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產業聯關分析에 依한 石油化學工業의 企劃 : 第II報

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Planning of the Korean Petrochemical Industry by Input-output Analysis : Part II

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要 約

第I報에 이어, 石油化學工業 全般에 걸쳐 詳細한 展望을 하였다. 또 最終需要部門의 一定額 增加에 따르는 石油化學品의 誘發生産量을 計算하였고 影響力係數와 感應度係數를 計算하여 圖示함으로써, 各産業이 全體經濟에서 어떠한 役割을 하는가를 具體的으로 提示하였다. 結論으로 에틸렌, 프로필렌, 부타디엔, 벤젠, 크실렌等의 基本原料가 되는 石油化學品에 對해서는, 物質 흐름表를 作成함으로써 原料와 製品間의 需給關係를 明白히하였다.

Abstract

Following the report Part I*, a detailed discussion of the output of petrochemical products was carried on. The induced production of petrochemical products, caused by an incremental final demand, was presented and discussed. The sensitivity coefficient versus influence coefficient plots were also presented to establish the correlation between any specific sector and the rest of the sectors, whereby the role of petrochemical products in the whole national economy could be derived. In summary, the material flow diagrams for the basic starting materials, such as ethylene, propylene, butadiene, benzene, and xylenes were presented for the years of 1970, 1974, 1978, and 1982.

* Part I: Hwahak Konghak, 13, 3 (1975), 119

Introduction

In the report Part I, we have constructed a new input-output table consisting of 90 endogenous sectors placing our major concern on the 64 petrochemical products, each being counted as a sector. There, we established the underlying mathematical principle for the method of analysis, and presented the definitions of influence coefficient, sensitivity coefficient, and induced production. We have also introduced our own method of forecasting the input coefficients and the elements of the final demand vectors.

We have run a complete computer program, and presented a comprehensive forecast of the total output of each individual sector together with the corresponding domestic demand, export, and import for the years of 1974, 1978, and 1982. In this report, we will continue to present further results of computer analysis and the discussion thereof.

Results of Computer Analysis and Discussion

1. Long Range Forecast of the Petrochemical Industry

(1) Petrochemical Raw Materials

Although the ethylene production in 1974 meet almost the demand, the propylene production covers only 60% of the total propylene demand. The unbalanced propylene demand is due primarily to the additional demand generated by the newly built polypropylene (PP), acrylonitrile, dodecyl benzene plants, etc. In 1982, the forecasted demands for ethylene and propylene will rise approximately to 2 and 1 million tons, respectively. These figures are 3 times those of 1978, and 20 times those of 1974. Therefore, the present plan for expanding the ethylene production to 0.65 million tons by 1977 must immediately be followed by a further expansion plan. The benzene production must be raised to 0.22 million tons by 1978, and 0.51 million tons by 1982. The separation of o- and p-xylenes from mixed xylene must be started up at latest by 1978, in view of the scheduled production of terephthalic acid (TPA) and DMT by around the same year.

(2) Basic Organic Chemicals

Although 5,000 metric tons of phenol is expected to be annually produced by the Raschig process from 1977, it will be necessary to switch to the cumene process from around 1980, so that both phenol and acetone can be obtained simultanuously. The expected acetone demand for the same year was found to be 10,000 metric tons.

The present 30,000 tons of annual ethanol production was initially aimed at replacing fermented alcohol. However, it seems to be not immediately possible to do so, and some other demands for ethanol must be urgently expedited. Since the acetaldehyde production is secured for some time, the 9900 tons of acetic acid production in 1974 can easily be expanded to 15,000 tons of annual capacity in 1982.

As to ethylene dichloride, a cheap source of chlorine is essential for an economical production of the chemical. At least two 100,000 tons of annual capacity chlorine plants will have to be erected by 1978. It is anticipated that a special government subsidy will be necessary to cover the high power and salt costs in Korea. Judging from the interrelation between PVC and EDC, the size of EDC production must be 420,000 tons by 1978, including the currently projected capacity of 270,000 tons of the two plants.

Octanol, used as the raw material for the production of dioctyl phthalate (DOP), has been imported annually in the amount of 5000 to 10,000 tons. Although a plant of 40,000 ton capacity may be sufficient in 1978, the capacity must be doubled in 1982.

A plant for manufacturing methyl methacrylate (MMA) and methacryllic acid (MA) in the amount of 20,000 tons a year will be desirable before 1982 because the demands for them reach to the same quantity in 1982.

Since the forecasted caprolactam demand in 1982 is 130,000 tons, 6 times that of 1970, the domestic demand can be amply covered by the present capacity of 33,000 ton plant and the projected production capacity of a 100,000 ton plant.

Because of the merits and demerits both in DMT and in terephthalic acid (TPA), as the raw materials for polyester, they will be used in parallel for some time by the manufacturers. The 120,000 ton capacity DMT plant and 100,000 ton capacity TPA plant, being pushed by the interested firms. should be expanded immediately after the completion of the project if the export of polyester fiber and textile goods again present a hopeful outlook.

(3) Synthetic Plastics and their Processed Goods

Table 1 shows the trend of demand for synthetic plastics. The *Table* indicates that PVC yields gradually its major role as plastics to LDPE with time. On the other hand, it must be noted that the demand for the synthetic plastics as a whole increases approximately 16-fold during the years from 1970 to 1982. This corresponds to an average annual growth rate of 26%. Generally, the demand for thermoplastics increases abruptly while that for thermosetting plastics increases slowly. The demand for further sophisticated plastics, grouped as the 'other synthetic plastics' here, increases ever steadily. The production of these plastics should be initiated from around 1980. The estimated over-all plastic materials export in 1982 is forecasted to be 240 million dollars by the 1970 fixed price.

Table 1. Demand prospect of synthetic resins.

Unit: MT per year

	1970		1974		1978		1982	
	Demand	%	Demand	%	Demand	%	Demand	%
LDPE	28,600	23.9	93,852	31.6	327,832	40.6	911,668	48.0
HDPE	13,821	11.5	31,272	10.5	61,400	7.6	155,474	8.2
P P	9,265	7.7	35,275	11.9	90,345	11.2	192,040	10.1
PVC	30,464	25.4	70,811	23.9	184,577	22.9	393,811	20.8
P S	7,347	6.1	26,483	8.9	67,040	8.3	125,600	6.6
PVA	1,438	1.2	2,163	0.7	3,111	0.4	3,150	0.2
Phenolic Resin	1,784	1.5	2,440	0.8	3,550	0.4	3,520	0.2
Urea Resin	2,238	1.9	4,680	1.6	12,000	1.5	19,700	1.0
Melamine Resin	2,206	1.8	2,504	0.8	3,573	0.4	6,610	0.4
Alkyd Resin	6,202	5.2	9,930	3.4	16,800	2.1	19,610	1.0
Other Synthetic Resin	16,503	13.8	17,435	5.9	36,695	4.6	66,828	3.5
Total	119,868		296,845		806,923		1,898,011	

(4) Synthetic Fibers

Synthetic fibers have been the most important export items in early 1970s. Many synthetic fiber plants were built in the years from 1970 to 1974. As the result, nylon production increased 3-fold, and polyester, 10-fold. However, a serious setback in the synthetic fibers export was brought about by the world oil crisis. Unless the aftermath of oil crisis and the ensuing world business recession fade soon away, the forecasted prosperity in the synthetic fibers business will also suffer seriously. If we were on the lucky side, the productions of nylon, acrylonotrile, and polyester fibers will swell up to 8-, 33-, and 51-fold in 1982 from those in 1970, respectively. No doubt, the production of DMT and TPA will furnish a strong background to such a prospering synthetic fiber business.

2. Induced Productions

Some interesting conclusions were obtained by computing the increased protion of the production for each individual sector induced by a certain incremental final demand.

(1) Production Induced by the Private Consumption Expenditure

Table 2 shows the additional productions of some nonpetrochemical sectors induced by an increase of 10 billion wons in the private consumption expenditure. One will note that the induced productions for the agricultural and textile goods fall gradually, and those for the sectors of 'metals and metallic products' and 'transportation equipment' rise rapidly with the years. It is also clearly discernible that the petroleum products are more sensitive to the change in final demand than coal and coal products.

Table 3 shows the induced productions for petrochemical products by the addition of 10 billion wons to the private consumption expenditure. Ethanol, LDPE, methanol, and PVC are the names whose productions are most effectively induced in 1970. Ethanol, being placed on the top in 1970, was produced by fermentation. Therefore, an increase in private consumption expenditure would merely lead to a more effective consumption of alcoholic beverages.

In 1974, the situation changes. The order of induced productions is: ethylene and propylene in tie, then ethanol, methanol, LDPE, EDC, vinyl chloride monomer (VCM), and so forth. One should note how closely was propylene related with the private consumption expenditure in 1974.

In 1978, the lineup is in the order of ethylene, propylene, LDPE, methanol, and so forth. However, in 1982, the order is ethylene, mixed xylene, LDPE, toluene, propylene, methanol, and so forth. It should be noted that, in 1982, aromatic derivatives start to play an important role in connection with the private consumption expenditure.

The induction coefficient is nothing but the induced production per unit incremental final demand. By having either one of these quantities, the correction to the demand forecast can easily be made for a change in the private consumption expenditure plan. For instance, if we take the private consumption expenditure 5% less for 1982, the production of ethylene to be reduced is calculated as follow:

48,000 billion wons $\times$ 0.05 = 2400 billion wons… reduction in the private consumption expenditure.

2400 billion wons $\times$ 1,715.7MT/10 billion wons = 41,180MT…ethylene production to be reduced

(2) Production Induced by the Housing Investment

Table 4 shows the induced productions of some of the non-petrochemical sectors by an increase of 10 billion wons in the housing investment. It is interesting to note that the induced productions of the 'metals and metallic products', 'machinery products', and 'transportation equipment' increase rapidly, while that of 'lumber and wood products' decreases gradually with the years. This may be an indicative of being metals rather than wood that will play an important role in future buildings. It is quite natural that the induced production of 'construction and building' by an incremental housing investment is placed on the top if one considers the fact that the latter is directly connected to the former.

The induced productions for the petrochemical products by the same incremental housing investment are shown in *Table* 5. It is noted that ethylene, EDC, VCM, PVC, 'building materials and house appliances' come in the given order, and then follow

Table 2. Induced production by the private consumption expenditure (Nonpetrochemical Sectors)

Unit: million wons

	1970	1974	1978	1982
Agr For'y Pdts	4,484	3,497	2,623	1,916
Fishery Pdts	248	234	213	189
Ores & Oil	188	241	302	359
Agr Fish'y Pdts Proc	1,813	1,675	1,489	1,296
Tex Fab & Yarn	1,261	1,486	1,660	1,769
Lmbr & Wd Pdts	58	66	77	92
Prin Pub & Ppr	336	287	219	167
Chem Fertlzr	156	143	133	113
Medcns & Cmtcs	190	240	289	339
Petr Pdts	254	330	396	445
Coal & Coal Pdts	259	207	167	139
Mets & Pri Met Pdts	414	725	1,238	1,980
Mach & Instr	217	287	371	463
Trans Equip	159	433	1,053	2,230
Misc Mfg	536	454	372	42
Elec & Water	229	276	341	408
Comm Trans Warehsg	1,033	1,208	1,357	1,484
Wholesale & Retail	1,831	2,276	2,736	3,201
Rl Est & Service	2,063	2,273	2,420	2,540
Total Petrochem Pdts	328	485	746	1,055

Table 3. Induced production by the private consumption expenditure (Petrochemical Sectors)

		1970				1974				1978				1982			
		Ind. Amt. Million₩	Rank	Ind. Amt. MT	Rank	Ind. Amt. Million₩	Rank	Ind. Amt. MT	Rank	Ind. Amt. Million₩	Rank	Ind. Amt. MT	Rank	Ind. Amt. Million₩	Rank	Ind. Amt. MT	Rank
	Starting Materials																
10	Ethylene					9.647		266.4	1	37.586	5	1,038,0	1	62.124	5	1,715,7	1
11	Propylene					8.507		266.4	1	17.045	10	529.8	2	19.374		602.2	5
12	Butadiene					1.997		39.7		2.924		58.1		4.774		94.9	
13	Benzene	0.358		18.0		4.100		98.0		10.747		256.9	9	18.548		443.3	7
14	Toluene	1.383		35.3		4.101		99.3	10	11.193		271.0	6	24.894	9	602.6	4
15	o-Xylene	1.699		47.3	9	2.298		52.5		2.930		67.0		4.768		109.0	
16	p-Xylene									12.318		124.0		19.979		201.1	
17	mixed Xylene	0.921		22.1		2.945		71.3		11.010		266.5	8	34.750	6	841.2	2
18	Cyclohexane					3.421		60.5		4.749		83.9		6.085		107.5	
	Petrochemicals																
19	Phenol	1.468		15.4		1.360		16.7		1.156		14.2		0.820		10.1	
20	Dodecyl Benzene	2.875		29.2		4.700		45.5		6.972		67.6		8.600		83.3	
21	Ethanol	49.275	1	240.5	1	40.487	3	197.6	3	30.869	6	287.5	5	22.023	10	164.7	
22	Methanol	3.032		129.1	3	4.857		189.0	4	9.606		373.8	4	13.837		538.4	6
23	Formalin	2.479		90.6	5	3.701		126.0	8	5.586		190.2	10	8.277		281.8	9
24	Acetone	1.208		16.3		1.616		21.8		1.968		26.5		2.040		27.5	
25	Acetaldehyde	0.924		21.8		0.898		13.0		1.041		15.0		0.914		13.2	
26	Acetic Acid	1.323		16.3		1.272		14.1		1.498		16.6		1.287		14.3	
27	Ethylene Oxide									4.583		59.1		7.402		95.4	
28	Ethylene Glycol	0.777		9.1		3.357		45.9		5.825		79.6		9.408		128.6	
29	Ethylene Dichloride					4.971		164.9	6	8.125		269.6	7	10.784		357.8	8
30	Propylene Oxide									1.839		16.6		5.135		46.2	
31	Propylene Glycol									3.209		21.7		8.958		60.6	
32	PPG	0.666		4.6		1.930		7.5		5.077		19.7		11.101		43.1	
33	Octanol	1.397		16.8		2.745		29.9		4.036		43.9		5.138		55.9	
34	Pentaerythritol	0.873		3.8		0.981		4.2		1.000		4.3		0.848		3.7	
35	Maleic Anhydride	0.625		3.8		0.908				1.334		11.0		6.983		57.8	
36	Phthalic Anhydride	4.176		44.5		5.787		7.5		7.378		78.5		12.007		127.8	
37	Ammonia	0.651		18.1		4.605		128.1	7	6.479		180.2		8.170		227.2	
38	Melamine	0.846		5.1		0.686		4.1		0.643		3.9		0.639		3.8	
39	VCM	2.249		44.6	10	5.837		105.4	9	9.539		172.3		12.661		228.7	
40	Styrene	1.335		23.3		4.462		60.8		5.955		81.1		8.910		121.4	
41	MMA, MA	5.728		28.7		7.689		38.5		9.370		46.9		9.488		47.5	
42	Vinyl Acetate	1.912		16.2		1.780		15.6		1.508		12.8		1.896		16.0	
43	Caprolactam	9.904		61.0	7	14.959	8	58.8		20.766	8	81.6		26.610	8	104.5	
44	Acrylonitrile	5.252		44.3		6.155		51.2		6.630		55.2		8.563		71.3	
45	DMT	3.155		21.5		14.309	10	97.4		12.568		85.6		20.383		138.8	
46	TPA									10.216		70.6		16.568		114.5	
	Synthetic Resins																
47	LDPE	13.210	6	139.8	2	18.994	6	188.7	5	42.615	4	423.3	3	73.928	3	734.4	3
48	HDPE	7.029		60.0	8	7.936		67.8		10.660		91.0		15.915		135.9	
49	P P	4.037		34.4		7.174		63.5		11.564		102.3		15.950		141.2	

		1970				1974				1978				1982			
		Ind. Amt. Mill-ion ₩	Rank	Ind. Amt. MT	Rank	Ind. Amt. Mill-ion ₩	Rank	Ind. Amt. MT	Rank	Ind. Amt. Mill-ion ₩	Rank	Ind. Amt. MT	Rank	Ind. Amt. Mill-ion ₩	Rank	Ind. Amt. MT	Rank
50	PVC	9.335		91.7	4	9.871		88.0		16.132		143.8		21.413		190.8	
51	P S	3.235		24.5		9.240		52.0		12.125		68.2		15.167		85.3	
52	PVA	2.325		10.4		2.190		9.8		1.872		8.4		1.317		5.9	
53	Phenolic Resin	2.994		14.1		2.773		11.9		2.355		10.0		1.669		7.1	
54	Urea Resign	0.999		10.6		1.288		13.7		1.475		15.7		1.447		15.4	
55	Melamine Resin	2.332		9.1		1.892		7.4		1.774		6.9		1.762		6.9	
56	Alkyd Resin	11.042	9	43.1		12.409		48.4		12.657		49.4		10.736		14.9	
57	Plasticizer	3.822		24.6		7.508		39.9		11.042		58.6		14.055		74.6	
58	Oth Syn Resins	19.009	5			23.523	5	74.4		28.700	7	90.8		31.162	7	98.6	
	Synthetic Fibers																
59	Nylon Fiber	24.228	3	62.1	6	36.592	4	59.8		50.798	3	83.0		65.092	4	106.4	
60	Acrylic Fiber	12.543	7	41.5		14.700	9	48.6		15.835		52.3		15.741		52.0	
61	Polyester Fiber	21.475	4	21.1		41.041	2	96.7		72.093	2	169.8		116.926	1	275.4	10
62	P.V.A. Fiber	1.141		2.2		1.051		2.1		0.891		1.7		0.698		1.4	
63	PP Fiber	4.563		10.8		7.175		17.0		10.369		24.6		13.843		32.8	
64	Oth Syn Fibers	0.019		0.0		0.017		0.0		0.015		0.0		0.011		0.0	
	Synthetic Rubbers																
65	SBR	3.137		33.2		4.867		47.1		7.127		68.9		9.957			
66	Oth Syn Rubbers	1.437		14.4		1.803		18.0		2.135				2.411			
	Processed Plastics																
67	Flm Sht Lthr	34.316	2			46.831				77.049	1			99.176	2		
68	Bldg Mat & Hshld Apl	2.075				3.531	1			5.905				9.122			
69	Tblwre & Contnr	10.611	10			12.194				13.956				14.676			
70	Hshld Gds	12.477	8			15.282				18.122	9			20.685			
71	Elec & Mach Pts	5.241				8.612	7			13.568				20.515			
72	Oth Plstc Gds	8.855				9.250				9.991				16.658			

Table 4. Induced production by the housing investment (Nonpetrochemical Sectors)

Unit: million wons

	1970	1974	1978	1982
Agr For'y Pdts	904	681	482	322
Fishery Pdts	14	12	9	7
Ores & Oil	739	723	760	817
Agr Fish'y Pdts Proc	339	282	226	177
Tex Fab & Yarn	126	146	160	168
Lmbr & Wd Pdts	739	710	652	575
Prin Pub & Ppr	331	271	186	139
Chem Fertlzr	37	34	30	23
Petr Pdts	440	525	596	644
Coal & Coal Pdts	132	136	147	161
Mets & Pri Met Pdts	3,708	5,363	7,380	9,615
Nonmet Min Pdts	1,363	1,094	856	664
Mach Instr	911	1,054	1,165	1,207
Trans Equip	118	298	675	1,296
Misc Mfg	54	43	36	30
Constr & Bldg	10,047	10,072	10,107	10,148
Elec & Water	339	406	495	590
Comm Trans Warehsg	867	964	1,027	1,051
Wholesale & Retail	1,285	1,535	1,774	1,972
RI Est & Service	308	317	321	321
Total Petrochem Pdts	263	410	593	861

methanol, formalin, alkyd resin, and other synthetic resins. All these findings do not contradict with our general concept on these materials in conjunction with housings.

If the housing investment for 1982 is increased by

Table 5. Induced production by the housing investment (Petrochemical Sectors)

		1970				1974				1978				1982			
		Ind. Amt. Million W	Rank	Ind. Amt. MT	Rank	Ind. Amt. Million W	Rank	Ind. Amt. MT	Rank	Ind. Amt. Million W	Rank	Ind. Amt. MT	Rank	Ind. Amt. Million W	Rank	Ind. Amt. MT	Rank
	Starting Materials																
10	Ethylene					3.280		90.5	10	27.172	7	750.4	2	42.436	6	1,171,9	2
11	Propylene					3.730		115.9	6	7.216		224.3	10	13.024		404.8	9
12	Butadiene					1.105		21.9		1.567		31.1		2.720		54.1	
13	Benzene	1.530		36.6		3.415		81.6		11.089		265.0	7	15.682		374.8	10
14	Toluene	1.636		39.6		3.992		96.6	8	9.668		234.0	9	22.219		537.9	8
15	o-Xylene	1.763		40.3	9	2.300		52.5		2.141		48.9		4.964		113.5	
16	p-Xylene									1.189		12.0		1.894		19.1	
17	mixed Xylene	1.488		36.0		3.490		84.4		10.120		245.0	8	31.138	8	753.8	6
18	Cyclohexane					0.335		5.9		0.458		8.1		0.577		10.2	
	Petrochemicals																
19	Phenol	1.367		16.8		1.180		14.5		0.960		11.8		0.705		8.7	
20	Dodecyl Benzene	2.583		25.0		4.012		38.8		5.689		55.1		7.294		70.7	
21	Ethanol	9.450	8	46.1	7	6.996		34.1		4.830		32.6		3.128		23.4	
22	Methanol	5.554	10	216.1	3	8.999		350.1	5	13.668		531.9	6	18.917		736.1	7
23	Formalin	9.501	7	323.4	1	14.773	9	502.9	2	21.288	10	724.7	3	28.285	10	962.9	4
24	Acetone	0.899		12.1		1.142		15.4		1.329		17.9		1.400		18.9	
25	Acetaldehyde	0.763		11.0		0.804		11.6		0.789		11.4		0.714		10.3	
26	Acetic Acid	1.076		12.0		1.149		12.7		1.120		12.4		0.987		11.0	
27	Ethylene Oxide									0.614		7.9		0.954		12.3	
28	Ethylene Glycol	0.140		1.9		0.455		6.2		0.781		10.7		1.212		16.6	
29	Ethylene Dichloride					21.390	5	709.6	1	31.351	5	1,040,2	1	46.057	5	1,528,1	1
30	Propylene Oxide									1.501		13.5		4.438		40.0	
31	Propylene Glycol									2.618		17.7		7.742		52.3	
32	PPG	0.598		2.3		1.647		6.3		4.142		16.1		9.415		36.6	
33	Octanol	2.011		21.9		3.495		38.0		1.641		17.9		7.493		81.5	
34	Pentaerythritol	0.784		3.4		0.837		3.6		0.816		3.5		0.720		3.1	
35	Maleic Anhydride	0.545		4.5		0.743		6.1		1.022		8.5		6.171		51.0	
36	Phthalic Anhydride	4.333		46.1	6	5.792		61.6		5.393		57.4		12.501		133.1	
37	Ammonia	0.609		16.9		1.277		35.5		1.770		49.2		2.583		71.8	
38	Melamine	0.300		1.8		0.283		1.7		0.304		1.8		0.473		2.8	
39	VCM	8.639	9	156.0	4	25.112	3	453.5	3	36.807	3	664.7	4	54.073	3	976.6	3
40	Styrene	1.800		24.5		7.163		97.5	7	10.104		137.6		8.734		119.0	
41	MMA, MA	5.145		25.8		6.564		32.8		7.645		38.3		8.047		40.3	
42	Vinyl Acetate	1.496		12.7		1.327		11.2		1.075		9.1		1.458		12.3	
43	Caprolactam	0.992		3.9		1.466		5.7		2.004		7.9		2.523		9.9	
44	Acrylonitrile	0.526		4.4		0.603		5.0		0.640		5.3		2.444		20.3	
45	DMT	0.316		2.2		1.402		9.5		1.213		8.3		1.933		13.2	
46	TPA									0.986		6.8		1.571		10.9	
	Synthetic Resin																
47	LDPE	4.295		42.7	8	6.458		64.1		15.514		154.1		27.588		274.1	
48	HDPE	1.991		17.0		2.205		18.8		2.870		24.5		7.222		61.7	
49	PP	1.479		13.1		3.327		29.4		5.785		51.2		8.220		72.7	

		1970				1974				1978				1982			
		Ind. Amt. Million ₩	Rank	Ind. Amt. MT	Rank	Ind. Amt. Million ₩	Rank	Ind. Amt. MT	Rank	Ind. Amt. Million ₩	Rank	Ind. Amt. MT	Rank	Ind. Amt. Million ₩	Rank	Ind. Amt. MT	Rank
50	PVC	35.855	2	319.5	2	42.471	2	378.4	4	62.250	2	554.7	5	91.449	2	814.9	5
51	PS	4.362		33.0		16.484	8	92.7	9	23.247	9	130.7		16.564		93.2	
52	PVA	2.017		9.0		1.807		8.0		1.470		6.6		1.080		4.8	
53	Phenolic Resin	2.794		11.9		2.412		10.3		1.961		8.4		1.440		6.2	
54	Urea Resin	1.481		15.7		1.945		20.6		2.099		22.3		1.890		20.1	
55	Melamine Resin	0.828		3.2		0.780		3.0		0.839		3.3		1.304		5.1	
56	Alkyd Resin	9.918	6	38.7	10	10.592	10	41.3		10.327		40.3		9.105		35.5	
57	Plasticizer	5.502		29.2		9.561		50.5		4.488		23.8		20.499		108.9	
58	Oth Syn Resins	16.965	3	53.7	5	20.137	7	63.7		23.847	8	75.5		28.752	9	91.0	
	Synthetic Fibers																
59	Nylon Fiber	2.427		6.2		3.586		5.8		4.901		8.0		6.172		10.1	
60	Acrylic Fiber	1.256		4.2		1.441		4.7		1.528		5.1		1.493		4.9	
61	Polyester Fiber	2.151		2.1		4.022		9.4		6.956		16.4		11.087		26.1	
62	PVA Fiber	0.114		0.2		0.103		0.2		0.086		0.2		0.066		0.1	
63	PP Fiber	0.457		1.1		0.703		1.6		1.000		2.4		1.313		3.1	
64	Oth Syn Fibers	0.002		0.0		0.002		0.0		0.001		0.0		0.001		0.0	
	Synthetic Rubbers																
65	SBR	1.773		17.1		2.695		26.0		3.820		36.9		5.080		49.1	
66	Oth Syn Rubbers	0.812				0.998				1.144				1.230			
	Processed Plastics																
67	Flm Sht Lthr	13.930	5			21.101	6			33.325	4			48.164	4		
68	Bldg Mat & Hshld Apl	65.788	1			88.308	1			112.865	1			137.217	1		
69	Tblwre & Contnr	2.097				2.461				6.754				3.505			
70	Hshld Gds	0.184				0.215				0.240				0.256			
71	Elec & Mach Pts	16.234	4			23.062	4			30.224	6			35.951	7		
72	Oth Plstc Gds	2.550				2.803				3.231				17.333			

5%, or 240 billion wons×0.05=12 billion wons, the induced productions of PVC, polystyrene (PS), and formalin, as calculated, are 978, 112, and 1155 metric tons, respectively.

3. Influence Coefficient and Sensitivity Coefficient

When the final demands of a certain specific industrial sector is increased, it will not only increase the production of the corresponding sector, but also change all other productions, influenced by the increase whose effect is propagated over all sectors through the network of the input coefficients. On the contrary, the increases in the productions of all other sectors are always sensed and responded by the remaining sector through the same network of the input coefficients. We agreed previously to call the former influence coefficient, and the latter, sensitivity coefficient.

A sector whose influence coefficient is greater than 1 is regarded as above average in its influential power on other sectors, and vice versa. Similarly, a sector whose sensitivity coefficient is greater than 1 is regarded as above average in its perceiving power of the outside changes, and vice versa. The plots of sensitivity coefficient versus influence coefficient for 1970 and 1982 are shown in *Figs.* 1 and 2. Those sectors which are not found in the plots are either those which are not produced nor imported, or those whose sensitivity coefficients are below 0.01.

In 1970, a great number of petrochemicals, such as dodecyl benzene, ethylene glycol, melamine,

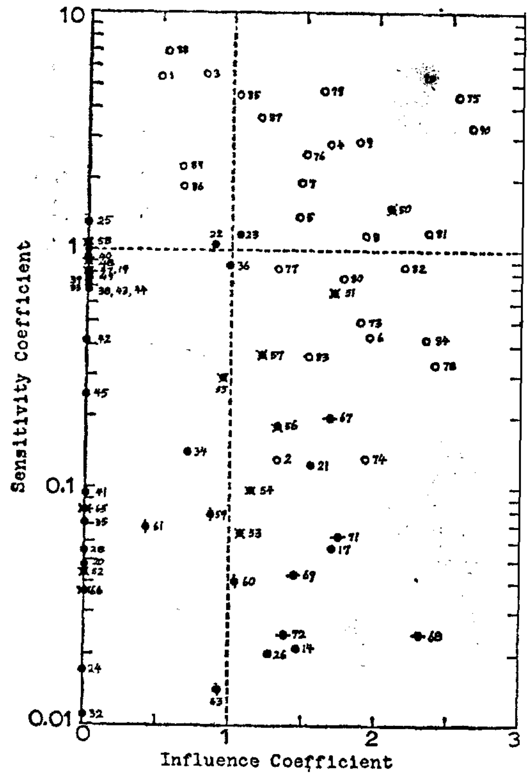

Fig. 1. Sensitivity coefficient *vs.* Influence coefficient for 1970.

: Synthetic resin
: Synthetic fiber
: Synthetic rubber
: Processed plastics
: Other industrial sector

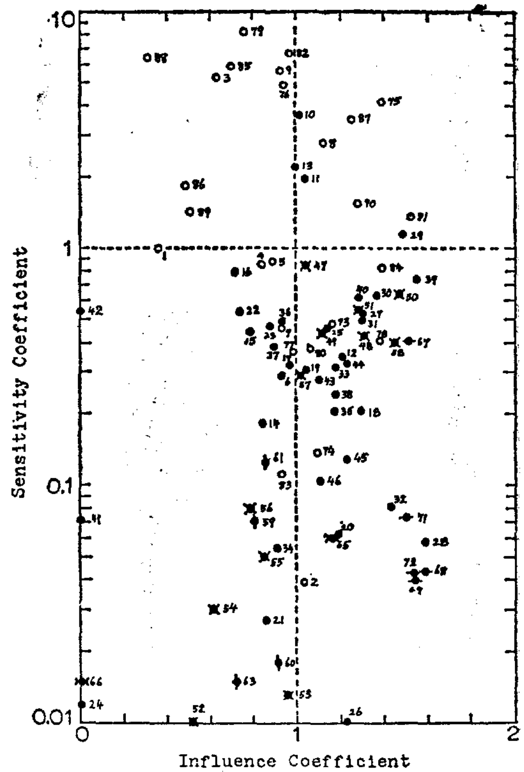

Fig. 2. Sensitivity coefficient *vs.* Influence coefficient for 1982

: Synthetic resin
: Synthetic fiber
: Synthetic rubber
: Processed plastics
: Other industrial sector

styrene, caprolactam, acrylonitrile, HDPE, etc. were among the imports. For these, the influence coefficients are zeros, and the plots line up along the vertical axis. However, as these imports are replaced, step by step, with the domestically produced goods, the corresponding plots are gradually dispersed into the coordinate space, leaving finally only four points on the axis line in 1982. Even these four points representing acetone, vinyl acetate, MMA and MA, and 'other synthetic rubbers' would have disappeared from the axis line had any definite plan for manufacturing these chemicals been established before this work was undertaken.

The products whose influence and sensitivity coefficients are above average are normally the products of basic industries. The machinery products, transportation equipment, 'other chemicals', naphtha, ethylene, propylene, benzene, EDC, inorganic basic chemicals, etc. are the examples.

The products which have undergone a high degree of processing, such as processed plastics, have relatively low sensitivity coefficients while, on the other hand, having relatively high influence coefficients. For such products, a forecast which did not take interindustry transactions into account has almost no meaning.

The sector like 'wholesale and retail trade' has a very high sensitivity coefficient and relatively a low influence coefficient. This is quite in accord with our general belief that this sector alone cannot transmit much effect on the most of other sectors.

The plots can be utilized, depending on one's viewpoint, for various purposes, such as diagnosing an economical health, defining the role of a specific industrial sector in the whole industry, and for calculating the amounts of transactions among the related industries.

CONCLUSION

We have presented so many features of the result of this analysis. All of them are as important as our final presentation here. Since our subject title was the planning of the Korean petrochemical industry, we would like to present, as our conclusion, the material flow diagrams for ethylene, propylene, butadiene, benzene, and xylenes in *Figs.* 3, 4, 5, and 6. Each numeric in the box indicates the actual quantity converted from the upstream side input material whose quantity is given outside the box at

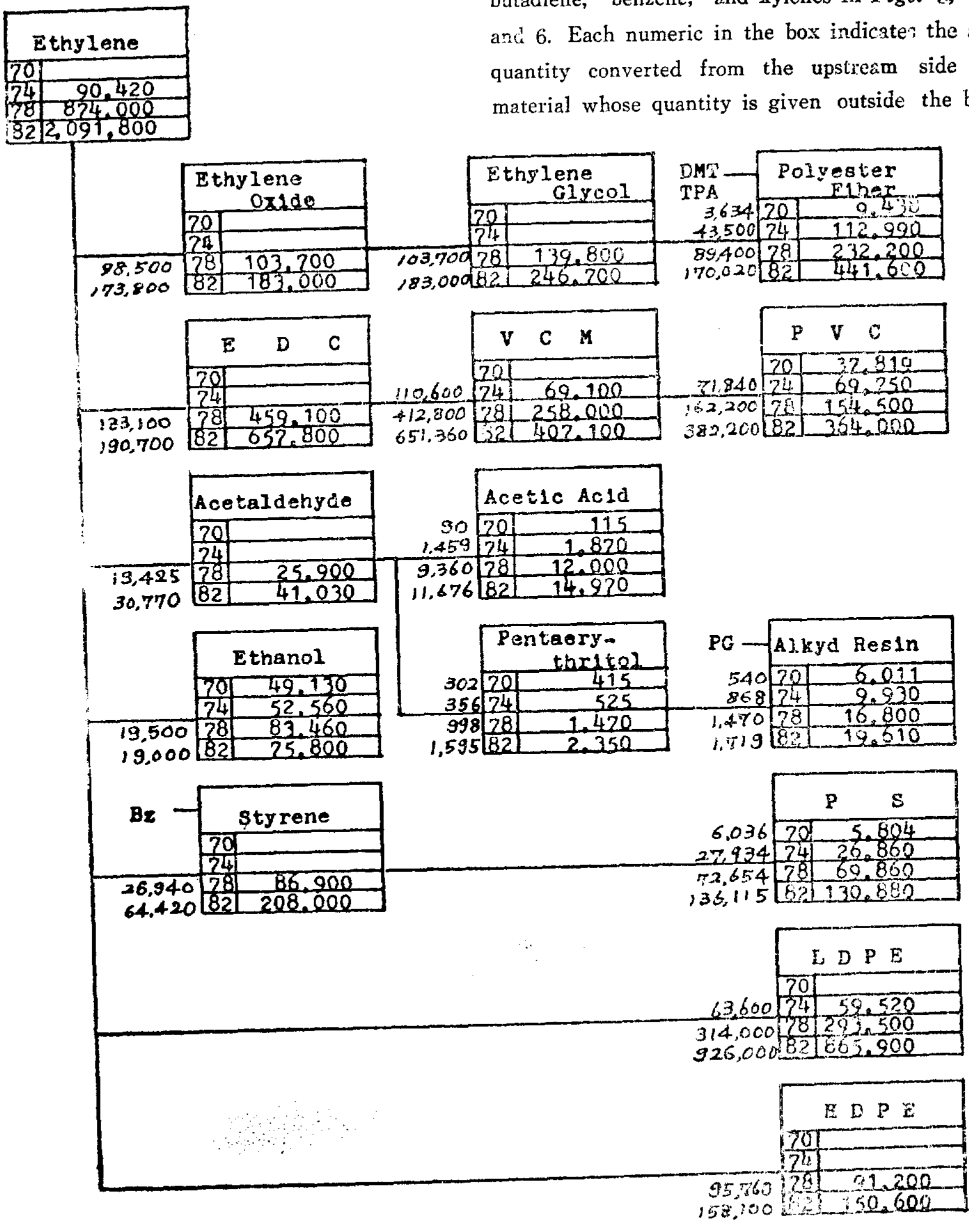

Fig. 3. Mateial flow diagram for ethylene series (MT)
Bz=benzene, PG=propylene glycol

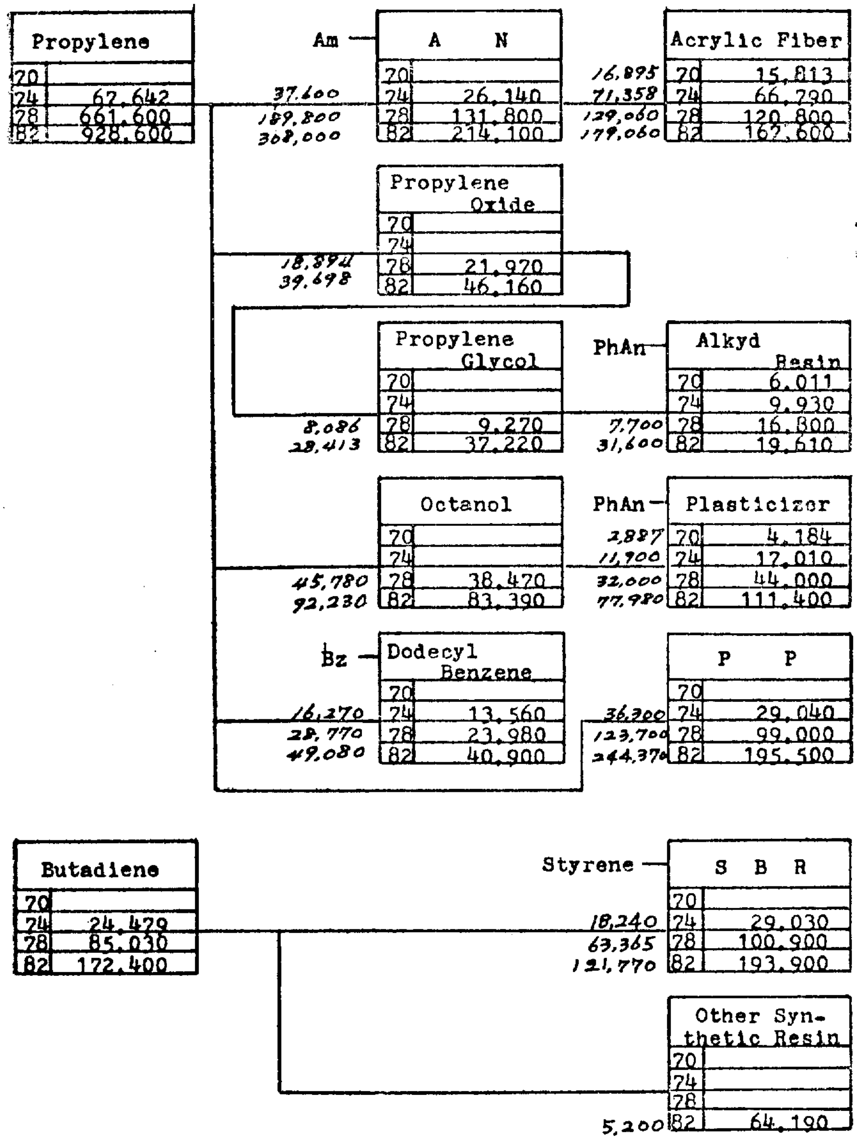

Fig. 4. Material flow diagram for propylene and butadiene series (MT)
Am=ammonia, Bz=benzene, PhAn=phthalic anhydride

the corresponding location. These results are, of course, based on the final demands model we have assumed. This model was sticked to throughout our analysis regardless of the oil crisis and the world business recession. The assumption may or may not be sound depending on the length of the recession period.

It should also be reminded that the input-output table used here is based on the 1970 prices. If a price system other than that of 1970 is used, the technology and inverse matrices will become considerably different. Our result should not be comprehended in any other price system. The conversion of our result into the running prices for an interested year still remains as a problem.

The top policy makers of the government, big investers, enterprisers, and economic research institutes should run a similar computer programming to

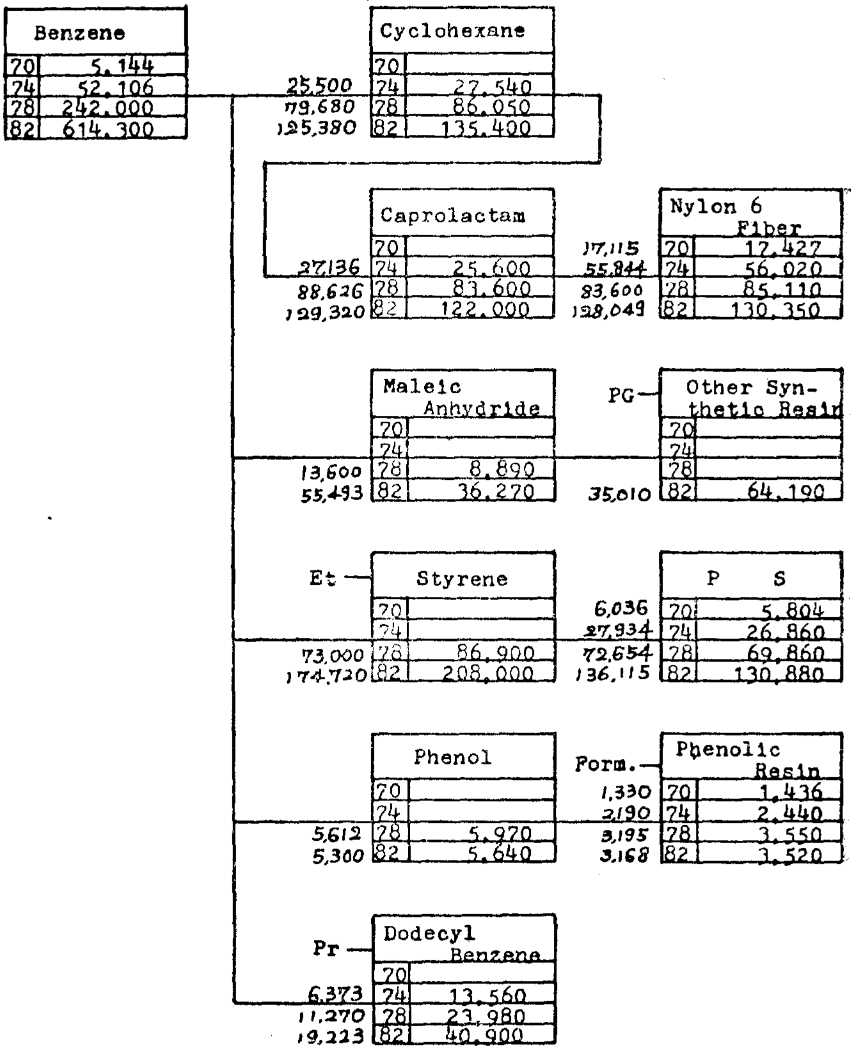

Fig. 5. Material flow diagram for benzene series (MT)
Et=ethanol, Pr=propylene, PG=propyleneglycol
Form=formalin

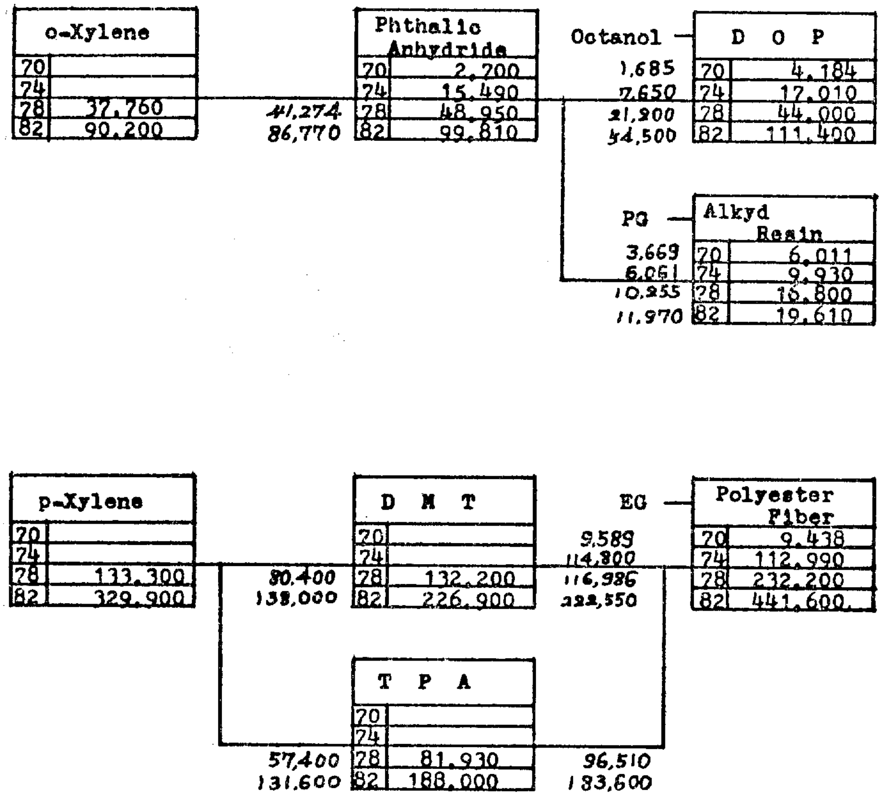

Fig. 6. Material flow diagram for o- and p-xylene series (MT)
PG=propylene glycol, EG=ethylene glcol

test their economic policies. Although we are not economists, we undertook this work mainly because this work required a great deal of chemical and engineering knowledges which may not be possessed by economists. On the other hand, the underlying principle of input-output analysis seemed to us relatively simple. We may, however, have violated inadvertently some economic and accounting principles. Any criticisms and suggestions are very welcome.