IMPACT OF POWER INTERRUPTIONS ON NATIONAL ECONOMY *

by

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and Rowaldo R. del Mundo ***

ABSTRACT

This paper shows that there is a significant correlation between energy consumption and national income or output. Thus, it is inferred that power interruptions and shortages result to losses in national income.

The study specifically deals with the impact of such power interruptions and shortages on the manufacturing industries, the sector in the economy that uses electric energy most intensively and which has one of the largest contributions to national income.

To quantify the impact of power interruptions on national economy, a simplistic approach is presented. Estimating graphs are generated for each industry group of the manufacturing sector as well as for the whole manufacturing industry.

INTRODUCTION

The demand for electrical energy has been observed to be increasing steadily and people are attributing this to the economic recovery of the country. As a result, businessmen are worried about the power supply situation in the country, both in terms of its availability and reliability of operations.

Do these foregoing statements mean that the availability of electrical energy influences the economy of a country? To what extent do power shortages and outages affect the economy?

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This paper, uses the Gross Domestic Product (see definitions) as the measure of the level of economic activity. Figure 1 and Table 1 show historical trends for gross domestic product (GDP), total energy consumption and total electricity consumption. Figure 1 shows a marked relationship between GDP and energy consumption; thus, one can make the conclusion that energy is a vital input to economic production.

Figure 2 shows the percentage contribution of the different sectors of the economy to the GDP for 1986. The industrial and service sectors account for 70% of the total GDP with the service sector contributing 6% more. Figure 3 shows the percentage contribution from the different subsectors of the industrial sector. The manufacturing subsector accounts for 74% which translate into about 24% of the total GDP.

Table 2 lists in decreasing order the contribution of the different industry groups of the manufacturing sector to the Gross Value Added (GVA). The highest contribution comes from food industry which accounts for 42%. This big amount can be attributed more to the large number of establishments and not necessarily to a large GVA per unit output. Tables 3 and 4 give the historical GVA and total electricity consumption, respectively, for each industry group from 1970 to 1981.

A method of assessing the impact of power interruptions is to estimate the outage costs, i.e., the economic costs suffered by society when the supply of electricity fails or is expected to fail. During or following an outage, consumers suffer direct costs since normal productive activity is disrupted. Opportunity costs are incurred due to spoilage and idle productive factors. Likewise, indirect costs are incurred when power is expected to fail. Consumers may adapt their production methods and techniques in ways that are more costly such as purchasing alternative and/or standby sources of energy. In addition, the opportunity cost of supplying electricity is also forgone.

Therefore, it is appropriate to measure the impact of power interruptions on the economy in relation to the effects of outages on productive activities. In the absence of primary data, one can at best use a simplistic approach in determining the effect of power outages on the economy. The concept of Electric Energy Intensity, defined as the electric energy required to produce one unit of GVA, will be used. A study of the historical electric energy intensity indicates that this parameter varies widely. Figure 4 illustrates the variations over the years for selected industry groups. Given this constraint, one can only come up with an approximate figure of the reduction in GDP given a certain amount of energy curtailment by using the maximum, minimum or average of the historical electric energy intensity. Using the average of the historical electric energy intensity, the average energy can be calculated for a given GVA as reflected in Table 5. Conversely, an equivalent GVA can be obtained given an amount of energy.

Specifically, the reduction in GVA (and consequently in national GDP) can be calculated by dividing the amount of curtailed energy by the average intensity. Figure 5 is a quick estimating set of graphs for this purpose. Table 5 shows the average energy requirement of the industries for the given GVA of 1986. Basing on the aggregated average intensity, a total of 5,922,873 megawatt-hours is required for all the manufacturing industries. For example, a 0.1% reduction or six (6) million Kw-hrs (0.001 X 5,922,873) energy curtailment due to interruptions and shortages will be translated into 33.9 million pesos (at constant price of 1972) for the food industry. This reduction is equivalent to 242 million pesos at 1986 current price (1986 price index = 712.4). The same procedure can be used for other industry groups. A more accurate impact can be calculated if data on power interruptions from industry groups can be obtained. In the absence of the data from the industries, the impact can be estimated by using the aggregated average intensity and outage data from the electric utilities. This is more realistic because curtailment cannot really be selective. So based on the average of all the industries, the 6 million Kw-hrs energy curtailment is equivalent to 21 million pesos and 150 million pesos at 1972 and 1986 prices respectively.

As stated earlier, the estimates of losses in the economy based on the average electric energy intensity are limited approximations because of its simplifying assumptions. Perhaps a better estimate can be made if instead of the electric energy intensity, the Electric Energy Content of the product is used. The energy content is the energy input required to produce a unit product. Hence, it is expressed in energy per unit output. The number of products not produced can be obtained by dividing the curtailed energy by the energy content (energy/product). Multiplying the number of products not produced to GVA per unit product gives the lost GVA. Thus, curtailment in energy can easily be transformed to opportunity costs lost which consequently represent a reduction in the national product. However, available data on energy content are, at present, insufficient for purposes of this study.

The energy intensities can be used by the government as one of the criteria in the choice of the industries to develop. Furthermore, based on the intensities, it will be logical to think that industries with low intensities should be given priority in electricity rationing because they contribute more to the economy even with less energy requirement. But one should not jump into the conclusion right away. The contribution of industries to GDP also varies and is limited by their production output. There is a need, therefore, to optimize the national income considering both the GVA share and energy intensity of the industries. This leads us to the next consideration made by this paper which is the level of industrialization of a country.

Industrialization could be measured using the ratio of the GVA contribution of the industrial sector, specifically the manufacturing industries, to the gross domestic product. This is commonly called the Industrialization Ratio. Since it has a relation to GDP, the share of each industry group is correctly expressed in percentage of the GDP as shown in Figure 2, Figure 3 and Table 2.

A careful study of other Asian countries' GDP, intensity and industrialization ratio reveals that there is indeed an existing relationship among these three (3) parameters. As reflected in Figures 6 and 7, countries with high GDP have high energy intensity. Indonesia may be an exception because of its oil exports. Furthermore, those with high energy intensity have higher industrialization ratio compared to others. Highly industrialization Taiwan has a very high energy intensity as well as industrialization ratio and is thus very dependent on energy. Meanwhile, Korea, which has surpassed Taiwan's GDP, has energy intensity which is comparable to that of Taiwan even with a lower industrialization ratio. Thus, the dependence on energy is also evident.

CONCLUSION

A simple method of assessing the impact of power interruptions to national economy is presented. It was found out that power shortage and outages may not only distract the investors to establish more manufacturing industries in the country but also reduce the national income substancially. Further research may be conducted to come up with methodologies in estimating outage costs which are more reflective of the production activities of the industries.

Electric utilities should focus their objectives on the economic efficiency of their operations in a nationalistic context. Energy sources should not only be available but also reliable. Reliability indices of power supply should always be available so that provision for outages can be provided.

A consequence of this study is the empirical relation that Gross Domestic Product can possibly be increased to a certain level only for a given energy intensity by making more efficient economic activities. Beyond that level, however, energy intensity has to increase. This means, that as a country becomes developed, it has to increase its energy consumption. Figure 8 is an illustration of this empirical relationship.

DEFINITIONS

GNP, GDP, GVA

Gross National Product is a national income measurement concerned with the flow of economic activities. It is broadly defined as a measure of the total value of final goods and services produced by the economy. One of the approaches to GNP is the Industrial Origin Approach (see any NEDA yearbook). This approach presents GNP as the value added contribution by each industry sector, that is, the sum of all the value added of all enterprises.

Value Added is a measure of the difference between the market value of all the goods that are produced and the cost of all the goods and materials produced by other producers. It is the net contribution of the enterprise to the total value of production. In equation form,

Value Added = Value of final sales - purchases from other enterprises

Gross Domestic Product (GDP) is the GNP with the exclusion of the net factor earnings from abroad. The earnings from abroad are those investments of the citizens in other countries and direct earnings when they work abroad.

ENERGY INTENSITY

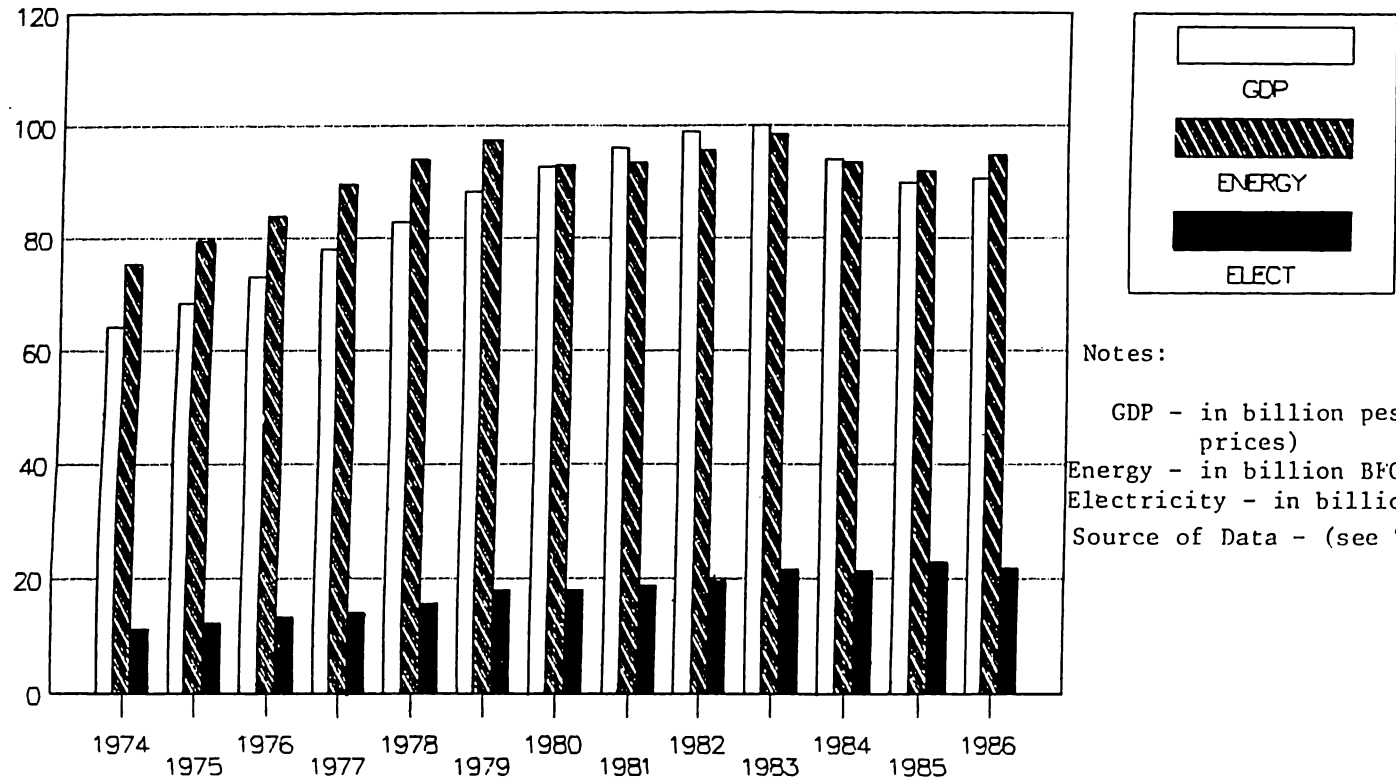
Energy intensity is the ratio of the energy consumption to the gross value added or gross domestic product.

INDUSTRIALIZATION RATIO

The ratio of the industries' gross value added to the gross domestic product of a country.

PHILIPPINES

GDP,ENERGY & ELECTRICITY CONSUMPTION



Notes:

GDP - in billion pesos (1972 prices)
Energy - in billion BFOE
Electricity - in billion KW-HRS
Source of Data - (see Table,1)

FIGURE I

TABLE 1

GROSS DOMESTIC PRODUCT
TOTAL ENERGY CONSUMPTION
TOTAL ELECTRIC ENERGY CONSUMPTION

YEAR	GDP	ENERGY CONSUMPTION	ELECTRICITY CONSUMPTION
1974	64,139.00	75,185.00	11,108.00
1975	68,361.00	79,352.00	12,221.00
1976	72,962.00	83,878.00	13,252.00
1977	77,990.00	89,731.00	13,833.00
1978	82,797.00	94,135.00	15,537.00
1979	88,346.00	97,420.00	17,804.00
1980	92,706.00	92,875.00	17,883.00
1981	96,207.00	93,474.00	18,583.00
1982	98,999.00	95,462.00	19,406.00
1983	99,920.00	98,472.00	21,454.00
1984	93,927.00	93,620.00	21,180.00
1985	89,803.00	92,080.00	22,766.00
1986	90,770.00	94,700.00	21,797.00

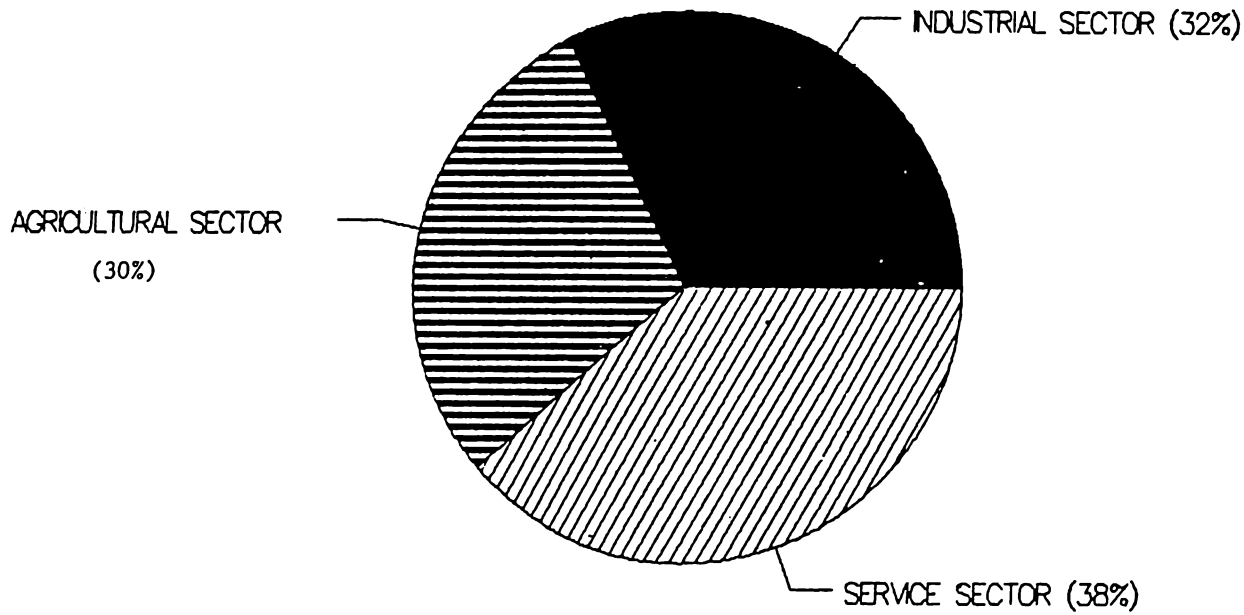
NOTES:

GDP in million pesos at constant prices of 1972
ENERGY CONSUMPTION in MBFOE
ELECTRICITY CONSUMPTION in Gigawatt Hours

SOURCES:

National Economic and Development Authority
Office of the Energy Affairs

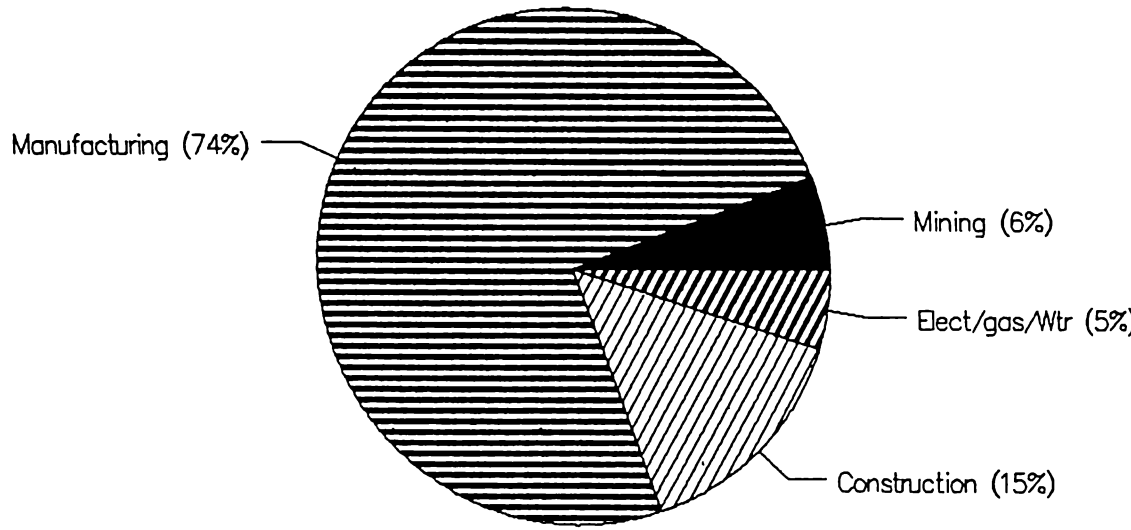
GROSS DOMESTIC PRODUCT
1986



. Source of Data: NEDA

FIGURE 2

INDUSTRIAL SECTOR
1986



Gross Value Added

Source of Data: NEDA

FIGURE 3

TABLE 2

GROSS VALUE ADDED
MANUFACTURING INDUSTRIES
1986
(In Million pesos at constant price of 1972)

Industry Group	GVA	PERCENT
Food Industries	8,727	41.73%
Electrical Machinery	1,913	9.15%
Chemical & Chemical Prod.	1,584	7.57%
Footwear and wearing app.	1,378	6.59%
Prod. of petroleum & coal	1,156	5.53%
Basic metal industries	1,018	4.87%
Tobacco Products	747	3.57%
Beverages	733	3.50%
Metal Products	725	3.47%
Miscellaneous manufacture	448	2.14%
Printing and Publishing	430	2.06%
Machinery	429	2.05%
Wood & Cork Products	388	1.86%
Non-metallic mineral prod	377	1.80%
Rubber Products	290	1.39%
Paper and Paper Products	172	0.82%
Transport Equipment	130	0.62%
Furniture and Fixtures	120	0.57%
Textiles	89	0.43%
Leather and Leather Prod.	61	0.29%
TOTAL	20,915	100.00%

Source: NEDA

TABLE 3

GROSS VALUE ADDED
by Industry Group: Manufacturing
(In million pesos at constant 1972 prices)

Industry Group	1970	1971	1972	1973	1974	1975	1978	1979	1980	1981
Food Industries	3,552	3,688	3,623	3,871	4,129	4,245	8,622	7,865	8,419	8,803
Beverages	609	662	724	758	787	808	685	707	732	730
Tobacco Products	784	818	950	1,291	1,457	1,542	438	1,038	1,039	1,100
Textiles	695	751	798	852	899	923	1,212	1,071	1,049	1,095
Footwear and wearing app.	447	491	431	533	544	591	344	932	1,019	1,189
Wood & Cork Products	497	568	582	627	638	471	518	686	665	707
Furniture and Fixtures	88	98	86	90	88	74	157	114	132	139
Paper and Paper Products	341	290	345	420	480	486	195	202	191	188
Printing and Publishing	262	258	265	339	430	447	283	301	324	344
Leather and Leather Prod.	30	24	22	25	26	30	26	49	68	70
Rubber Products	161	209	220	238	257	263	292	312	302	311
Chemical & Chemical Prod.	935	1,356	1,812	1,994	2,075	2,165	2,162	2,321	2,365	2,317
Prod. of petroleum & coal	858	939	1,048	1,358	1,219	1,230	1,657	1,398	1,373	1,287
Non-metallic mineral prod	495	455	445	597	541	597	520	535	574	540
Basic metal industries	500	391	409	526	505	587	742	865	853	791
Metal Products	372	393	401	414	424	398	932	1,040	1,041	977
Machinery	178	169	184	206	193	190	618	670	726	764
Electrical Machinery	359	369	355	376	408	443	821	1,005	1,153	1,401
Transport Equipment	492	518	516	561	688	842	775	898	885	910
Miscellaneous manufacture	168	164	172	176	193	205	109	230	265	296
TOTAL	11,823	12,611	13,388	15,252	15,981	16,537	21,108	22,239	23,175	23,959

Source: NEDA

TABLE 4

ELECTRICITY CONSUMPTION
Manufacturing Industries
(In Thousand of Kilowatt-Hours)

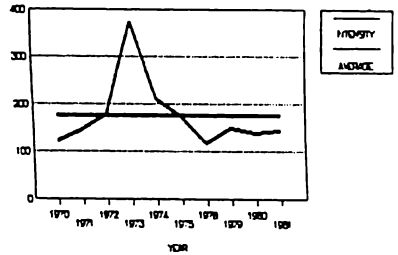
Industry Group	1970	1971	1972	1973	1974	1975	1978	1979	1980	1981
Food Industries	428,175	537,709	645,107	1,449,248	871,857	736,974	990,375	1,160,136	1,158,468	1,261,650
Beverages	90,764	91,900	166,080	97,570	96,803	84,164	195,705	133,634	154,762	145,275
Tobacco Products	26,124	24,404	91,327	32,186	53,558	35,572	48,021	47,274	32,430	82,186
Textiles	324,841	348,556	343,142	424,164	518,008	431,068	811,016	845,469	872,545	940,322
Footwear and wearing app.	21,135	23,058	17,225	15,629	15,868	18,202	48,611	179,182	111,196	134,905
Wood & Cork Products	283,690	157,746	176,905	265,430	946,633	277,272	300,729		360,909	369,703
Furniture and Fixtures	4,697	4,354	9,756	6,912	7,104	8,880	54,815	29,345	34,669	28,529
Paper and Paper Products	185,302	216,197	361,104	510,909	468,881	203,003	430,010	922,317	698,468	483,746
Printing and Publishing	27,788	24,300	29,293	34,259	30,518	26,117	26,082	45,834	47,619	42,409
Leather and Leather Prod.	4,319	4,896	3,411	5,972	6,359	5,871	11,889	11,120	9,540	7,549
Rubber Products	65,300	66,428	117,229	74,772	85,906	80,342	159,511	110,377	123,870	130,579
Chemical & Chemical Prod.	322,019	465,639	444,117	541,488	525,974	471,142	264,167	675,286	847,777	839,731
Prod. of petroleum & coal	124,987	123,766	98,418	99,354	84,497	161,733	86,326	66,733	120,499	57,245
Non-metallic mineral prod.	351,396	537,221	520,281	1,733,470	1,372,682	678,612	836,891	1,085,471	992,723	1,322,589
Basic metal industries	323,635	247,206	128,728	240,387	259,650	287,317	300,049	383,201	764,875	624,891
Metal Products	40,400	49,814	81,215	65,869	45,535	71,476	131,685	112,888	109,144	100,057
Machinery	11,400	15,033	34,211	26,781	32,607	34,243	24,280	45,921	98,554	75,661
Electrical Machinery	39,450	48,038	72,964	50,383	56,793	71,520	166,964	159,332	143,634	176,889
Transport Equipment	21,857	22,879	37,740	36,006	34,262	47,443	167,224	105,851	91,244	232,442
Miscellaneous manufacture	31,397	40,308	7,913	8,169	8,492	7,317	24,273	37,557	31,031	31,949
TOTAL	2,728,756	3,056,030	3,386,172	5,719,558	5,521,987	3,744,268	5,078,623	6,156,920	6,804,037	7,080,307

Source: National Statistic Office (NSO)

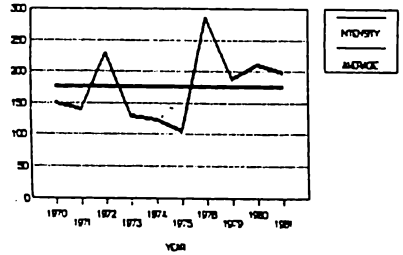
ELECTRIC ENERGY INTENSITIES

Manufacturing Industries

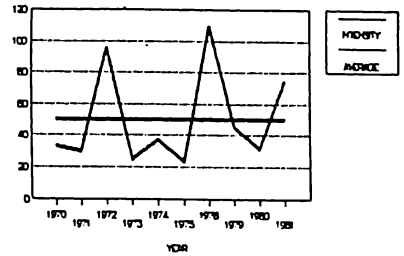
Food Industries



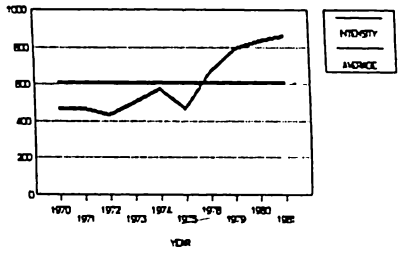
Beverages



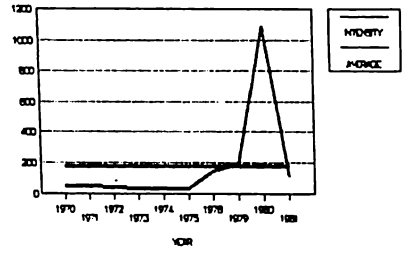
Tobacco



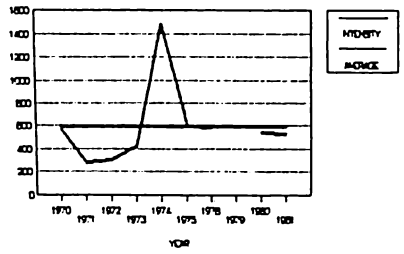
Textiles



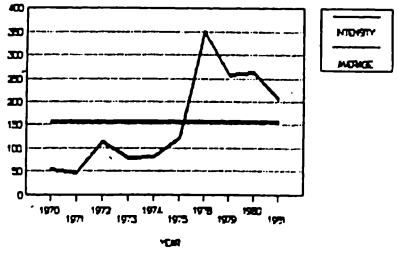
Footwear & Wearing Apparel



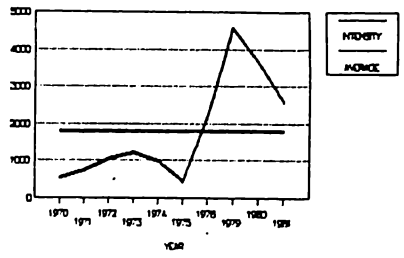
Wood & Cork Products



Furniture & Fixtures



Paper & Paper Products



Printing & Publishing

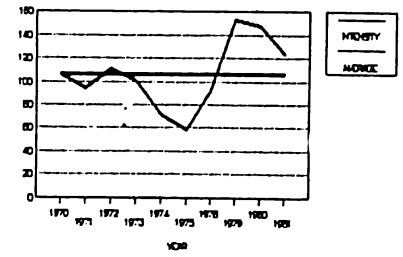
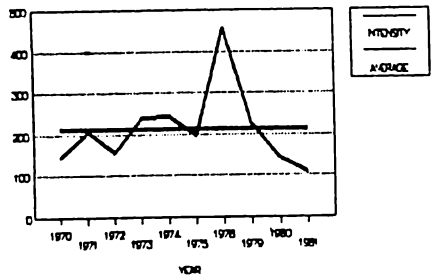
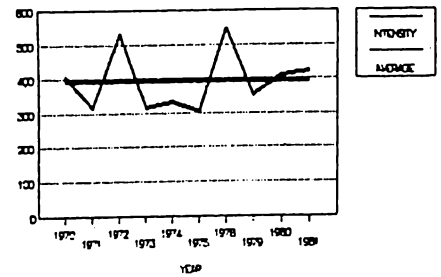


FIGURE 4

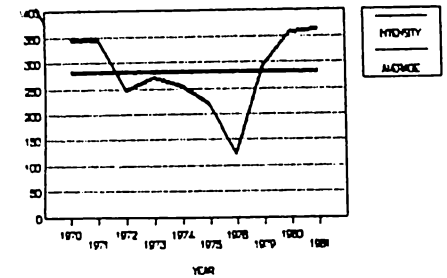
Leather



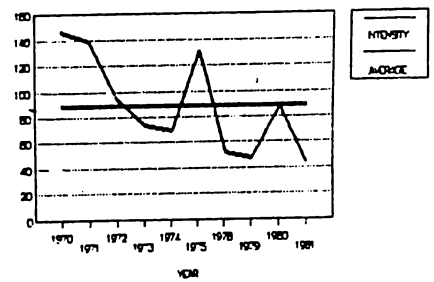
Rubber Products



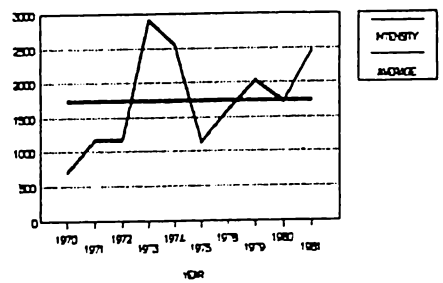
Chemical



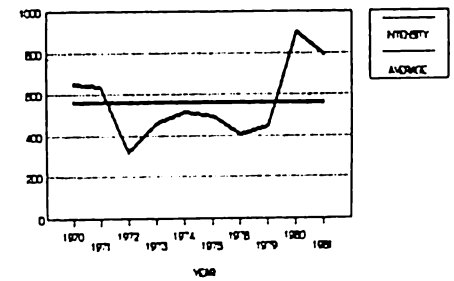
Products of Petroleum & Coal



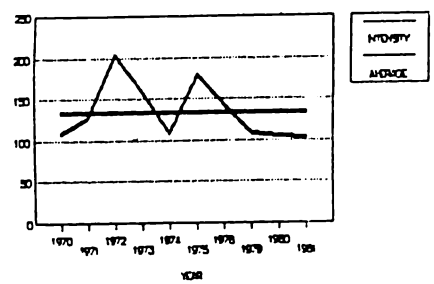
Non-metallic Mineral Products



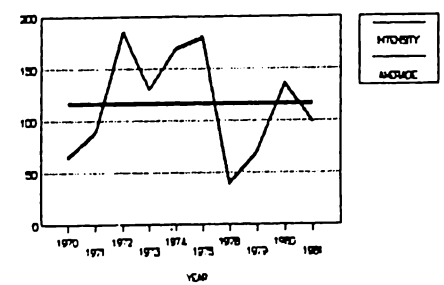
Basic Metal



Metal Products



Machinery



Electrical Machinery

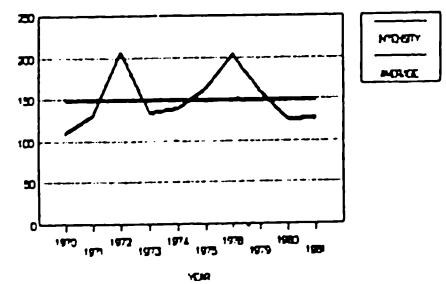
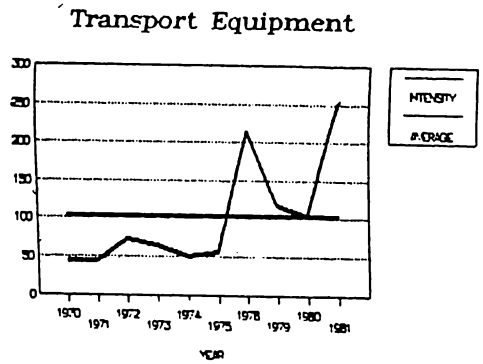
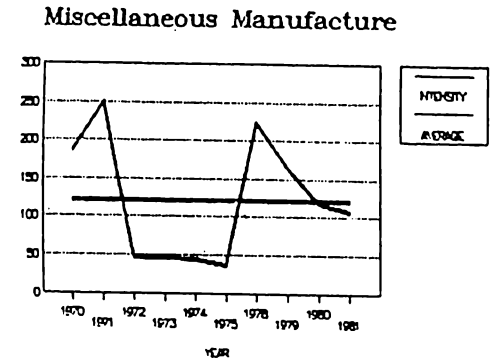


FIGURE 4 (cont.)





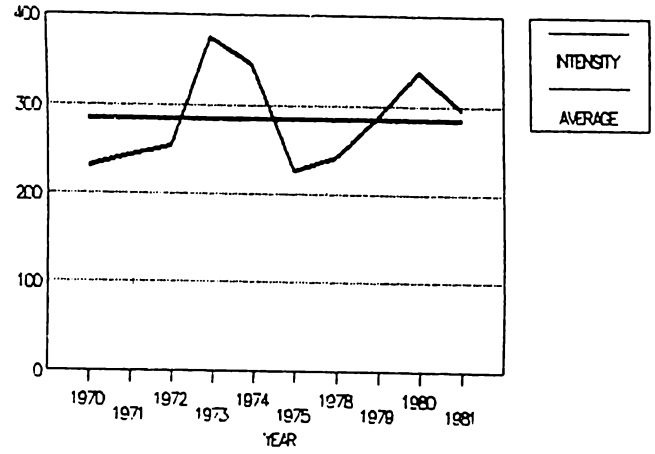


FIGURE 4 (cont.)

TABLE 5

AVERAGE ELECTRIC ENERGY REQUIRED
Based on the average electric energy intensity
(In Thousand KW-HRS)

Industry Group	GVA for 1986	INTENSITY AVERAGE	INTENSITY MINIMUM	INTENSITY MAXIMUM	AVERAGE ENERGY REQUIRED
Food Industries	8,727	174.68478	114.86604	374.38595	1,524,474
Beverages	733	175.82846	104.16337	285.70073	128,882
Tobacco Products	747	50.51553	23.06874	109.63699	37,735
Textiles	89	605.17054	430.00251	858.74155	53,860
Footwear and wearing app.	1,378	176.10031	29.16912	1090.47694	242,666
Wood & Cork Products	388	588.28618	277.72183	1483.75078	228,255
Furniture and Fixtures	120	156.30096	44.22449	349.14013	18,756
Paper and Paper Products	172	1796.00483	430.04733	4565.92574	308,913
Printing and Publishing	430	105.61895	58.42729	152.27243	45,416
Leather and Leather Prod.	61	211.45140	107.84286	457.26923	12,899
Rubber Products	290	394.07756	305.48289	546.27055	114,282
Chemical & Chemical Prod.	1,584	280.95746	122.18640	362.42167	445,037
Prod. of petroleum & coal	1,156	88.38227	44.47941	145.67249	102,170
Non-metallic mineral prod	377	1745.44555	709.89091	2903.63484	658,033
Basic metal industries	1,018	559.00992	314.73839	896.68816	569,072
Metal Products	725	134.10691	102.41249	202.53117	97,228
Machinery	429	116.07152	39.28803	185.92935	49,795
Electrical Machinery	1,913	149.29850	109.88858	205.53239	285,608
Transport Equipment	130	102.42375	44.16795	255.43077	13,315
Miscellaneous manufacture	448	121.94525	35.69268	249.43902	54,631
TOTAL	20,915	283.18781	226.41761	375.00380	4,991,027 or 5,922,873

NOTES:

Total Average Energy Required = Sum of all the average energy required for each industry
= 4,991,027

or

Total Average Energy Required = Total GVA X Average Intensity of all industries
= 20,915 X 283.18781
= 5,922,873

ESTIMATING GRAPHS

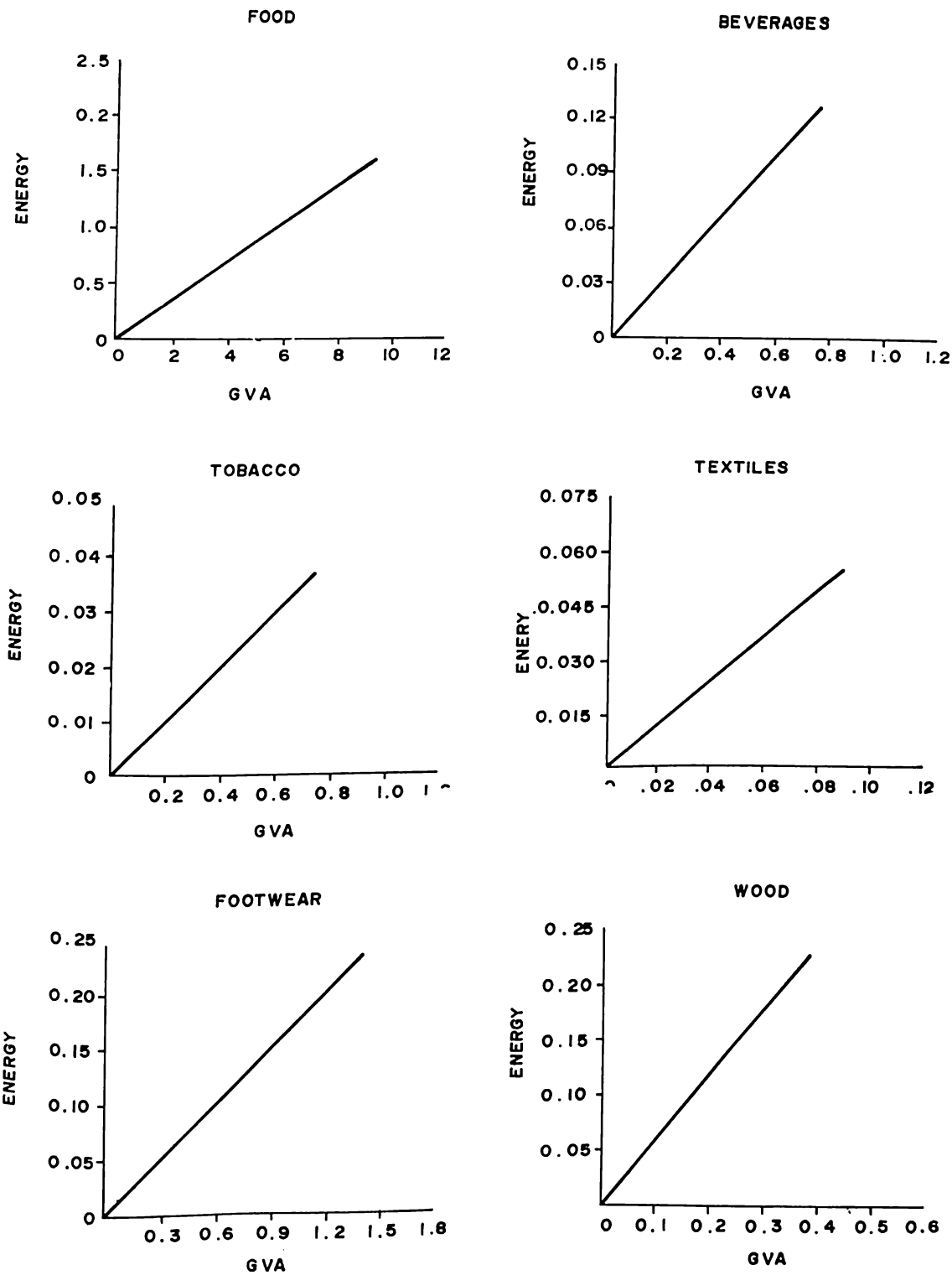


FIGURE 5

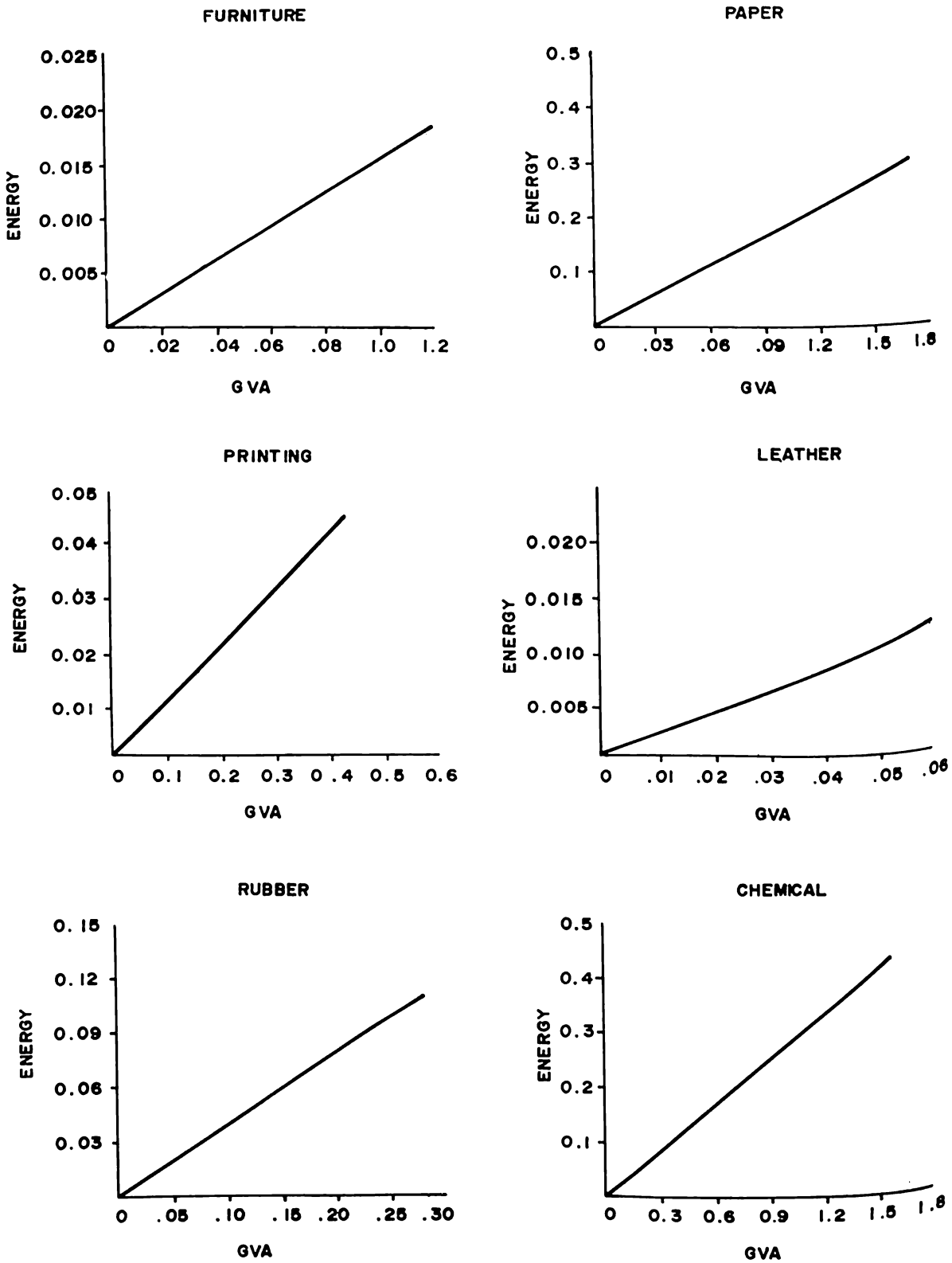


FIGURE 5 (cont.)

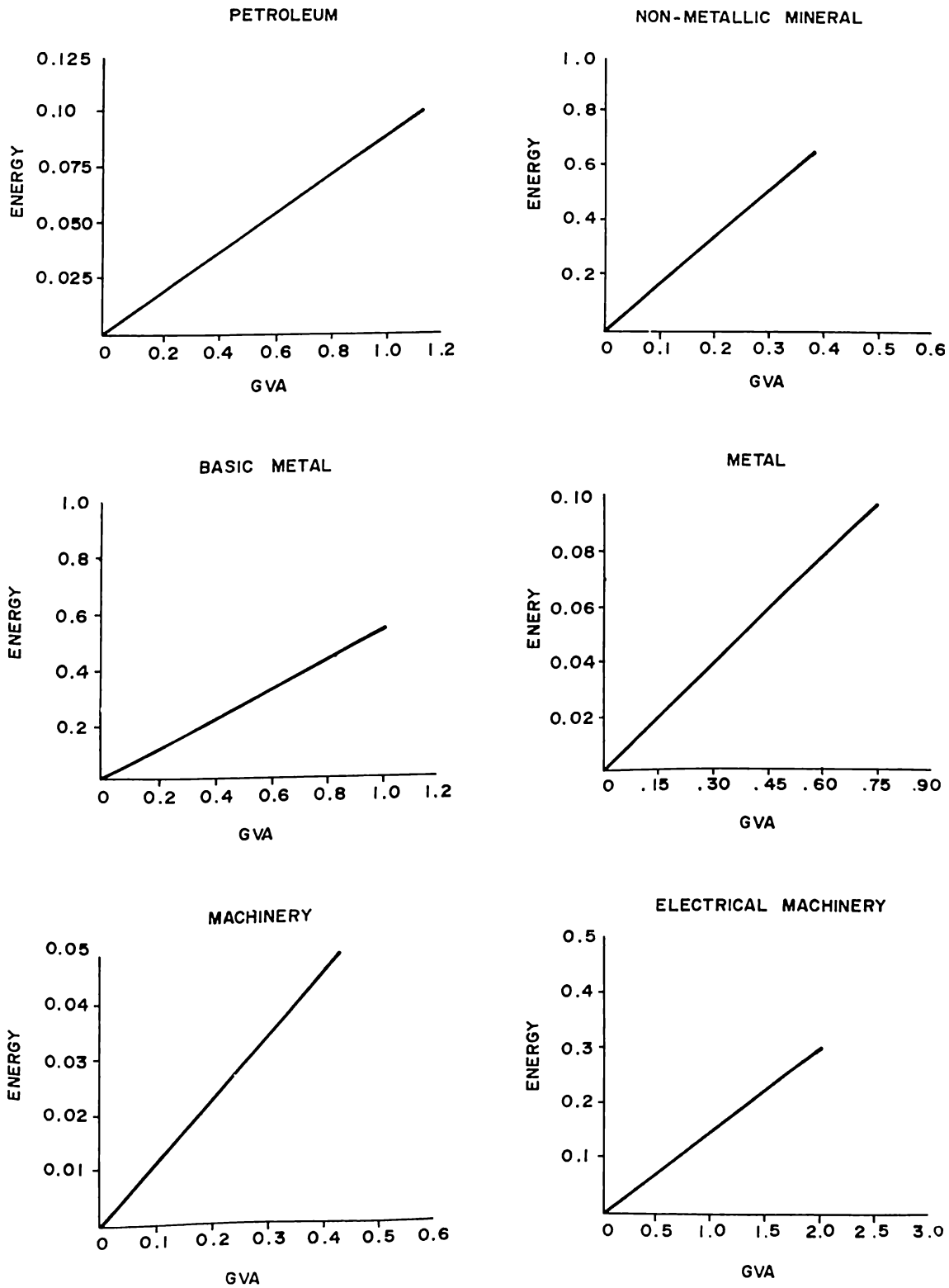
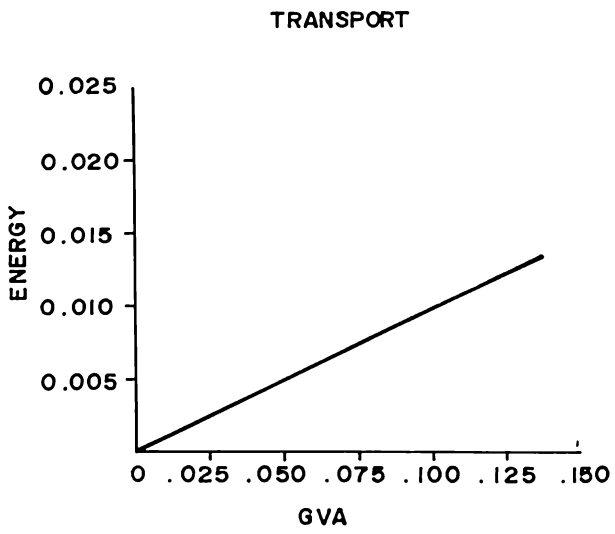
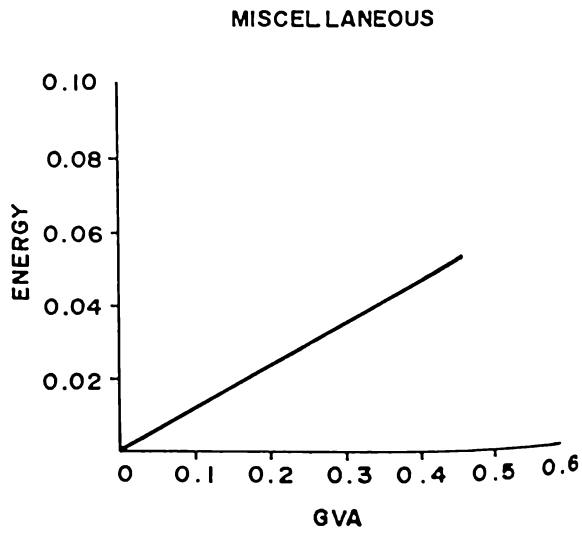
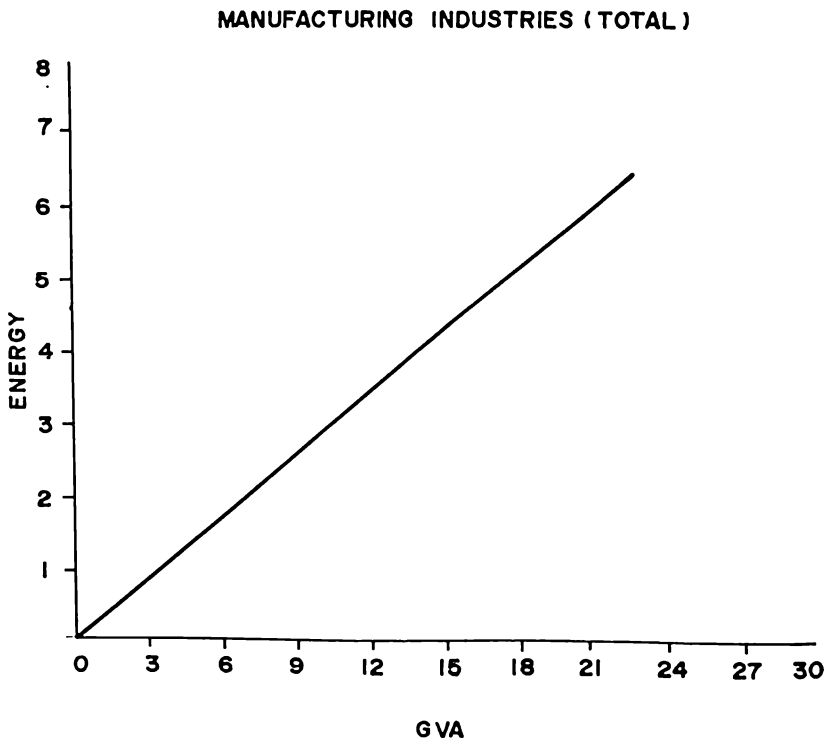


FIGURE .5 (cont.)





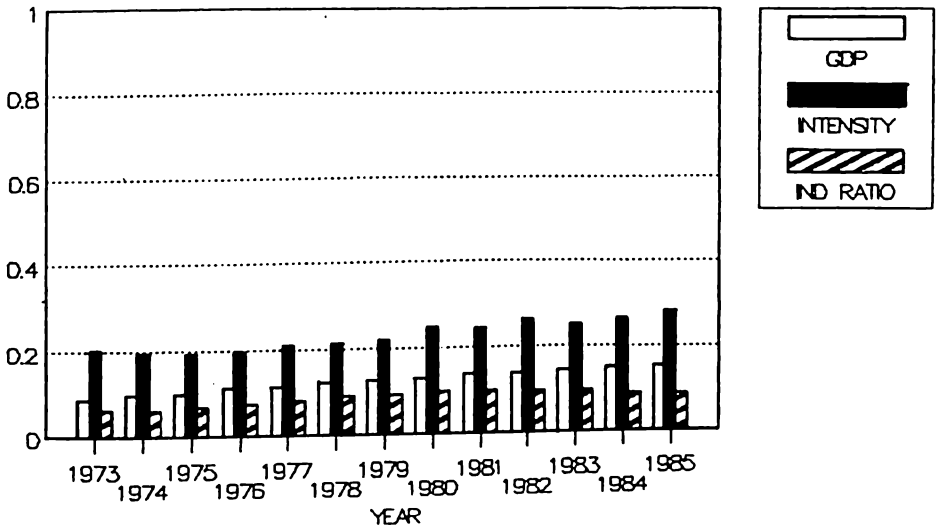


Notes :

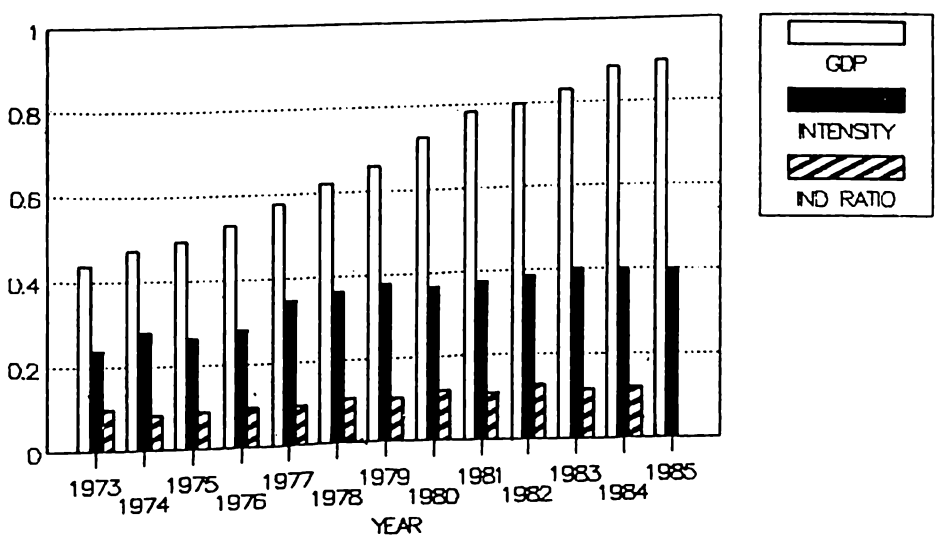
Energy - in billion kw-hrs.
GVA - in billion Pesos of 1972 prize

FIGURE 5 (cont.)

Bangladesh



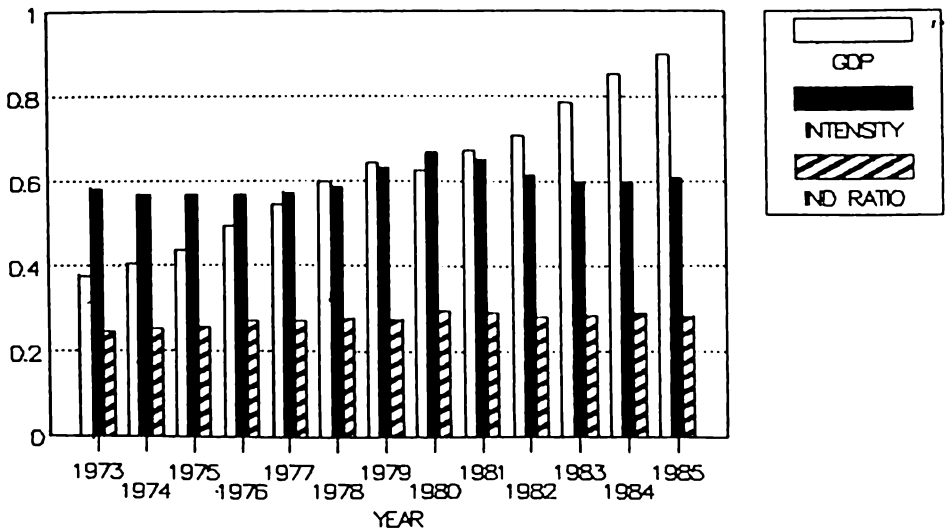
Indonesia



GDP, ENERGY INTENSITY, INDUSTRIALIZATION RATIO
Selected Asian Countries

FIGURE 6

Korea



Malaysia

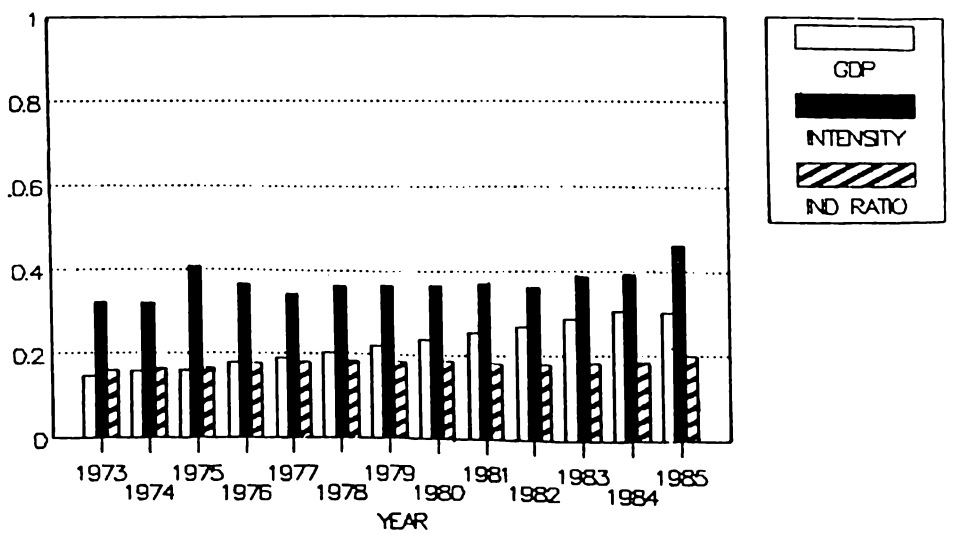
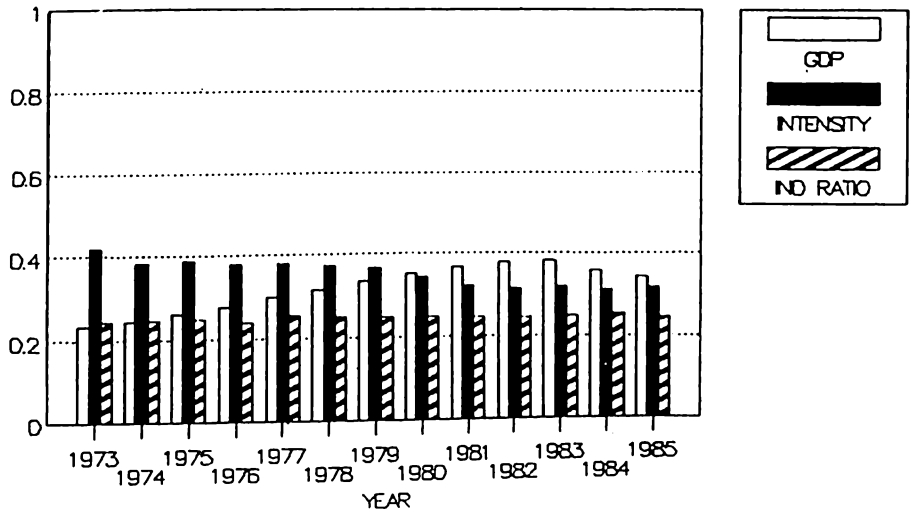


FIGURE 6 (cont.)

Philippines



Taipei, China

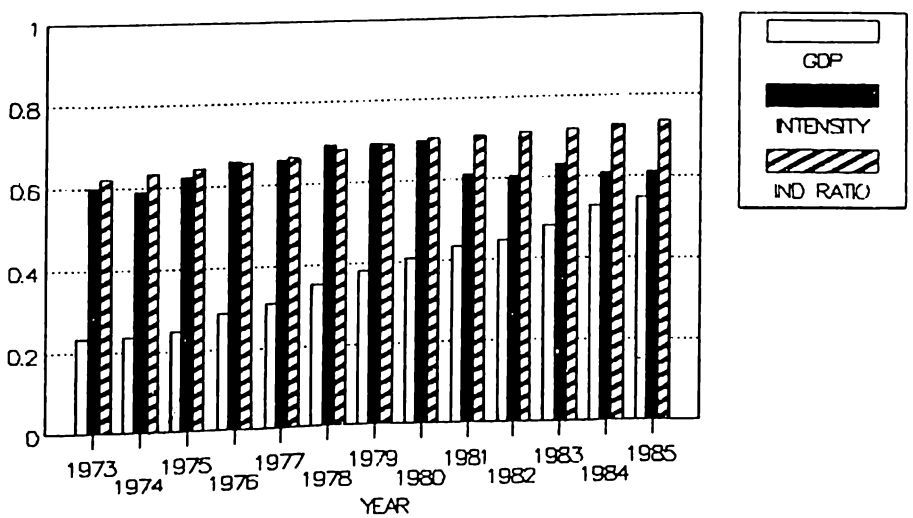
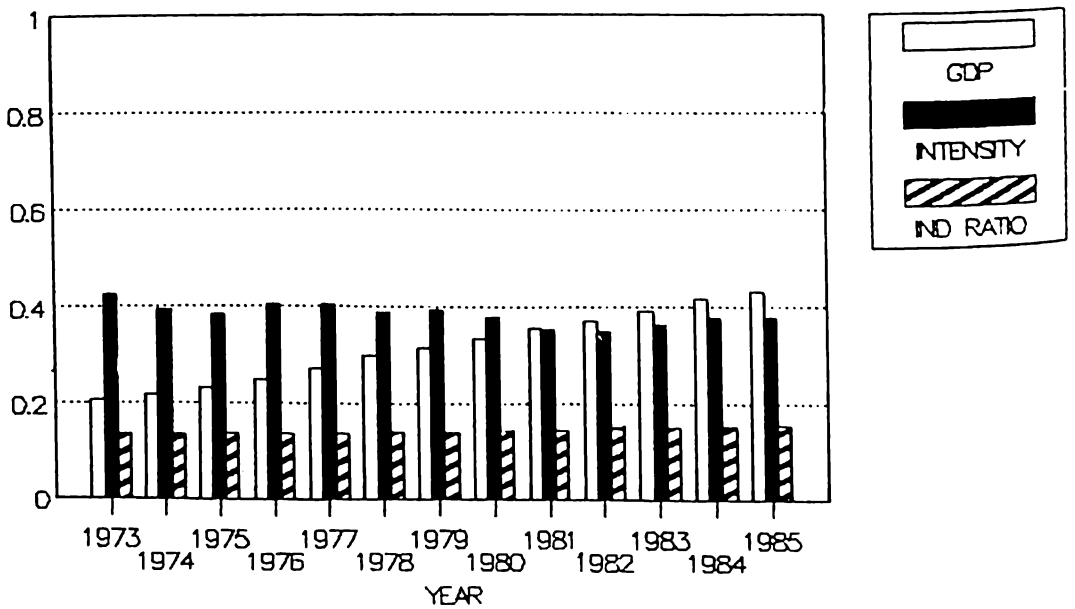


FIGURE 6 (cont.)

Thailand



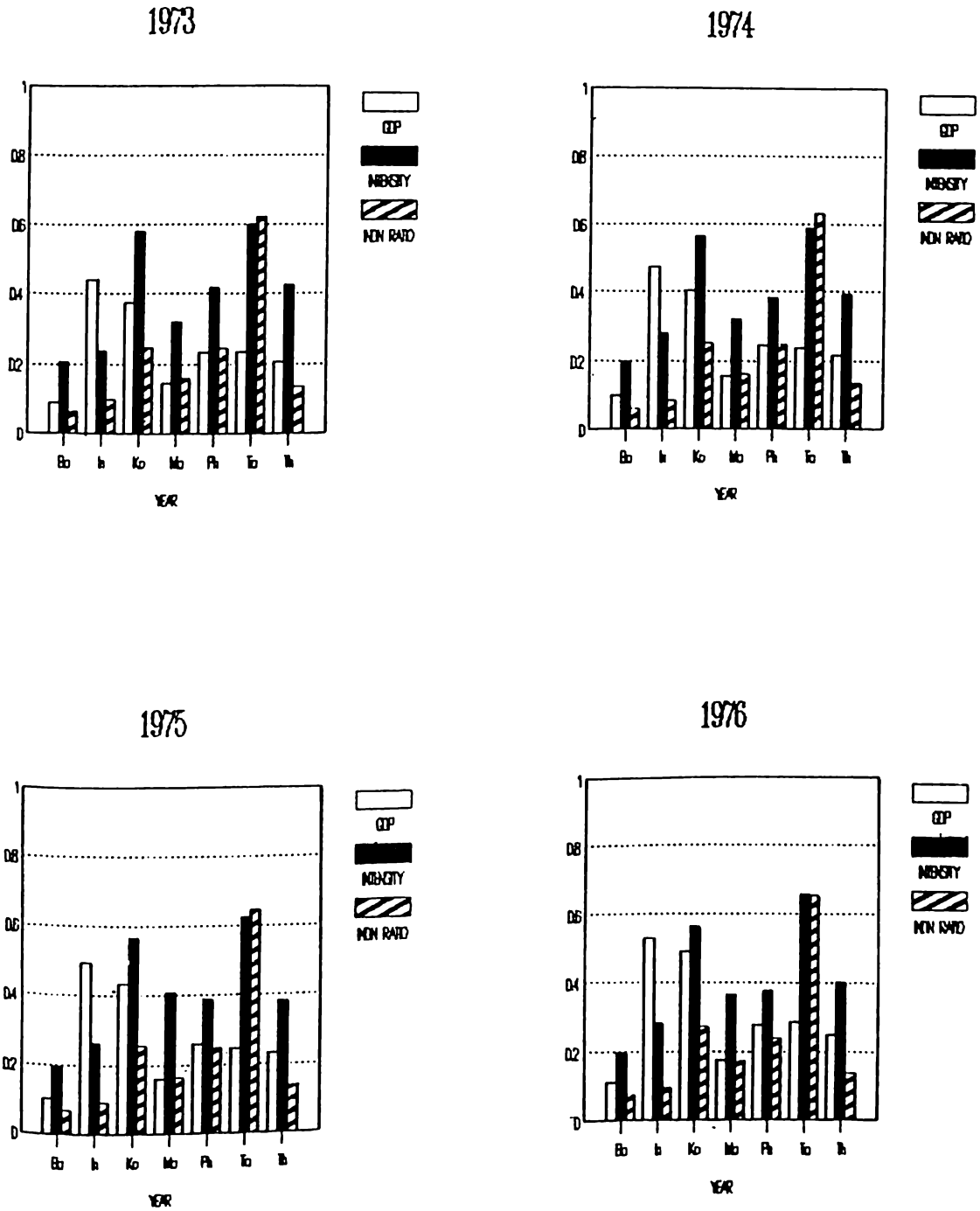
Notes:

GDP - X100 billion US dollars
at 1980 constant price

Intensity - tons of oil equivalent
(toe) per thousand US dollars

Source: Energy Planning Unit, Asian Development Bank (ADB)

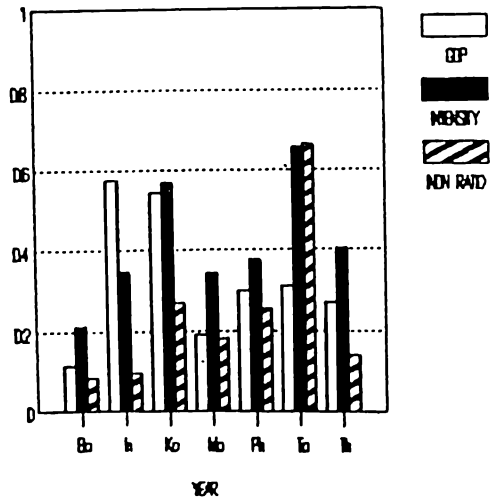
FIGURE 6 (cont.)



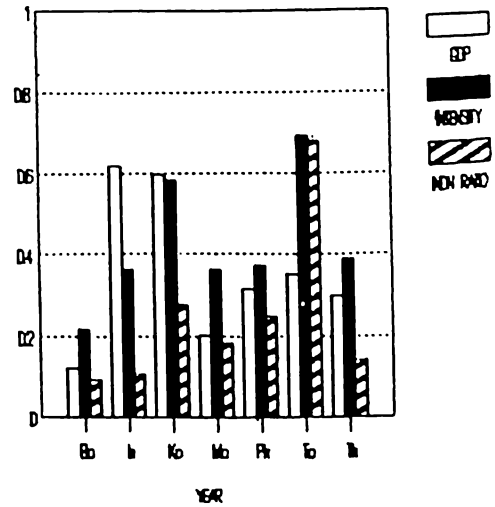
GDP, INTENSITY, INDUSTRIALIZATION RATIO
(by Year)

FIGURE 7

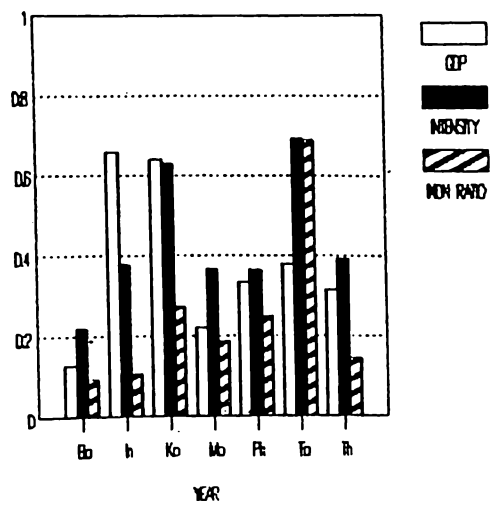
1977



1978



1979



1980

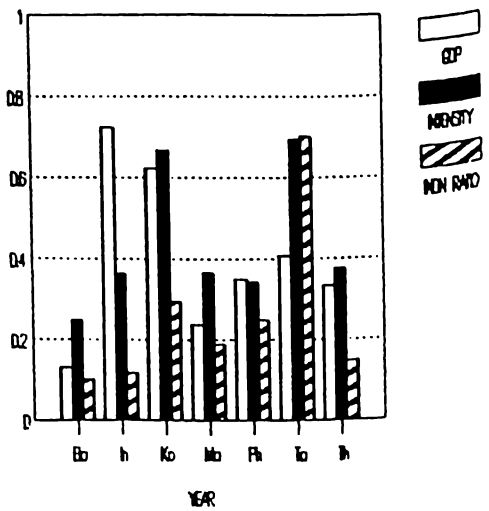
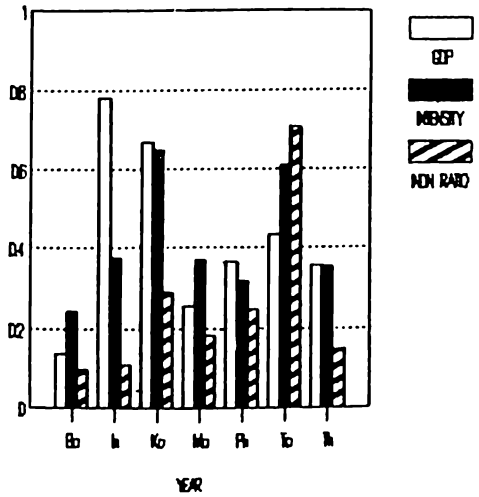
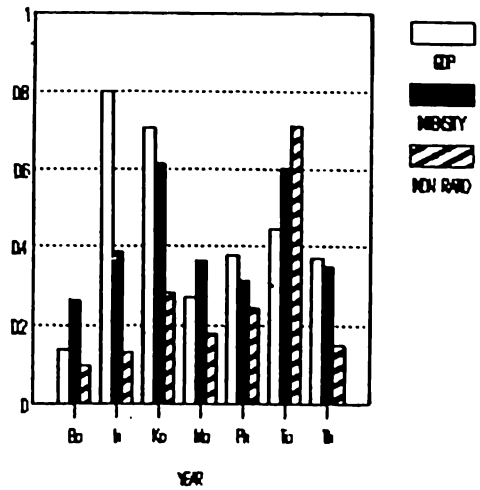


FIGURE 7 (cont.)

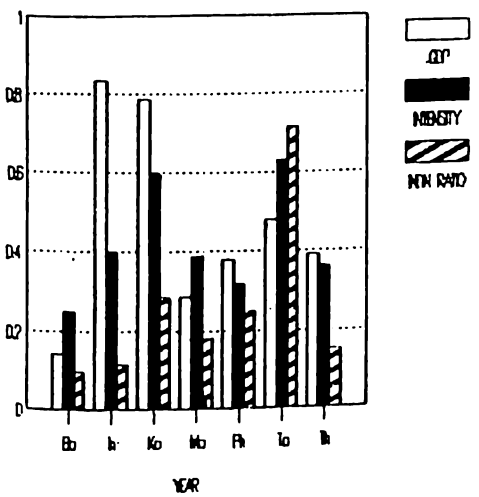
1981



1982



1983



1984

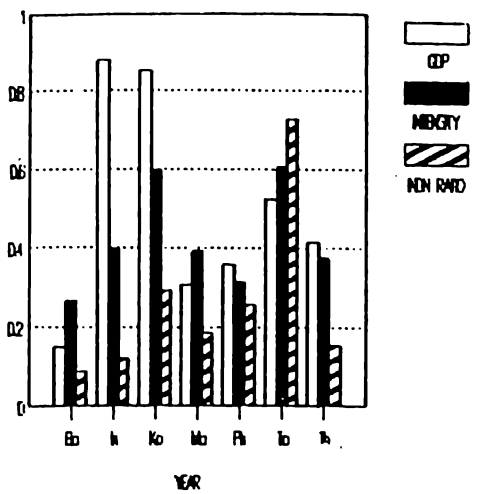
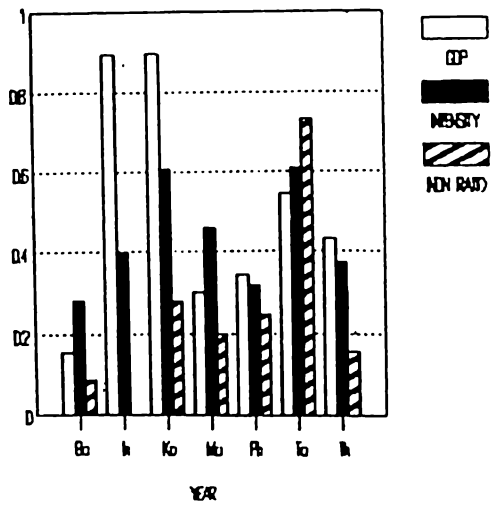


FIGURE 7 (cont.)

1985

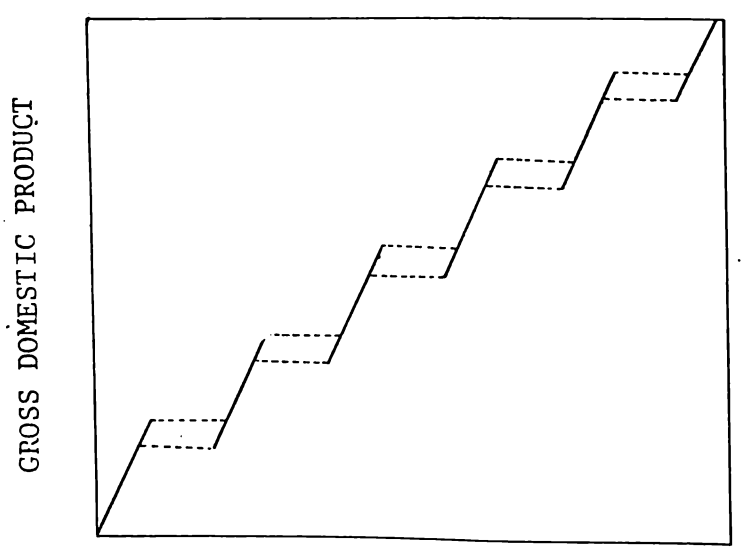


Notes:

Ba - Bangladesh
In - Indonesia
Ko - Korea
Ma - Malaysia
Ph - Philippines
Ta - Taiwan
Th - Thailand

Source: ADB

FIGURE 7 (cont.)



GDP VS. INTENSITY

FIGURE 8