by the lack of entry in the import column).

Exports as a proportion of gross outputs are shown, also, to complete the listing of industry activity. Those which are not import dependent are export dependent in varying degree. For the export-dependent industries gross output exceeds the total requirement of that output in Minnesota. Export dependency also ranged from 100 percent dependency in iron ore mining to no dependency in eight industries (which are, of course, the import-dependent industries).

Multiplier Analysis

The full interindustry transactions table is used in the derivation of the industry multiplier series in Table 2.2. Two types of demand multipliers are presented, namely, the conventional Type I multiplier and the less conventional (extended) Type II. multiplier. In addition, industry supply multipliers, which are derived from the row, or disbursements, coefficients

TABLE 2.1 Gross Output, Total Requirements and Excess and Deficit Supply of Specified Industry, Minnesota, 1972.

Industry No.	Title	Output	Total Requirement 1/	Excess Supply		Deficit Supply	
				Total 2/	Proportion of Gross Output	Total 3/	Proportion of Total Requirement
		($1,000)	($1,000)	($1,000)	(Pct.)	($1,000)	(Pct.)
1	DAIRY FARM	503790.	407539.	96251.	19.105	0	0
2	POUL.,EGGS	131894.	132948.	0	0	1054.	.793
3	MEAT AN.	1249891.	1621247.	32815.	2.625	404171.	24.930
4	FOOD, FEED	885153.	722514.	208473.	23.552	45834.	6.344
5	VEGETABLES	61673.	76076.	0	0	14403.	18.932
6	SUGAR CROP	30338.	8554.	21783.	71.803	0	0
7	OIL-BEARIN	315335.	213428.	101908.	32.317	0	0
8	OTHER CROP	30128.	119165.	1348.	4.474	90384.	75.848
9	FOR.,FISH.	5239.	67851.	0	0	62612.	92.279
10	AGR.,FOR.,	67049.	104552.	0	0	37503.	35.870
11	MINING	666384.	555676.	572935.	85.977	462228.	83.183
12	CONSTRUCTI	2965272.	3041763.	30325.	1.023	106817.	3.512
13	MEAT PRODU	1781534.	774509.	1074226.	60.298	67201.	8.677
14	DAIRY PROD	1200109.	680873.	539914.	44.989	20678.	3.037
15	FRUIT & VE	322699.	275837.	96742.	29.979	49880.	18.083
16	GRAIN MILL	481105.	391213.	191254.	39.753	101362.	25.910
17	BAKERY	92484.	154180.	0	0	61696.	40.016
18	SUGAR PROD	89764.	154658.	0	0	64895.	41.960
19	SOYBEAN, V	240837.	162372.	138777.	57.623	60312.	37.144
20	ALCH. BEV.	292930.	369375.	92860.	31.701	169305.	45.835
21	MISC. FOOD	90659.	265520.	4924.	5.094	173785.	65.451
22	CHEM. & AL	482011.	966765.	45098.	9.356	529852.	54.807
23	PETR. REF.	372004.	653534.	0	0	281529.	43.078
24	FARM MACH.	190159.	143368.	46791.	24.606	0	0
25	OTHER MFG.	8682153.	11127591.	2279038.	26.250	4724475.	42.457
26	TRANSPORTA	1556393.	1410150.	250808.	16.115	104564.	7.415
27	COMM., UTI	1475625.	1704357.	34407.	2.332	263139.	15.439
28	WH. & RET.	5419457.	4720873.	698584.	12.890	0	0
29	FIN.,INS.,	4263822.	4685206.	86959.	2.039	508343.	10.850
30	SERVICES	4256506.	4227303.	269676.	6.336	240474.	5.689
31	GOV'T ENT.	387541.	391123.	30644.	7.907	34225.	8.751
32	SCRAP	26617.	42434.	0	0	15817.	37.274
33	TOTAL	38622556.	40372552.	6946542.	17.986	8696537.	21.541

1/ Gross output less export to rest of nation
2/ Rest of nation industry net purchases of specified Minn. Industry output
3/ Minnesota industry net purchases of specified rest of nation industry output

Table 2.2 Demand and Supply Multiplier of Specified Industry, Minnesota, 1972.

Industry No.	Title	Demand Type I 1/	Demand Extended Type II 2/	Supply Type I 3/	Supply Extended Type II 4/
1.	Dairy Farm	1.856	8.542	2.328	4.469
2.	Poul., Eggs	2.336	7.869	2.130	5.996
3.	Meat An.	2.293	8.020	2.591	5.193
4.	Food, Feed	1.523	7.917	2.624	4.806
5.	Vegetables	1.363	8.206	1.588	9.694
6.	Sugar Crop	1.477	7.790	1.532	3.780
7.	Oil-Bearing	1.422	8.292	1.989	2.939
8.	Other Crop	1.382	8.187	2.112	9.290
9.	For., Fish.	1.568	8.309	2.915	12.215
10.	Agr., For.	1.802	8.153	3.126	7.136
11.	Mining	1.640	7.739	1.221	1.991
12.	Construction	1.671	7.958	1.282	9.875
13.	Meat Products	2.608	7.669	1.252	3.836
14.	Dairy Products	2.869	9.500	1.624	4.242
15.	Fruit and Veg.	1.939	7.630	1.300	6.873
16.	Grain Mill	2.135	7.949	2.093	4.563
17.	Bakery	1.757	8.334	1.305	9.967
18.	Sugar Prod.	1.866	7.361	1.862	10.556
19.	Soybean & Veg. Oil	2.274	8.684	1.729	2.825
20.	Alch. Veb.	1.861	8.003	1.250	6.989
21.	Misc. Food	1.801	7.045	1.410	9.350
22.	Che. & Al.	1.738	7.146	2.032	7.708
23.	Petr. Ref.	1.413	4.838	2.059	9.860
24.	Farm Mach.	1.673	7.422	1.433	6.461
25.	Other Mfg.	1.683	7.409	1.761	6.810
26.	Transportation	1.506	8.458	1.881	7.262
27.	Comm., Utilities	1.508	8.077	1.975	9.266
28.	Wh. & Ret.	1.420	8.690	1.401	8.491
29.	Fin., Ins.	1.366	8.884	1.620	9.356
30.	Services	1.541	8.440	1.651	9.110
31.	Gov't. Ent.	1.493	8.530	2.219	8.962
32.	Scrap	2.024	5.560	3.561	10.401
33.	Value Added	--	7.963	--	9.096

1/ Demand Type I multiplier is given in the conventional Leontief inverse, i.e., $[I-A]^{-1}$, which consists of the 32 interacting sectors in the Minnesota tables.

2/ Demand Extended Type II multiplier is given in the extended Leontief inverse of 33 interacting sectors, including the value added row and the final local demand column in the Minnesota tables.

3/ Supply Type I multiplier is given in the inverse of the row, or disbursement, coefficients matrix, i.e., $[I-D]^{-1}$.

4/ Supply Extended Type II multiplier is given in the inverse of the extended row coefficients matrix of the 33 interacting sectors in the Minnesota tables.

table are presented, also.

The industry demand multipliers range from a low of 1.363 for the Type I multiplier to a high of 9.5 for the extended Type II multiplier. The high multiplier value is associated with a low level of imports (from input-supplying industries outside Minnesota to output-producing industries in Minnesota). A high auxiliary coefficient value (i.e., employment, value added and capital stock) also contributes to a high value for the extended Type II multiplier. Conversely, a low demand multiplier denotes a high import dependency and a low auxiliary coefficient value.

The Type I multiplier designation denotes the use of the 32-industry tables in the computation of the Leontief (i.e., I-A) inverse. An extended Type II multiplier, on the other hand, is derived from a 33-industry table (because of the inclusion of the value added and final local disbursements sectors in the Leontief inverse). The expanded Type II multipliers are larger than the Type I multipliers because of the induced value added effects. The induced effects are transmitted from the "Value Added" row to the local "Final Disbursements" column in the derivation of the new Leontief multipliers.

The supply multipliers are derived in exactly the same manner as the demand multipliers, except for the use of row,rather than column, coefficients. Supply multipliers generally are larger than the corresponding industry demand multipliers for industries with output disbursements to local intermediate markets (Type I) or local final markets (Extended Type II). Supply multipliers show the total output effects of a given change in value added and imports (Type I) or imports only on a supply constrained economy.

Investment Strategy

Preparation of alternate criteria in public development planning are illustrated in the derivation of the direct, indirect and induced effects of a given increase in industry production. These effects can be converted into equivalent capital stock and primary input requirements.

When the primary input requirement is derived as a proportion of the capital stock requirement for each industry, a series of ratios are obtained which show the total value added per $1 of capital stock. The ratios are derived from the multiplier values, except that the Type I multiplier corresponds with the sum of the direct and indirect effects and the extended Type II multiplier corresponds with the total effects of specified export (not local) demand changes.

Public benefits may be measured, also, in terms of value added per $1 of public investment or, more specifically, additional public income (and/or benefits) per $1 public outlays.A linkage between public outlays and private and public benefits must be established, however, to obtain the additional benefits derived from public, as distinct from private, expenditures. This is an essential step in the measurement of public benefits and costs of state industry development efforts which is discussed next in Part II of this report.

PART II: BUILDING REGIONAL INFORMATION SYSTEM FOR AGRICULTURAL AND RURAL DEVELOPMENT PLANNING IN NORTHEAST THAILAND [3/]

Elements of a regional information system for agriculture-related development planning in Minnesota differ only in specific values from corresponding elements of a regional information system for agricultural and rural development in Northeast Thailand. Thus, in Part II, the underlying concepts of Part I, rather than the specific estimates, are used in building the second regional information system. This effort starts with the building of a set of regional input-output and social accounts. These accounts were designed and partially implemented as an initial test of feasibility and usefulness. The demonstration area includes four changwats in Northeast Thailand (namely, Khon Kaen, Kalasin, Maha Sarakham and Roi Et).

The selected geographical area is characterized by an above-average economic dependence on agriculture. More than 90 percent of the economically active population is engaged in farming as the principal, if not the only, remunerative and productive activity. This area faces severe land and water restrictions in the expansion of its agricultural productivity. Massive public investments in farm irrigation systems, farm-to-market roads, and basic community facilities have been proposed for the area. A start in this direction was made in 1978 in the announcement of a 10 billion baht 10-year program for farm irrigation development.

What public investment to make, when, where and how much are the difficult questions of economic planning which are faced repeatedly as the Thai government moves ahead on its regional development commitments. The underlying purpose of this study was to provide part of the supporting statistics for planning the capital improvements most urgently needed in agricultural and rural development and for keeping track of the economic effects of these investments.

Study Area

In 1970, approximately 3.2 million people lived in the study area. This was 26.4 percent of the total Northeast Region population and 8.7

3/ This section is based, in part, on progress report prepared for Agricultural Sector Analysis Program, Division of Agricultural Economics, Ministry of Agriculture and Cooperatives, Bangkok and Center for Agricultural and Rural Development, Iowa State University, Ames Iowa, June 21, 1978.

percent of the total Thailand population (18).

More than 90 percent of the people live on farms in the study area. In the nation as a whole, less than 80 percent live on farms. The farm population is not isolated, given the many small farms in close proximity, which typically form small villages of 50 to 100 farms.

Of the 1.6 million economically active persons in the study area, only 480,364, or 30 percent of the total, were employed in 1970. Over 1.1 million, or 69.1 percent of the total, were waiting for the farm season.

Almost all economically active persons in the study area -- 93.5 percent -- were reported working or waiting for work in agriculture. Only 1.1 percent of the total was active in manufacturing, while trade and service industries accounted for 4.4 percent of the total. For Thailand, these percentages were 79.9 percent, 4.3 percent, 5.1 percent, and 7.2 percent, respectively.

Gross regional product per economically active person in 1970 is estimated at 3,660 baht in the study area, 3,860 baht in the Northeast Region, and 8,974 baht in Thailand (12,16). Regional differences here are due, in part, to the industry distribution of employment and it dependence on agriculture.

Industry gross product comparisons generally show much less variability than the comparisons of over-all gross product, except for agriculture. Here, the gross regional product varies from 1,916 baht in the study area to 2,012 baht in the Northeast Region, and 3,939 baht in Thailand. Reporting of employment by counting persons, rather than jobs, under-estimates total remunerative employment in non-farm activities, which thus greatly over-estimates the gross regional product per worker in the non-farm sector and under-estimates it in the farm sector.

A detailed industry breakdown of the study area economy in 1976 is available from survey and other data prepared by the Division of Agricultural Economics and the National Economics and Social Development Board (12,21). These data, which are summarized in Table 3.1, show the distribution of gross output by industry and final demand sector. They show, also, the input requirements and value added of each industry. Gross output is equal to intermediate disbursements, plus final sales and,also, to intermediate purchases, plus value added, plus imports.

Detailed industry data show strong forward (to processors) and backward (to input suppliers) linkages of the agriculture sector in the study area. In 1972, intermediate sales of the agricultural industries were 69 percent of total intermediate sales while their intermediate purchases were 21 percent of total intermediate purchases in the selected study area industries. Value added by agriculture was 75 percent of total value added by these industries. This compares with 55 percent of all industry value added in 1970 (12,16). Lack of completeness in the survey data results in an underestimation of gross regional product and its non-agricultural share.

Table 3.1.Gross Output, Intermediate and Final Demand, Imports and Value Added of Specified Industry Agro-Economic Zone 3, Thailand, 1976. 1/

Industry 2/ No.	Title	Gross Output	Output Disbursements: Intermediate Local Sales	Output Disbursements: Final Sales Local	Output Disbursements: Final Sales Export	Input Requirements: Intermediate Local Purchases	Input Requirements: Value Added	Input Requirements: Imports
		(million baht)						
1.	Glutinous Rice Prod.	295.5	295.5	0	0	69.0	208.2	18.3
2.	Non-Glutinous Rice	1,272.4	1,272.4	0	0	126.6	1,706.5	39.3
3.	Cassava Production	206.0	206.0	0	0	29.3	161.1	15.6
4.	Kenaf Production	183.3	183.3	0	0	6.4	172.4	4.5
5.	Other Agr., For., Fish	2,612.8	1,196.9	1,194.3	221.6	146.8	2,466.0	0
6.	Livestock Products, Fish.,Hunt.	936.8	712.3	224.5	0	514.5	422.2	4/
7.	Mining & Quarrying	59.7	59.3	0.4	0	2.3	57.4	0
8.	Small Rice Mills	1,276.9	0.8	1,276.1	0	1,159.9	81.7	35.3
9.	Large Rice Mills	252.1	72.2	13.1	166.8	195.2	23.5	33.4
10.	Cassava Chip Mills	112.2	109.1	0	3.1	100.5	6.9	4.8
11.	Cassave Pellet Mills	152.1	0	0	152.1	130.0	13.7	8.4
12.	Cassava Flour Mills	163.5	15.0	0	148.5	105.4	23.5	34.6
13.	Other Food.,Bev.,Tobacco Prod.	176.2	65.0	111.2	0	62.7	113.5	0
14.	Other Manufacturing	538.6	274.8	263.8	0	228.6	310.0	0.1
15.	Construction	586.1	0.8	585.3	0	101.6	484.4	0
16.	Rice Buyers 3/	322.1	186.1	0	136.0	289.6	25.8	6.7
17.	Rice Wholesalers 3/	45.8	32.1	13.7	0	30.4	1.6	13.8
18.	Rice Retailers 3/	79.4	8.1	71.3	0	75.2	3.7	0.5
19.	Cassava Buyers 3/	192.4	192.4	0	0	167.5	24.3	0.6
20.	Cassava Chip Dealers 3/	1.2	1.2	0	0	1.1	0.1	4/
21.	Kenaf Balers 3/	279.5	0	0	279.5	95.5	93.1	90.9
22.	Kenaf Buyers 3/	200.9	94.4	0	106.5	178.2	19.6	3.1
23.	Fertilizer Wholesalers 3/	73.4	73.4	0	0	0.5	9.9	63.0
24.	Fertilizer Retailers 3/	58.0	58.0	0	0	45.1	12.5	0.4
25.	Other Wholesale & Retail 3/	5/	5/	5/	5/	5/	5/	5/
26.	Transportation & Storage	30.7	20.5	10.2	0	0.1	16.1	14.5
27.	Services 6/	1,522.6	481.0	1,041.6	0	488.3	1,034.3	0
	Total	11,630.2	5,610.6	4,805.5	1,214.1	4,350.3	6,892.1	387.8

1/ Based on farm survey data (see,ref.21),& Northeast Region income & product accounts (see,ref. 12).
2/ Based on industry classifications used in Division of Agricultural Economics, Ministry of Agriculture and Cooperatives and National Economic and Social Development Board, Bangkok, (see, refs.15,27).

3/ Total output value, including purchases of materials for resale (see, ref. 7 for methodology).
4/ 0.5 million baht or less.
5/ Data not available.
6/ Excluding Communications and Government Services.

Building Regional Information System

Numerous and important forward and backward linkages between agriculture and the rest of the study area economy warrant the construction and use of an input-output model for development planning and analysis (8,9,22). Such a model is viewed as only part of a more complete regional socio-economic information system for monitoring and assessing changes in industry employment, investment and outputs (1,9,10 25,26). An important part of this system is a social accounting matrix, which is built around a production (i.e., input-output) model, as shown in Table 4.1.

The purpose of an accounting system in both business and government is for reporting and monitoring the current status of internal resource use. The purpose of regional accounts is also for reporting and monitoring the use of a region's resources -- its people and its natural endowments. Hence, the particular accounts which are developed relate to the principal regional concerns -- production, consumption, employment, taxes, income, financial institutions, capital, and trade with other regions and nations. In the demonstration SAM, the eight accounts relate specifically to the statistical indicators which depict these concerns at the study area level of development planning and analysis.

The individual sectors contained in each regional account are the following:

1. Production: A total of 27 sectors (listed in Table 3.1) represent largely the agriculture-related activities in the study area.

2. Consumption: Two categories of final sales are included, namely, household, with five sectors (food; clothing; housing; transportation; peraonal care), and government, with five sectors (general; education; roads; water and wastewater; other).

3. Employment: Three of the five occupation sectors pertain to non-agricultural jobs (i.e., prof., tech., and adm.; sales, clerical and services; craftsman and other) while the remaining two sectors differentiate between farmers who work on their own account adn those who do not (including mine and forest labor).

4. Tax: Three different sources of public income are listed in sectors (i.e., exports, imports and domestic sales; business and property; income and value added).

5. Value Added: Four income-receiving sectors, to which the value added is attributed, are identified. They represent the production factors and include households (wage and salary; self-employed), government and business.

Table 4.1 Layout of Social Accounting Matrix, Agro-Economic Zone 3, 1976. 1/

Receiving Account No.	Title (sectors)	Current: Production (1-27)	Current: Consumption (28-37)	Current: Employment (38-42)	Current: Tax (43-45)	Current: Value Added (46-49)	Current: Institutional (50-57)	Capital (58-65)	Rest-of-World (66-68)	Total (69)
1.	Production	$T_{1.1}$	$T_{1.2}$	0	0	0	0	$T_{1.7}$	$T_{1.8}$	T_1
2.	Consumption	0	0	0	0	0	$T_{2.6}$	0	0	T_2
3.	Employment	$T_{3.1}$	$T_{3.2}$	0	0	0	0	0	0	T_3
4.	Tax	$T_{4.1}$	$T_{4.2}$	0	0	0	$T_{4.6}$	$T_{4.7}$	$T_{4.8}$	T_4
5.	Value Added	$T_{5.1}$	$T_{5.2}$	$T_{5.3}$	0	0	0	$T_{5.7}$	$T_{5.8}$	T_5
6.	Institutional	0	0	0	$T_{6.4}$	$T_{6.5}$	$T_{6.6}$	$T_{6.7}$	$T_{6.8}$	T_6
7.	Capital	$T_{7.1}$	$T_{7.2}$	0	0	0	$T_{7.6}$	$T_{7.7}$	$T_{7.8}$	T_7
8.	Rest-of-World	$T_{8.1}$	$T_{8.2}$	0	0	0	$T_{8.6}$	$T_{8.7}$	$T_{8.8}$	T_8
9.	Total	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8	T

1/ Layout conforms with data inputs and outputs of regional forecasting system which introduces new values of exogeneous variables affecting regional accounting entries (see, ref. 4,9,10). Formulation of individual accounts would follow procedures used by Stone (see, ref. 31,32).

6. Institutional: This account provides for the distribution of factor income to eight institutional sectors (i.e., property; small business; large business; low income household; high-income household; local government; government enterprise; other government).

7. Capital: Income accumulation among the insitutional sectors is represented by eight sectors (i.e., government bonds; private bonds; equity financing; accumulated savings; change in business inventory; gross private capital formation; basic community facilities; agr. and ind. development).

8. Rest-of-World: The seven intra-regional accounts are consolidated in three extra-regional sectors, namely, production, consumption and accumulation.

Use of the socio-economic accounts in agricultural and rural development planning depends on a forecast system for "driving the account entries from one period to the next (9,10). In the regional accounts, each sector total, and the sector distribution of these totals, are derived from a forecasting system. The social accounting matrix simply organizes these forecasts for use in regional development studies. The forecasting system prepars each round of forecasts which are reconciled, subsequently, with the double entry book-keeping system.

The principal components of an area economic forecasting system are included in the regional accounts. They focus on the production system represented by the study area input-output table (see, ref. 9, Figure 1). Demand "drives" the production system. The Consumption Account summarizes the demand variables. Demand, in turn, depends on local investment and export markets. Population and resources, as well as government, affect demand.

Population is a determinant of the number of households. Labor force participation also depends on population. When the level of employment falls below the total labor force, unemployment increases, which leads to less in-migration and/or more out-migration. The size of household affects per capita income levels while the number of employed persons per household affects total household income levels.

The level of production is constrained by the levels of labor and capital inputs. Excess demand occurs as these constraints become more severe. As production increases, however, labor and capital requirements increase, given employment-output and capital-output relationships. Income payments to these primary inputs also depend on labor and capital requirements and the relative scarcity and bargaining position of labor. These income payments determine total value added and, thus, the level of industry income payments to households, government and financial institutions, including business investment. In this forecasting model, therefore, the performance of the production system is of central importance in determining the levels of area employment and income.

Measuring Community Effects of Regional Development

Use of a regional information system in agricultural and rural development planning and analysis includes measurement of community effects of development alternatives. Regional output, employment and income multipliers are used to show industry-by-industry changes associated with certain external changes. At this point, the analysis is confined to a given time period, for example, the base-year 1976. Analysis of this historical base-year is useful insofar as it helps in assessing the probable effects of alternative programs -- what might have been rather than what was. More frequently sought, however, is the futuristic type of analysis which looks to a target year, like 1981. Both the analysis and the forecasts are considered integral parts of the policy information package.

Multiplier Analysis

Rice, cassava and kenaf are the principal export crops of the study area. Changes in the export levels affect related industries in the area, namely, the processing, wholesaling, retailing and transportation businesses.

Community economic effects originating from changes in crop production are (1) the direct changes in the value of farm marketing, (2) the indirect effects of changes in farm-related processing, marketing and transportation, and (3) the induced effects of changes in farm and non-farm consumption and investment expenditures. The total community effects of changes in crop production are increased as farm-related and household-related businesses increase in number and sales volume.

Expansion of off-farm businesses and both on-farm and off-farm labor productivity in the five-year period from 1976 to 1981 would mean expansion of residentiary activities in the study area. Thus, the 1981 output multipliers would be larger than the 1976 multipliers. The 1981 employment and income multipliers also would be larger than the corresponding 1976 multipliers.

The projected increases in the community economic effects of crop production are indirectly the result of a redistribution of some residentiary activities from the Bangkok metropolitan area to the study area. Not only the higher productivity per worker and the greater proliferation of residentiary activities in the study area, but, also, the decentralization of economic activity must be taken into account in projecting future community economic effects of local agricultural development.

Community multiplier analysis is combined with benefit-cost analysis in measuring the social and economic incidence of agricultural program costs and benefits. This approach was advanced by Tinbergen 18 years ago as the semi-input-output method (34,35). Applications of the semi-input-output method are demonstrated by Cornelisse and Telanus for Turkey (3), Karunaratne for Papua New Guinea (6), Kuyvenhoven for Nigeria (7), and Pronk and Schreuel for India (24).

The semi-input-output method in this study makes use of the area input-output table by, first, separating the 27 industries into two activity groups -- export-producing and residentiary. Tinbergen designates these two groups as the international (tradeable) and national (non-tradeable) sectors. On a regional level, the trade is with rest of nation. Using this dichotomy, the Tinbergen cost-benefit criterion calls for the maximization of area gross product pubject to an area capital constraint. The semi-input-output method provides for the inclusion of the indirect community effects of residentiary industry development. In mathematical form, the semi-input-output cost-benefit criterion for the j-th industry, T_j, is represented by the equation,

$$T_j = \frac{k_j + K'_n \left[I-A_{nn}\right]^{-1} A_{jn}}{v_j + V'_n \left[I-A_{nn}\right]^{-1} A_{nj}} \qquad \text{Eq. (5.1)}$$

where, k_j is the direct capital coefficient of the j-th industry, v_j is the direct value added coefficient of the j-th industry, K'_n is the row vector of residentiary (non-tradeable) industry capital coefficients, V'_n is the row vector of residentiary industry value added coefficients, $\left[I-A_{nn}\right]^{-1}$ is the inverse of residentiary industry input-output coefficient matrix, A_{nj} is the column vector inputs from export-producing (tradeable) industry j to n residentiary industries.

The semi-input-output method focuses on the use of scarce capital inputs in the residentiary activities, which, because of their "non-tradeable" nature, are development "bottlenecks". Capital requirements of these sectors must be satisfied through output-increasing capital investments inasmuch as imports are not available to substitute for local production. Because of interindustry linkages, output expansion in the j-th development sector would require output-increasing capital investment in the residentiary sectors to provide the residentiary input requirements for the designated groups of interdependent industries. For a developing regional economy facing severe capital constraints, the ranking of projects according to their capital requirements per unit of value added (or gross regional product) provides an appropriate criterion for project selection.

In regional economic development, import substitution is a two-sided strategy. Import expansion relaxes output constraints in the tradeable sectors. Import replacement, on the other hand, may be associated with the development of new local industry. This may be part of national efforts towards industry decentralization and regional diversification.

Development of the Northeast, for example, as a viable economic community in a rapidly developing national economy may require capital-using strategies of import replacement, coupled with expansion of both export-producing and residentiary activities. In such a policy environment, the semi-input-output method would be an inadequate approach to regional development planning. Instead, two-region input-output tables

are needed to show industry specific production flows between development region A and the rest of nation, B. Industry-specific exports from Region A to Region B would be a measure of the economic base of Region A and its long-term economic growth prospects while industry-specific imports (by industry of origin) from Region B to Region A would be a measure of the potential for industry diversification and long-term regional stabilization. A more complex cost-benefit criterion than the semi-input-output method is needed, therefore, to rank proposed regional projects under alternative development strategies.

Alternative Agricultural Program and Investment Criteria

Alternative methods of measuring community economic effects of area agricultural development presented here extend the application of the Tinbergen and Basmussen approaches to project analysis. 4/ An

4/ The Rasmussen linkage and spread indices can be used, also, in ranking proposed development projects along side the rankings based on conventional and/or modified cost-benefit analysis. Use of the complete input-output coefficients table implicitly accounts for linkage and spread effects of export-producing industry development. Column and row means, and the coefficients for variation of the input-output coefficients, are computed in this procedure (27). The mathematical forms for deriving these effects are given by a series of equations, as follows (see, ref. 6, p. 292):

$$m = \sum_{i=1}^{n}\sum_{j=1}^{n}\frac{k_{ij}}{n^2} \quad ; \quad v_i = \frac{SD_i}{\sum_{j=1}^{n} k_{ij}/n} \quad ; \quad v_j = \frac{SD_j}{\sum_{i=1}^{n} k_{ij}/n} \quad ;$$

$$f_i = \frac{\sum_{j=1}^{n} k_{ij}/n}{m} \times 100 \quad ; \qquad b_j = \frac{\sum_{i=1}^{n} k_{ij}/n}{m} \times 100 \quad ;$$

$$s_i^f = \frac{v_i}{\sum_{j=1}^{n} v_j/n} \times 100; \qquad s_j^f = \frac{v_j}{\sum_{i=1}^{n} v_i/n} \times 100$$

where k_{ij} is interdependency coefficient of the j-th column and the i-th row in the inverse of the Leontief technical coefficient matrix corrected for imports, i.e., k_{ij} = inverse of [I-A-M]; m is the overall mean of all interdependency coefficients; b_j is the index of backward linkage for the j-th purchasing sector; f_i is the index of forward linkage for the i-th producing sector; v_j is the coefficient of variation of the j-th purchasing sector; v_i is the coefficient of variation of the i-th producing sector; s_j^f is the index of forward spread effect of the j-th purchasing sector; s_i^f is the index of forward spread effect of the i-th producing sector; SD_j is the standard deviation of the j-th; SD_i is the standard deviation of the i-th row of interdependency coefficients.

Essential technique in the alternative approaches is the simulation of the area economic effect of projected developmnet which show the time flows of investment requirements of projected increases in area industry outputs associated with the project development. A regional economic model for simulating the time paths of the social and economic indicators in the system of social accounts thus is an essential requirement of an extended project evaluation capability. Such a model, rather than a single input-output table or a partial method based on this table, is proposed for the study area (9,10).

High levels of underemployment, low levels of income per person, and limited development of non-farm activities in the study area were noted earlier. Policy objectives directed towardds improving regional income levels and employment opportunities and, thus, reducing the disparities in social and economic well-being between the region, and its sub-region, and the nation, would shape the use of regional investment criteria derived from the computable regional model. These criteria may include the maximization or minimization of any one of a series of key economic indicators, such as gross area product, consumption, total employment, residentiary employment, export-producing employment, income difference between poorest and richest households, and private and public investment, subject, of course, to one or more resource or policy constraints. In each case, the reality of a limited domestic budget for economic development conditions the attainment of a policy objective. In addition, certain minimal levels of family income and labor productivity must be achieved, or exceeded, at all times as a prerequisite for national economic survival and political tranquility.

Use of alternative investment criteria requires an extended data base for the analysis and related forecasting of the social and economic indicators. The social accounts listed earlier include the principal area level indicators for program and project analysis. The system of the social accounts would be related to the development policy objectives as follows:

1. Gross area product is compiled two ways: as locally-produced income (transaction matrices $T_{5.1}$, $T_{5.2}$, $T_{5.3}$, and $T_{5.7}$ in Table 4.1)and externally-produced income (transaction matrices $T_{5.8}$) received by economic units in the area and as final area product (transactions Matrices $T_{1.2}$ and $T_{1.7}$) and net exports (transaction matrix $T_{1.8}$ minus transaction matrices $T_{8.1}$, $T_{8.2}$, $T_{8.4}$, $T_{8.5}$, and $T_{8.6}$).

2. Total area consumption is compiled in the Consumption Account (transaction matrices $T_{1.2}$, $T_{3.2}$, $T_{4.2}$, $T_{7.2}$ and $T_{8.2}$).

3. Total area employment is compiled in the Employment Account, by occupation and farm employment status (transaction matrices $T_{3.1}$ and $T_{3.2}$), with job-person matrix to convert from a person-count to a job-count basis for specifying industry employment.

4. Total personal income is compiled, in part, in the Value Added Account, by employment status (transaction matrix $T_{5.3}$) and in the Institutional Account, by income status (transaction matrix $T_{6.5}$).

5. Total investment outlay is compiled in the Capital Account (transaction matrix $T_{1.7}$).

6. Total outflow of area income earned is compiled in the Rest-of-World Account (transaction matrices $T_{8.1}$, $T_{8.2}$, $T_{8.5}$, and $T_{8.6}$).

7. Total inflow of income from Rest-of-World also is compiled in the Rest-of-World Account (transaction matrices $T_{1.8}$, $T_{4.8}$, $T_{5.8}$, $T_{6.8}$, and $T_{7.8}$).

8. Total outflow of area savings is compiled in the Capital Account (transaction matrix $T_{8.7}$).

9. Total inflow of savings from Rest-of-World is compiled, also, in the Capital Account (transaction matrix $T_{7.8}$).

Thus, each social account fulfills some part of the total data needs for implementing the use of alternative program and investment criteria for integrating rural area development.

Integrating Regional Input-Output and Sector Analysis

The final task is the building of linkages from the regional input-output and social accounts to the ASA models. These linkages will make possible assessment of the economic effects, over time, of given changes in agricultural output, employment and income.

In this task, a first step is the linear program formulation of the input-output model. This task has been completed, in part, for the study area (21). In this step, the 27-industry breakdown of the area economy is used to illustrate the model construction.

A second step is expansion of the linear programming input-output model to the system of social accounts. The 68-sector breakdown of the eight social accounts is used in the expanded computer program.

A third step is data preparation for the extended model. Data sources and requirements must be specified in the implementation procedures (see, ref. 5,8,9,10,29,30,31).

Illustrative Model

The linear programming formulation of the input-output model cited earlier is expanded to include a complete listing of industries in the

study area (Table 6.1). Labor and capital restraints are introduced to the farm-related and non-farm sector of the area economy. Rather than minimizing the cost of meeting a given set of final demands, the alternative objective of minimizing investment requirements in meeting a given set of final demands is introduced. This formulation is consistent with the semi-input method of sector investment evaluation. As demonstrated by Cornelisse and Versluis, the investment minimization criterion yields the same results to sector and project rankings as the Tinberger criterion in the semi-input-output method (2).

Introduction of the two sets of labor and capital restrictions is important insofar as seasonal demands may rise sharply together, thus briefly limiting the expansion of an activity. By using seasonal labor and capital restrictions, this phenomenon can be incorporated realistically into the computational procedures. Further realism is introduced by making possible an exchange of labor and capital resources between the farm-related and non-farm sectors.

Finally, by minimizing investment, an additional element of the real-world is introduced into the development planning exercise. The results of this procedure will conform closely with the cost minimization procedure if the input requirements and capital requiprements also compare closely, industry by industry.

Linear Programming Formulation of Social Accounting System

The second step in building a linked linear programming/input-output model of the study area economy follows readily from the first: the eight classes of accounts are introduced systematically into the model formulation as a set of eight classes of restrictions. The activity levels of the 68 sectors are restricted, therefore, by the internal demands imposed upon these activities by all sectors. Each of the eight interdependent sets of activities and restrictions is presented in this section as separately specified modules in the complete social accounting/regional forecasting system.

The Production Module is now presented as an expanded input-output model (Table 6.2). For illustrating the sector layout of each module, the 27-industry input-output table is reformulated as a linear programming model with industry-specific input-output coefficients and demand and supply (i.e., labor and capital) constraints. Receiving sectors for industry gross outputs are the expanded intermediate demand and the previous final demand sectors.

Industry production is constrained by intermediate and final demands for industry output. Production is also constrained by employment (see, rows 51-55) and capital (i.e., business value added in row 62).

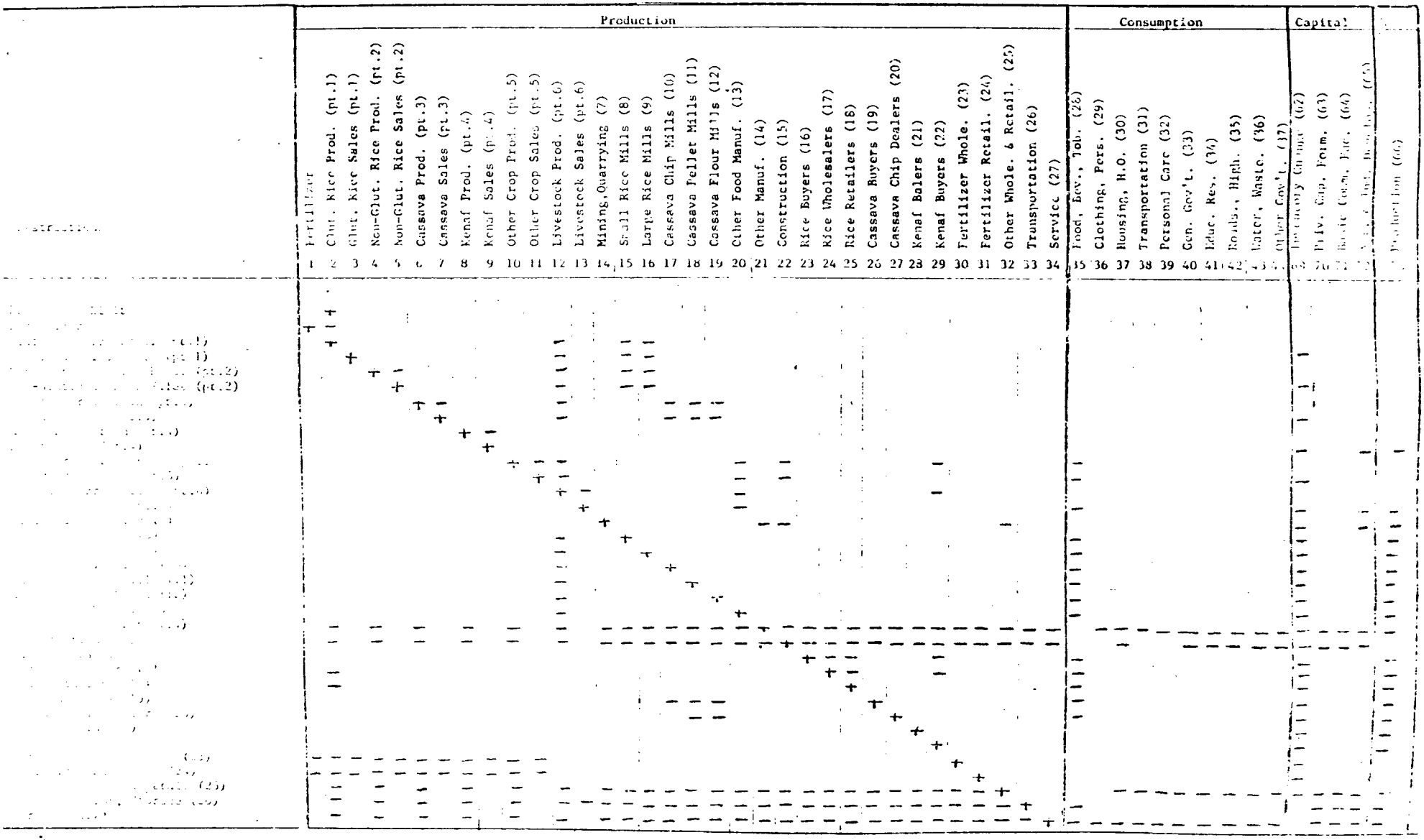
The Production Module accounts for the production of goods and services in the study area. It imposes constraints on the Consumption Account, the Capital Account (sector 69, Change in Business Inventory), and the Rest of World Account.

Table 6.1. Product Disbursements, Purchases and Restrictions in Linked Linear Programming/Input-Output Illustrative Model, Agro-Economic Zone 3, 1976. 1/

Restriction	Crop Prod.	Borrowing	Fertilizer Buy.	Crop Sales	Borrowing	Crop Buyers	Processors	Dealers	Comm. Sales	Fert. Dealers	Transportation	Borrowing	Mining	Manufacturing	Construction	Trade	Transportation	Services	Data Specification
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
Farm:																			
1. Land																			≤ Available land, by type and month
2. Labor	+																		≤ Available labor, by month
3. Capital	+	-																	≤ On-farm Capital, by month
4. Prod. Limit	+																		≤ Limit (rai, kg, etc.)
5. Fertilizer	-		+																≥ 0
6. Crop Prod.	+			-															≥ 0
7. Crop Sales				+		-	-												≥ 0
Farm-Related:																			
8. Labor						+	+	+	+	+	+		+	+	+	+	+	+	≤ Available labor, by type and season
9. Capital					-	+	+	+	+	+	+	-	+	+	+	+	+	+	≤ On-business capital, by easons
10. Crop Buyers						+	-												= Final demand
11. Comm. Proc.							+	-	-										= Final demand
12. Comm. Dealers								+	-										= Final demand
13. Comm. Sales									+										= Final demand
14. Fert. Dealers			-							+									= Final demand
15. Transportation	-			-		-	-	-	-	-	+								= Final demand
Non-Farm:																			
16. Labor						+	+	+	+	+	+		+	+	+	+	+	+	≤ Available labor, by type and season
17. Capital					-	+	+	+	+	+	+	-	+	+	+	+	+	+	≤ On-business capital, by season
18. Mining													+						= Final demand
19. Manufacturing	-													+					= Final demand
20. Construction	-					-	-	-	-	-	-		-	-	+	-	-	-	= Final demand
21. Trade	-					-	-	-	-	-	-		-	-	-	+	-	-	= Final demand
22. Transportation						-	-	-	-	-	-		-	-	-	-	+	-	= Final demand
23. Services	-					-	-	-	-	-	-		-	-	-	-	-	+	= Final demand
24. Imports	-					-	-	-	-	-	-		-	-	-	-	-	-	N Rest-of-World Account
25. Value Added	-	-	-	+	-	+	+	+	+	+	+	-	+	+	+	+	+	+	N Value Added Account
26. Objective Funct.	-	-	-	+	-	+	+	+	+	+	+	-	+	+	+	+	+	+	N Minimize Investment

1/ Adapted from Figure 4 in: Ken Nicol, Kasem Seresukhedom and Somnuk Sriplung (see, ref. 21).

Table 6.2. Product Disbursements of Production Sectors to Specified Receiving Sectors in Linkes Linear Programming/Input-Output Model.



The Consumption Module follows the formulation of the Consumption Account. The Consumption Account, however, is introduced as a set of consumption restrictions of the row sector in each account.

The Consumption Module restricts the Consumption Account and the Institutional Account. Personal and government consumption limits are introduced as restrictions on total expenditures of the two personal consumption sectors and the three government consumption sectors. These limits specify that total consumption expenditures must not exceed a given proportion of the total income of these economic units (see, rows 36, 37, 43, 44 and 45).

The rate of consumption of each economic unit is given by the specified consumption coefficient (see, columns 61, 62, 63, 64 and 65). The level of consumption is derived in the program, given the total expenditure restrictions and the specified consumption coefficients (see, rows 38 to 42 and 44 to 50).

The Employment Module follows the formulation of the Employment Account. The Employment Account imposes a set of overall employment constraints on the production and consumption sectors which can be relaxes, however, by in-migration of scarce skills and by occupational mobility.

The Employment Module restricts the Production Account and the Consumption Account. All restrictions are given in monetary values. Hence, a wage rate is implicit in the transformation of the monetary values into numbers of economically active persons and/or employed persons (see, rows 51 to 55).

Each of the five occupational groups has a unique wage rate and an utilization rate which determines the labor requirement per unit of specified industry output. Both production and consumption sectors utilize the specified labor-input groups in providing various consumption services (see, column 1 to 34, 38 and 40 to 44). In addition, through occupational mobility, the employment restrictions are relaxed, at a specified cost, but only between production periods (see, columns 45 to 50).

The Tax Module follows the formulation of the Tax Accounts. Certain tax rates are implied, also, in the derived levels of tax receipts. Intergovernment transfers of tax receipts occur within the given planning period.

The Tax Module restricts five classes of accounts -- the Production Account, the Consumption Account, the Institutional Account, the Capital Account, and the Rest-of-World Account. One or more of three types of tax income (i.e., export, import and sales; property and business; income and value added) are received from economic units represented by the five account classes (see, columns 1 to 34, 35 to 39, and 69 to 74).

The Value Added Module follows the formulation of the Value Added Account. The Value Added Account is the business sector counterpart

of the Employment (i.e., households) Account and Tax (i.e., government) Account. It, also, provides a consolidated account for compiling total value added by industry.

The Value Added Module restricts four account classes -- the Production Account, the Consumption Account, the Capital Account and the Rest-of-World Account. One or more of four types of income are received from each of these accounts (see, columns 1 to 34, 35 to 39, 41, 42, and 69 to 73).

The Institutional Module is the row counterpart of the Institutional Account. This account directs all income receipts to appropriate economic units, namely, household, business and government. Two types of households and business and three types of government are specified.

The Institutional Module restricts economic activity in only two classes of accounts -- the Institutional Account and the Rest-of-World Account. One or more of eight institutional sectors receive income payments from six Institutional sectors and two Rest-of-World Sectors (see, columns 62 to 65, 73 and 74).

The Capital Module provides a summary statement of all monetary and real transactions in capital account. Three debt-financing sectors draw funds from savings sectors and the rest-of-World sector and, in turn, make these funds available for private and ogvernment investment.

The Capital Module restricts economic activity in three classes of accounts -- the Institutional Account, the Capital Account, and the Rest-of World Account. The three debt-financing sectors receive income from the two business sectors, the two household sectors, and the three government sectors in the Institutional Account (see, columns 58 to 64). The savings sector also receives income from these seven sectors. The four investment sectors, in turn, receive the income collected by the three debt-financing sectors (see, columns 65 to 67).

The Rest-of-World Module is the counter part of the Rest-of-World Account. This module receives income payments from producing and savings sectors in the area economy.

The Rest-of-World Module restricts economic activity in five account classes -- the Production Account, the Consumption Account, the Institutional Account, the Capital Account, and the Rest-of-World Account. The production restriction applied to 34 production and four investment sectors and one trading sector (see, columns 1 to 34, 69 to 73 and 75). The consumption restriction applies to eight consumption sectors and one trading sector (see, columns 35 to 44 and 75). The accumulation restriction applied to eight institutional sectors and four financing (and savings) sectors (see, columns 57 to 68).

Survey and Secondary Data Requirements

Implementation of the expanded input-output model and the social accounting system as a linear programming model depends on the availability

of the specified data, namely, the parameters and the variables of the eight social accounts. These data are forthcoming from the surveys and the secondary data sources cited earlier in this report.

Use of published reports and documents is confined largely to the preparation of control totals of area income, output and employment for the base-year,1976,and a target year, e.g., 1981. Steps in the preparation of the base-year control totals are as follows:

1. Estimate area employment, earnings, and value added, by industry (as specified in national I-O references tables).

2. Estimate area gross output, by industry, using one or more ratio estimators (e.g., ratio of area-to-nation employment, earnings and/or value added), or alternatively,using survey data.

3. Estimate area industry input requirements (i.e., intermediate demands) by purchasing industry, using national input-output coefficients, or, alternatively, survey data.

4. Estimate area final demand requirements, by purchasing sector, using one or more ratio estimators (e.g., ratio of area-to-nation personal consumption expenditures, personal income, and/or population), or, alternatively, survey data.

5. Estimate excess (or deficit) industry gross output, by producing industry, using location quotient, two-region input-output or survey procedures. Non-comparable imports and comparable exports and imports would be derived,

6. Estimate area gross product, by input-supplying sector, i.e., household, government and business, by industry, and by final demand sector.

7. Estimate economically-active and employed persons, by occupation and industry, and employment-output ratios, by industry.

8. Estimate capital expenditures and capital-output tables, by industry.

Each of the procedural steps implements one or more of the eight modules in the linked linear programming/input-output system. The results are a series of estimates of industry output, income and employment and corresponding series of estimates of industry capital requirements and disbursements to final demand sectors.

The sequence of data preparation starts with a table of industry and sector requirements (which are satisfied by the producing industries and sectors). The input-output table for the 27-industry breakdown of the area economy is prepared, first. Control totals for the non-farm industries are entered from secondary sources, with value added estimated from gross area product series (see, ref. 11, 12, 13, 14, 16, 17, and 18). Final demand is derived from the relationship of final demand component

to gross domestic (area) product (see, ref. 12 and 16). Gross output is estimated from the relationship of value added to gross output (see, ref. 11, 13 and 17). When all gross output, value added and final demand estimates are complete, the area industry and sector input requirements are derived using industry intermediate and final demand coefficients from the table of I-O coefficients for Thailand (see, ref. 14). Requirements for each industry output are totaled and these totals are compared with the corresponding gross output estimates. If the gross output is greater than the total output requirements of local intermediate and final demand sectors, then the initial estimates stand. If the gross output is smaller, then the initial estimate is revised downward (on a proportionate basis) until an exact balance is obtained between total requirements and total (gross) output. The new table (of input requirements which are met be local producing sectors) is the new interindustry transaction table. This table shows the purchases and disbursement of locally-produced industry output.[5/]

The three tables derived from secondary data are prepared simply for use in guiding futher work in implementing a survey-based supporting data system for a linked linear programming/input-output model. The small cost of preparing the first-round tables from secondary data supports this procedure, given the considerable value derived from the exercise, not only in acquiring familiarity with the building of an input-output table, but, also, in testing the importance of having accurate estimates of different sectors of the economy. A sensitivity analysis can be undertaken to determine the internal consequence of a given level of error in the estimate of each interindustry transaction.

Data requirements of the linked linear programming/input-output model which are not satisfied from published reports and documents must be satisfied by sample surveys. Use of farm surveys in building linear programming models is presented in the report series of the DAE/ASA Program (see, ref. 28). Farm survey data are available for building an input-output table for Agro-Economic Zone 3 (see, ref. 21). The agricultural business survey completed in May 1978 is an additional data source, especially for building the farm-related and non-farm industry accounts.

Use of the 1978 farm-related business survey requires careful classification of all sales and pruchases according to the 27-industry breakdown in the regional input-output model. This, in turn, requires a compilation of (1) purchases from each input-output supplying industry and (2) sales to each purchasing (intermediate demand) industry and final demand sector. These industries are regrouped into the 27-industry breakdown in the social accounts.

5/ A two region input-output model program is available for deriving the regional tables from the national model, given regional gross outputs and final demands (see, ref. 5 and 9). This program computes input-output coefficients for the four quadrants (i.e., Region A, Region B, imports from Region B to Region A, and exports from Region A to Region B), including the Leontief multipliers for each industry in each quadrant.

Farm and farm-related business survey data may be used, also, in implementing the individual social accounts for the base year, 1976. Each of the eight account classes depend, in part, on the sample surveys, as follows:[6/]

1. The Production Account, with 27 sectors, has six sub-accounts. Of the 27 sectors, 22 are farm or farm-related sectors for which survey data to implement each sub-account are available. In addition to building the interindustry transactions table (a sub-account), the survey data are used in building row sectors in the employment, tax, value added, capital, and rest-of-world sub-accounts.

2. The Consumption Account, with 10 sectors, has six sub-accounts. Of the 10 sectors, the food consumption sectors are most closely related to the farm sectors. Farm and non-farm household and government expenditures data are needed to implement each sub-account.

3. The Employment Account, with five sectors, has only one sub-account to differentiate between employed persons by occupation. Household survey data are needed which show the occupation, industry and employment status of the economically-active population.

4. The Tax Account, with three sectors, has only one sub-account to transfer tax receipts to the three types of government. These receipts are later re-distributed to other accounts. Survey data are needed to implement the three sectors in this account.

5. The Value Added Account, with four sectors, has only two sub-accounts to redistribute the gross area product to the resource owners (in household, government and business sectors). Survey data are needed to show the type of income receipts of each economic unit -- farm and non-farm households, farm-related and non-farm businesses, and local government.

6. The Institutional Account, with eight sectors, has five sub-accounts to differentiate among recipients of the income payments of each institutional sector. Survey data are needed to show the flow of income receipts through the Employment, Tax, and Value Added Accounts to the Institutional Account, and, then, to its five sub-accounts. These sub-accounts have a total of 18 income-receiving sectors.

6/ A complete set of tables for each of the eight accounts and eight modules was in preparation in summer and fall, 1978. (see, progress report, "Regional Input-Output and Social Account Systems for Agricultural Sector Analysis, Agro-Economic Zone 3, Northeast Thailand", Division of Economic Analysis, Ministry of Agriculture and Cooperatives, Bangkok, 1978.)

7. The Capital Account, with eight sectors, has six-sub-accounts to differentiate among financing sources and capital inputs. Farm and farm-related business survey data provide estimates of capital-output relationships and investment expenditures for 22 of the 27 producing sectors. Additional survey data are needed to estimate money flows through each one of the six sub-accounts which have a total of 44 production, tax, value added, institutional, capital and rest-of-world income-receiving (i.e., row) sectors.

8. The Rest-of-World Account, with three sectors, has six sub-accounts to differentiate between recipients of income payments originating outside the study area. The farm and farm-related business surveys provide data for estimating product flows and the corresponding money flows for 22 of the 27 producing sectors. These surveys also provide data on income flows to several of the farm-related tax, value added, institutional, capital and rest-of-world sectors, which total 19.

Thus, the completed farm and farm-related business surveys would provide much of the data for building both the 1976 input-output table and the social accounting system for the study area. Limited additional household, non-farm business and government surveys are needed to complete the data requirements, especially for the Consumption, Tax, Institutional and Capital Accounts.

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