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INPUT-OUTPUT ANALYSES OF PETROLEUM UTILIZATION IN THE PHILIPPINES

By

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Introduction

In this paper, the amount of petroleum consumed by each sector of the Philippine economy for two years (1965 and 1969) will be analyzed in terms of how it was actually utilized in the production cycle to satisfy the final demand sectors.

This approach can yield insights into how the petroleum utilization per sector under an assumed technology can change as a result of changes in the mix of commodities going to final demand. This cannot possibly be inferred from the results obtained in econometric demand analysis. One can also determine the breakdown by sources of the energy embedded in one unit of output going to the final demand sectors. This is possible as the input-output analysis provides us a matrix of coefficients indicating the direct and indirect interrelationships among the sectors of the economy.

In the econometric study of demand, the linkage between sectors are ignored, whereas in the present system, the simultaneous interplay of the major sectors are captured. Thus, it is possible to answer the following question: Of the total energy embedded in a unit of output of sector i going to final demand, how much comes indirectly from the other sectors? The notion of direct and indirect content can be further clarified by an example. Consider the energy used in the production of iron and steel that goes to final demand. Treat this as the direct energy content. Note however that a unit of iron and steel produced requires energy for their production. If one

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sums up the energy attached to other inputs, the indirect energy content is obtained.

For instance, in the United States, it is found that only 35 per cent of total energy supply is consumed directly by its citizens. Most of the energy received by the consumers is embedded in the other products and services they consume.[1]

The Input-Output Framework

According to the input-output system,[2] the output of industry i is allocated according to a fixed proportion a_{ij} to industry j (j = 1, n) and to the final demand sector Y_i. In equation form this can be represented as:

$$(1.1) \quad X_i = \sum_{j=1}^{n} a_{ij}X_{ij} + Y_i$$

where X_i = total output (pesos) of industry i

X_{ij} = output of industry i going to industry j

Y_i = the output of industry i sold to final demand

a_{ij} = units of X_i output needed to produce one unit of X_j output = X_{ij}/X_j

In matrix form (1.1) could be expressed as:

$$(1.2) \quad X = AX + Y$$

where X = vector of sectoral output

Y = vector of final demand

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[1] F. Thomas Sparrow, "Energy Modelling," in R. El Mallkh and Carl McGuire (eds.), *Energy and Development* (Colorado: International Center for Energy and Economic Development, 1974).

[2] Standard references on input-output systems are: H.B. Chenery and P. Clark, *Interindustry Economics*, (New York: Wiley and Sons, Inc., 1959); R. Dorfman, P. Samuelson, and R. Solow, *Linear Programming and Economic Analysis*, (New York: McGraw-Hill Book Co., 1958); P.N. Rosmussen, Studies in Inter-sectoral Relations, (Amarwedam North Holland Publishing Co., 1957).

From (1.2) X can be solved in terms of the final demand Y, thus:

(1.3) $X = (I-A)^{-1} Y$

where I = an identity matrix

A = technology matrix whose elements are the a_{ij}'s

The elements of $(I-A)^{-1}$ can be interpreted as the total number of units (total in the sense that it contains both direct and indirect input) required from industry i by industry j for j to produce one unit good of type j for final demand. The matrix $(I-A)^{-1}$ for the Philippine economy was published for 1965 by the National Economic Council (NEC) and for 1969 by the National Economic and Development Authority (NEDA).

Petroleum in Input-Output Analysis

We can introduce the petroleum term[3] in the following manner. Let:

(1.4) $P = \sum_{k=1}^{n} P_k + P_y$

where P = a scalar representing total petroleum output (BTU)

P_k = petroleum sales (BTU) to sector k

P_y = petroleum sales (BTU) to final demand

From (1.3), we can further define (1.4) as:

(1.5) $P = \sum_k (P_k/X_k) X_k + (P_y/\hat{Y}) \hat{Y}$

$= \sum_{k=1}^{n} \sum_{i=1}^{n} (P_k/X_k) (I-A)^{-1}{}_{ki} Y_i + (P_y/\hat{Y}) \hat{Y}$

[3] Based on the works of P.N. Rosmussen, *Ibid.*, pp. 29-40 and R. Herendeen, "Use of Input-Output Analysis to Determine the Energy Cost of Goods and Services," in M. Macrakis (ed.) Energy: *Conservation, Development and Institutional Problems* (Cambridge: MIT Press, 1974).

where $\hat{Y}$ = petroleum sales (pesos) to final demand, a scalar.

Define $R_k = P_k/X_k$. Then, in matrix form, (1.5) becomes:

$$(1.6) \quad P = R'(I-A)^{-1} Y + (P_y/\hat{Y}) \hat{Y}$$

What would be of interest is the first term in (1.6) $R'(I-A)^{-1}$. The kth element of this vector represents the total petroleum energy (BTU), incorporating both the direct and indirect petroleum energy content needed by sector k to deliver one peso worth of output to final demand.

Empirical Application to Philippine Data

To be able to make the input-output tables for 1965 and 1969 fit the limited petroleum data, each I-O transaction table should be reduced to a 7 X 7 matrix. Fortunately, reduced matrices with these specifications are available from some sources.[4]

The application of the input-output scheme has the following objectives:

a. to determine the pattern of sectoral utilization of petroleum in producing goods for final demand for 1965 and 1969;

b. to compare the 1965 pattern with 1969;

c. to study changes in sectoral petroleum utilization if a 1965 technology should have been used in 1969 production.

To make 1965 and 1969 comparable, the corresponding $(I-A)^{-1}$ matrices were expressed in constant 1967 prices.

Table 1 summarizes sectoral petroleum intensities in the production of final demand goods. It also shows the direct component which is actually the petroleum — output ratio of the sector. The

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[4] The $(I-A)^{-1}$ for 1965 can be found in G. Jurado and J. Encarnación, Jr., "Some Exercises with the National Economic Council Input-Output Tables," in *NEDA Journal of Development*, Vol. I, No. 1, 1974. The 1969 (I-A) is in D. Canlas, J. Encarnacion and T. Ho, *Sectoral Employment, Income Distribution and Consumption: A Macromodel with an Input-Output Structure*, Discussion Paper No. 75-16 (Institute of Economic Development and Research, School of Economics, University of the Philippines, January 1976).

total energy is the sum of direct and indirect components. It seems that the mining and transportation sectors appear to have been more petroleum-intensive in both years.

The increase in total petroleum intensity in 1969 was registered by the agriculture, manufacturing, construction and transportation sectors, with manufacturing garnering the highest increase. This is seen in Table 2. When we consider the direct component alone, all sectors except mining experienced positive changes. The change was more pronounced in the construction sector which increased by 49 per cent, in agriculture by 44 per cent and in services by 52 per cent.

However, in examining the percentage share of direct energy per sector, it seems that goods delivered by the mining and transport and utilities sector in 1965 had more direct energy content than the rest. This is obvious, as normally these goods are produced with very little intermediate inputs coming from the rest of the economy. Also, the agricultural sector produced final demand goods with more petro-

TABLE 1

Sectoral Petroleum Intensities: 1965 and 1969
(BTU/Peso at 1967 Prices)

	1965			1969		
	Energy		Direct/Total	Energy		Direct/Total
Sectors	Direct	Total	%	Direct	Total	%
1. Agriculture	1,472.98	2,706.43	54.42	2,125.09	3,038.02	69.95
2. Mining and Quarrying	18,555.24	21,870.10	84.84	18,285.25	21,788.59	83.92
3. Manufacturing	2,819.96	7,176.27	39.30	3,183.82	8,092.32	39.34
4. Construction	916.43	5,407.30	19.65	1,366.68	5,744.69	23.79
5. Transportation, Communication, Storage and Utilities	47,391.22	51,967.96	91.19	54,857.28	56,237.25	97.55
6. Commerce	548.51	2,930.91	18.71	690.32	2,470.17	27.95
7. Services	211.33	3,119.39	6.77	319.88	2,344.15	13.64

Sources of Basic Data: NEDA, *1969 Input-Output Transaction Tables.*
NEDA, *Statistical Yearbook, 1975.*
Philippine National Oil Commission.

leum energy content than manufacturing. In 1969, the proportion of direct energy considerably changed for almost all the sectors. Mining suffered a slight drop, while the rest, except for manufacturing, registered significant increases.

In general, one can therefore say that, between 1965 and 1969, the major sectors of our economy had utilized more direct energy in the production of goods going to final demand. As regards total petroleum expended per unit of final demand good, the picture is somewhat contrasting. While in some sectors it increased, in others it declined. This can be attributed to changes in the indirect component.

The sectoral source of the indirect energy content of each sector's input in 1965 can be seen in Tables 3 and 4. These tables break down the indirect energy embedded in one unit of output of sector i that goes to final demand.

TABLE 2

Percentage Change in Petroleum Intensities, 1965-1969

Sectors	Direct Component	Total
1. Agriculture	44	12
2. Mining and Quarrying	−1	−0.37
3. Manufacturing	13	13
4. Construction	49	6
5. Transportation, Communication, Storage and Utilities	16	8
6. Commerce	26	−16
7. Services	52	−25

Source of Basic Data: NEDA, *Statistical Yearbook, 1975.*
NEDA, *1969 Input-Output Transaction Tables.*
Philippine National Oil Commission.

For instance in 1965, of the energy content of one unit of agricultural output, only about 59.37 per cent came directly from agriculture, the remaining came from the other sectors with the transportation and utilities sector contributing the biggest value of 27.47 per cent.

The indirect energy from mining went primarily to construction (10.63 per cent) and manufacturing (10.41 per cent). This is expected because the construction sector, as cement and other mineral products are, normally, major inputs in construction.

The outputs of the commerce and services sector drew much indirect energy from the transportation and utility sector.

Manufacturing was another sector from which some sectors drew much of the indirect energy embedded in final output, which implies that manufacturing products are pervasively used. This is true especially for the construction and services sectors.

In 1969, transportation and manufacturing, on the whole, remained to be the major sources of indirect energy. This is shown in Tables 5 and 6.

TABLE 3

Breakdown of Total Petroleum Energy Peso of Final Demand, 1965 (BTU/Pesos at 1967 Prices)

	Users/Sectors						
Sources/Sectors	1	2	3	4	5	6	7
1. Agriculture	1,606.77	123.52	494.73	231.29	105.32	29.18	126.62
2. Mining and Quarrying	60.26	18,808.14	747.00	574.93	147.84	42.53	117.53
3. Manufacturing	270.05	845.08	3,844.78	1,579.67	745.36	198.47	578.29
4. Construction	.57	2.33	2.83	936.41	2.52	12.82	3.29
5. Transportation, Communication, Storage and Utilities	743.43	2,032.62	2,070.75	1,988.40	50,905.24	2,027.24	2,027.18
6. Commerce	20.21	49.30	67.61	78.96	49.48	606.94	39.38
7. Services	5.13	9.11	8.57	17.64	12.20	13.73	327.10
TOTAL ENERGY	2,706.43	21,870.10	7,176.27	5,407.30	57,967.96	2,930.91	3,119.39

TABLE 4

Breakdown of Total Petroleum Energy/Peso of Final Demand, 1965
(Percent)

Sectors	1	2	3	4	5	6	7
1. Agriculture	59.37	.56	6.89	4.28	.20	.99	4.06
2. Mining and Quarrying	2.23	86.00	10.41	10.63	.28	1.45	3.77
3. Manufacturing	9.98	3.86	53.58	29.21	1.43	6.77	18.54
4. Construction	.02	.01	.04	17.32	.004	.44	.11
5. Transportation Communication, Storage and Utilities	27.47	9.29	28.02	36.77	97.96	69.17	64.99
6. Commerce	.75	.27	.94	1.46	.09	20.71	1.26
7. Services	.19	.04	.12	.33	.02	.07	7.28

Sources of Basic Data: Philippine National Oil Commission.
NEDA, *1965 Input-Output Transaction Tables.*

TABLE 5

Breakdown of Total Petroleum Energy/Peso of Final Demand, 1969
(BTU/Peso at 1967 Prices)

	Users/Sectors						
Sources/Sectors	1	2	3	4	5	6	7
1. Agriculture	2,260.18	209.75	867.00	332.54	86.50	37.89	165.89
2. Mining and Quarrying	51.05	18,523.92	705.33	531.43	132.97	31.11	81.58
3. Manufacturing	287.75	846.68	4,181.32	1,539.71	377.40	161.18	.55.96
4. Construction	3.07	13.39	13.94	1,397.17	304.47	17.10	8.44
5. Transportation, Communication, Storage and Utilities	409.10	2,114.91	2,212.26	1,827.99	55,232.70	1,467.96	1,246.21
6. Commerce	27.26	61.46	94.27	92.81	72.70	733.61	46.14
7. Services	4.61	18.28	18.20	23.04	30.51	21.32	339.96
TOTAL ENERGY	3,038.02	21,788.59	8,092.32	5,744.69	56,237.25	2,470.17	2,344.10

Source of Basic Data: Philippine National Oil Commission.
NEDA, *1969 Input-Output Transaction Tables.*

Major changes in the sources and in the proportions of indirect energy utilized by each sector are reflected in Table 7 which shows the percent changes, from 1965 to 1969, of the indirect energy contribution of one sector to another sector. The indirect energy coming from the mining sector declined in all areas, which implies that, in general, the intermediate inputs of this sector to the other also declined. (Note that this sector is a highly energy-intensive sector and yet its indirect energy contribution to the other sectors dropped, which could only imply that the sectoral demand for its output also dropped). Similarly, indirect energy coming from the transportation sector went down in four sectors, namely, agriculture (45 per cent), construction (by 8 per cent), commerce (by 27 per cent) and services (by 38 per cent).

In terms of the total energy used by each sector in producing the total output going to final demand, by how much had direct energy and indirect energy component changed in 1969 relative to 1965? To be able to answer this question, we have to multiply these two components by the total sectoral outputs going to final demand in 1965 at constant prices and deduct these results from corresponding results obtained if we multiply the same components in 1969 by 1969 outputs in constant prices. The results, as summarized in Table 8 show that all sectors, except commerce, registered positive changes in the direct component. In agriculture, the change is in the magnitude of 3.57×10^{12} BTUs. The transportation sector has the highest incremental change of 28×10^{12} BTUs followed by the manufacturing sector with 14×10^{12} BTUs.

In contrast, negative changes occurred for four sectors in the indirect energy component. This was true for agriculture, transportation, commerce and services. It was positive and highest in the manufacturing sector. In fact, it was even more than its direct energy components.

Although the mining sector experienced a decline in energy intensity in 1969 (18,285 BTUs/peso output) compared to 1965 (18,555 BTUs/peso output), in the aggregate, it still obtained positive changes in both direct and indirect components, as it delivered a bigger volume of output in 1969 (268 million pesos) than in 1965 (100 million pesos).

Aggregating these changes in both components across sectors, the total direct energy that went with the total basket of goods received

TABLE 6

Breakdown of Total Petroleum Energy/Peso of Final Demand, 1969
(Percent)

Sectors	1	2	3	4	5	6	7
1. Agriculture	74.40	.96	10.71	5.79	.15	1.53	7.08
2. Mining and Quarrying	1.68	85.02	8.72	9.25	.24	1.26	3.48
3. Manufacturing	9.31	3.88	51.67	26.80	.67	6.52	19.45
4. Construction	.10	.06	.17	24.32	.54	.69	.36
5. Transportation, Communication, Storage and Utilities	13.47	9.71	27.34	31.82	98.21	59.43	53.16
6. Commerce	.897	.28	1.16	1.62	.13	29.70	1.97
7. Services	.15	.08	.22	.40	.05	.91	14.50

Sources of Basic Data: Philippine National Oil Commission.
NEDA, *1969 Input-Output Transaction Tables.*

TABLE 7

Change In Indirect Energy By Sector Between 1965 and 1969
(In Percent)

Sectors	1	2	3	4	5	6	7
1. Agriculture	—	69.81	75.25	43.78	(17.87)*	29.85	31.00
2. Mining and Quarrying	(15.28)	—	(5.58)	(7.56)	(100.58)	(26.85)	(30.59)
3. Manufacturing	4.70	.21	—	(2.53)	(49.37)	(18.79)	(21.15)
4. Construction	4.32	474.68	406.71	—	11,982.15	33.38	156.53
5. Transportation, Communication, Storage and Utilities	(44.97)	4.05	10.02	(8.07)	—	(27.50)	(38.52)
6. Commerce	34.88	24.66	39.43	17.54	46.93	—	17.17
7. Services	(10.14)	100.66	112.37	30.61	150.08	55.28	—

*Figures in parenthesis are negative.

Sources of Basic Data: Philippine National Oil Commission.
NEDA, *1969 Input-Output Tables.*

TABLE 8

Total Change in Direct and Indirect Energy Components Between 1965 and 1969

(10^{12} BTU)

Sectors	Direct	Indirect	Net Change
1. Agriculture	3.573	−.304	2.769
2. Mining and Quarrying	3.042	.607	3.649
3. Manufacturing	13.052	21.602	35.654
4. Construction	1.112	.241	1.353
5. Transportation, Communication, Storage and Utilities	28.066	−2.907	25.165
6. Commerce	−.078	−5.565	−5.643
7. Services	.676	−3.122	−2.446
TOTAL CHANGE	50.443	10.058	60.501

Sources of Data: Philippine National Oil Commission.
NEDA, *Input-Output Transaction Tables, 1969.*
NEDA, *Statistical Yearbook, 1975.*

by final demand between 1965 and 1969 was 50×10^{12} BTUs and for the indirect component, 10 X 12 BTUs. This represented a net change of 60×10^{12} BTUs. In other words, the total energy expended in the economy in 1969 to deliver goods to final demand increased by this magnitude relative to the 1965 energy level.

Technology and Final Demand Effects

In the context of input-output framework, the net change in energy is a composite effect of two factors: (1) change in technology and (2) change in the basket of goods that goes to final demand. These two effects can be shown formally as follows. Let

$$(1.7) \quad \Delta T = R'_{69}(I\text{-}A_{69})^{-1}\, Y_{69} - R'_{65}(I\text{-}A_{65})^{-1}\, Y_{65}$$

where ΔT is a vector of net changes in sectoral energy, $R'(I\text{-}A)^{-1}$ is the vector of total sectoral energy (BTU) per peso of final demand good for a particular year and Y is final demand. Now, define:

$$(1.8) \quad \Delta R' = R'_{69}(I\text{-}A_{69})^{-1} - R_{65}(I\text{-}A_{65})^{-1} \text{ and}$$

$$(1.9) \quad \Delta Y = Y_{69} - Y_{65}$$

Then, (1.7) can be expressed as:

$$(1.10)\quad \Delta T = \Delta R'Y_{65} + R'_{65}(I\text{-}A)^{-1}_{65}\,\Delta Y + \Delta R'\Delta Y$$

In (1.10), the first term in the R.H.S. is the technology effect, the second is the final demand effect and the third is the cross effect.

The decomposition procedure was applied to the sectoral net changes in energy as shown in the previous table. The results are summarized in Table 9. It can be observed that final demand effect is positive for all sectors except commerce. It was more pronounced in the manufacturing sector. Of the total net change of 35.66×10^{12} BTUs, 25.85×10^{12} BTUs, representing about 72.50 per cent could be attributed to change in final demand. Similarly, in the transportation sector, the final demand effect was also high, accounting for 19.05×10^{12} BTUs or 76 per cent of total change. The technology effect was positive for agriculture, manufacturing, construction and transportation. It was negative for the rest. Again, the manufacturing and transportation sectors registered the highest changes. It is 6.50×10^{12} BTUs for manufacturing and 3.08×10^{12} for transportation.

When these changes due to these components are aggregated across sectors, it is easily seen that the final demand effect was predominant. It accounted for 46.80×10^{12} BTUs, comprising 77.35 per cent of total net change in energy. The technology effect was 5.38×10^{12} BTUs or 8.99 per cent of the total and the cross effect (or the joint effect of change in technology and change in final demand) was 6.13×10^{12} BTUs, representing 10.13 per cent of the total.

TABLE 9

Effects of Technology and Final Demand
Between 1965 and 1969
(10^{12} BTUs)

Sectors	$\Delta R'Y_{65}$	$\Delta R'_{65}(I\text{-}A_{65})^{-1}\Delta Y$	$\Delta R'\Delta Y$	ΔT Total
1. Agriculture	1.29	1.31	.17	2.77
2. Mining and Quarrying	.01	3.67	−.014	3.64
3. Manufacturing	6.50	25.85	3.3	35.66
4. Construction	.72	.59	.034	1.35
5. Transportation, Communication, Storage and Utilities	−3.08	19.05	3.03	25.16
6. Commerce	−2.55	−3.67	.0006	−5.64
7. Services	−3.65	1.60	−.398	−2.44
Total	5.38	46.80	6.13	60.50

Let us recapitulate these results. In general, it can be stated that between 1965 and 1969, the energy consumption in the economy had grown and this was primarily due to the corresponding growth in the final demand goods. For some sectors namely, agriculture, manufacturing, construction, and transportation, the energy-intensity in the technology employed increased, but more significantly in the manufacturing and transportation sectors. In contrast, mining, commerce, and services sectors appeared to have experienced a decline.

On the whole, technology and final demand determined the magnitude and pattern of energy utilization in the total economy. Their effects did not necessarily work in the same direction. In some sectors, the technology appeared to have induced a less energy-intensive production and yet it was counteracted by the final demand effect. This was true for the services and mining sectors. In the other sectors, these forces worked in complementary manner.

Let us examine further the role of technology. What could have happened to the energy picture, had the 1965 technology been applied in 1969? This involves the computation of $R'_{65}(I\text{-}A_{69})^{-1}Y_{69}$. The results are summarized in Table 10. It is obvious that the 1965 technology was less energy-intensive. Had it been employed in 1969, total energy expended could have gone down by 12.07×10^{12} BTUs or about 5 per cent of total energy used by the major sectors in 1969. However, its effects vary across sectors. In agriculture, it could have reduced energy utilized by 10.80 in manufacturing, 5.90 per cent in construction and 7.59 per cent in transportation. Contrastingly, it could have increased consumption in mining by .51 per cent, in commerce by 18.58 per cent and in services by 33.06 per cent. It is rather disturbing to note that the biggest consumers of petroleum — manufacturing and transportation sectors — had become more energy-intensive due to technological changes.[5]

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[5] The term technological change here must be interpreted with caution. Probably, it could not be technological change in the strictest sense, considering the very short period of time (1965-1969) within which changes are being compared. An alternative interpretation would be that the effects discussed above could be attributed to industry's reaction to the general lowering of petroleum prices since 1965. It could even be the result of wasteful utilization of energy.

TABLE 10

Comparison Between 1965 and 1969 Technology
(10^{12} BTUs)

Sectors	Energy Due to 1965 Technology	Energy Due to 1969 Technology	Absolute Change	Percentage Change
1. Agriculture	11.86	13.31	1.45	10.89
2. Mining and Quarrying	5.86	5.83	–0.03	–0.51
3. Manufacturing	76.77	86.57	9.80	11.32
4. Construction	12.13	12.89	0.76	5.90
5. Transportation, Communication, Storage and Utilities	74.44	80.55	6.11	4.59
6. Commerce	12.57	10.60	–1.97	–18.58
7. Services	16.30	12.25	–4.05	–33.06

Substitution Between Labor and Energy

It is also interesting to compare the relationship between changes in labor input and changes in petroleum input in 1965 and 1969. This is intended more as a test of the possibility of substitution between labor and petroleum. It is possible that if the petroleum input per unit of output increases, there is a corresponding decrease in labor input.[6] Corollary to this hypothesis about labor-petroleum substitutability is the hypothesis that capital and petroleum are complementary inputs. To test the first hypothesis, we can immediately compare the sectoral labor-output ratios and sectoral petroleum-output ratios for 1965 and 1969. The comparison can be seen in Table 11. It is easily seen in the table that if the index of energy-output ratio increases, the labor-output ratio decreases and vice-versa. This is true for the first six sectors.

This could mean two things: (1) That there was substitution between energy and labor in production; or (2) That substitution was

[6] Bernt, E. and D. Wood, "Technology, Prices and the Derived Demand for Energy," *Review of Economics and Statistics*, Vol. LVII, No. 3, (August 1975).

TABLE 11

Index of Energy: Output and Labor: Output Ratios: 1969
(1965 = 100)

Sectors	Energy: Output Index	Labor: Output Index
1. Agriculture	144.26	88.99
2. Mining and Quarrying	98.54	106.66
3. Manufacturing	112.91	75.51
4. Construction	149.16	76.43
5. Transportation, Communication, Storage and Utilities	115.18	80.91
6. Commerce	125.80	75.33
7. Services	157.42	108.70

Sources of Basic Data: Philippine National Oil Commission
Philippine Labor Statistics, 1975.

absent but it was just that labor became more efficient and energy utilization more inefficient.

At this point, we really do not know which interpretation to take. Indeed, this calls for a more rigorous empirical test.

Input-Output and Forecasting

Forecast of petroleum demand by sector is also feasible in an input-output framework.[7] This can be done with the following assumptions in mind: (1) that technology in the base year (the year for which a I-0 account one is using is prepared, say, 1965) is invariant through time — which means that for the forecast year one assumes that the 1965 technology will be employed; (2) that the composition of the basket of goods that goes to final demand is constant and that this basket of commodities grows at an assumed rate.

[7] See for instance, J. Just, "Impacts of New Energy Technology Using Generalized Input-Output Analysis." M. Macrakis (ed.), *Energy: Demand Conservation and Institutional Problems* (Cambridge: MIT Press, 1974), Chapter 10.

For a certain span of time, say from t_0 to t_{o+n}, these assumptions may hold for predictive purposes when n is small. However, when n is large, this assumption may not be plausible anymore (except when the economy is not growing) because it is inevitable that technology must change or evolve after the lapse of a longer period of time.[8] Assumption 2 can also be faulted on the same score.

Summary and Conclusion

There is a strong indication that some sectors of our economy had been employing energy-intensive technologies. They had also become more petroleum-oriented in 1969. Whether this is still true in the present is another question. Nonetheless, it is possible to interpret this as a general reaction to the declining relative prices of petroleum between 1965 and 1969. If so, then it is more probable that after 1973 when prices skyrocketed, the economy must have started to feel the pangs of the price effect, more intensely perhaps in the initial year. The adjustments may be painstaking, as substantial capital equipments in the economy must have been committed to petroleum as a basic fuel. Therefore, it is not expected that the total consumption of petroleum will drop dramatically. Perhaps, in sectors like commerce and services, where there is wider room for flexibility as these are relatively less capital-intensive sectors, the adjustments may transpire with ease.

It was shown in the above discussion that the final demand sectors could also affect the total level of petroleum consumption. If the demand is towards more petroleum-intensive goods, then total petroleum consumption will surely increase. Otherwise, it will decline. In the long run, the latter state of affairs is inevitable as the producing sectors will pass on to consumers increases in production cost due to higher energy price, in the form of higher prices for goods which are more energy-intensive. This will discourage the purchase of these goods to a substantial degree if the demand is price elastic. Otherwise, it will take a tremendous increase in prices to lower demand.

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[8] Rudyard Istvan, "Inter-Industry Impacts of Alternative Utility Investment Strategies," M. Macrakis (ed.), *Energy: Demand, Conservation and Institutional Problems* (Cambridge: MIT Press, 1974), Chapter 11.