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Indonesia
Selected Issues of Energy Pricing Policies

(In Three Volumes) Volume III: Methodological and Statistical Appendices

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CURRENCY EQUIVALENTS

Before November 15, 1978	US$1.00 = Rp 415
Annual Averages 1979-82	
1979	US$1.00 = Rp 623
1980	US$1.00 = Rp 627
1981	US$1.00 = Rp 632
1982	US$1.00 = Rp 661
After March 30, 1983	US$1.00 = Rp 970

FISCAL YEAR

Government	-	April 1 to March 31
Bank Indonesia	-	April 1 to March 31
State Banks	-	January 1 to December 31

INDONESIA

SELECTED ISSUES OF ENERGY PRICING POLICIES

This report is based on the findings of two missions to Indonesia; one in November 1981 and the second in February 1982. The missions consisted of the following:

William Branson (Consultant, Princeton University/NBER);

Dennis Framholzer (Consultant, Stanford University);

Noriko Iwase (Indonesia Division, East Asia and Pacific Country Programs Department);

Lawrence Lau (Consultant, Stanford University);

Dan Morrow (Indonesia Division, East Asia and Pacific Country Programs Department);

Mark Pitt (Consultant, University of Minnesota); and

Armeane M. Choksi (Chief of Mission; Country Strategy and Trade Policy Division, Country Policy Department).

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INDONESIA

SELECTED ISSUES OF ENERGY PRICING POLICIES

VOLUME III: METHODOLOGICAL AND STATISTICAL APPENDICES

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APPENDIX I

TABLES

Table I.1: ABBREVIATIONS, CONVERSION FACTORS AND ENERGY EQUIVALENTS

Abbreviations and Conversion Factors

bbl	U. S. barrel (1 bbl = 42 U.S. galloons = 0.159 kl)
Btu	British thermal unit; the amount of heat required to raise the temperature of one pound of water one degree Fahrenheit
BOE	Barrel of oil equivalent
cal	calorie
cd	calendar day
cu ft	cubic feet (1 cu ft = 0.02832 cu meter)
cu meter	cubic meter 1 m^3 = 35.31 cu ft)
ft	foot (1 ft = 0.3048 m)
gal	U. S. Gallon (1 gal = 3.785 l = 0.003785 m^3)
Gwh	gigawatthour (1 Gwh thermal = 123 TCE)
in.	inch (1 in. = 0.0254 m)
kcal	kilocalorie (1 kcal = 1,000 cal)
kce	kilogram of coal equivalent
kg	kilogram (1 kg = 1,000 gr = 2.205 lb)
kl	kiloliter (1 kl = 1,000 L = 6.29 bbl)
km	kilometer (1 km = 1,000 m = 0.621 miles)
kw	kilowatt (1 kw = 1,000 watt)
kWh	kilowatt-hour (1 kWh thermal = 3,413 Btu = 0.000123 TCE)
l	liter (1 liter = 0.2642 U.S. gallons = 0.001 m^3)
lb	pound (1 lb = 0.4536 kilograms)
m	1 meter (1 m = 3.28 ft)
mi.	mile (1 mile = 1.609 kilometers)
mt	metric ton (1 mt = 1,000 kg = 2.205 lb)
MW	megawatt (1 MW = 1,000 kw = 1,000,000 watt)
MWe	megawatt electric output
MWth	megawatt thermal output
SCF	one cubic foot of natural gas, measured at 60 ^{0} F and 1 atm..
SD	stream day or operating day for a production process
ST	short ton (1 ST = 907 kg)
tonne	metric ton (1 tonne = 1,000 kg = 2,205 lbs)
TCE	tonne of coal equivalent
TOE	tonne of oil equivalent

Multiples:

M - 10^3, thousand

MM - 10^6, million

G - 10^9, billion

T - 10^{12}, trillion

Table I.2: ENERGY EQUIVALENTS OF FUELS

Fuels	Quantities Approximately Equivalent to 1 TCE in U.S. Units	in Metric Units
Liquid		
Crude Oil	4.79 bbls	0.76 kl
All Refined Products	4.96 bbls	0.79 kl
Kerosene	4.91 bbls	0.78 kl
Ethanol	8.08 bbls	1.28 kl
Methanol	11.87 bbls	1.89 kl
Natural Gas Liquids	6.01 bbls	0.96 kl
Syncrude	4.96 bbls	0.79 kl
Liquefied Natural Gas (LNG)	8.08 bbls	1.28 kl
Liquefied Petroleum Gas (LPG)	6.67 bbls	1.06 kl
Gaseous		
Natural Gas	27,780 SCF	787 cu meter
City Gas	27,780 SCF	787 cu meter
Solid		
Coal (Bukit Asam - Air Laya)	1.23 ST	1.12 tonne
Coal Briquets	1.23 ST	1.12 tonne
Charcoal	1.08 ST	0.98 tonne
Wood and Agricultural Wastes	2.21 ST	2.00 tonne

Table I.3: GENERAL ENERGY EQUIVALENTS

To Convert:	Multiplication Factors											
From \ To	KCE	TCE	Million TCE	BOE	TOE	Joule	Kilo Joule	Terra Joule	Cal	K Cal	Btu	MM Btu
1. KCE	1	10^{-3}	10^{-9}	4.79×10^{-3}	0.684×10^{-3}	0.029×10^{9}	0.029×10^{6}	0.029×10^{-3}	7×10^{6}	7.0×10^{3}	27.78×10^{3}	27.78×10^{-3}
2. TCE	10^{3}	1	10^{-6}	4.79	0.684	0.029×10^{12}	0.029×10^{9}	0.029	7×10^{9}	7.0×10^{6}	27.78×10^{6}	27.78
3 Million TCE	10^{9}	10^{6}	1	4.79×10^{6}	0.684×10^{6}	0.029×10^{18}	0.029×10^{15}	0.029×10^{6}	7×10^{15}	7.0×10^{12}	27.78×10^{12}	27.78×10^{6}
4. BOE	209	0.21	0.21×10^{-6}	1	0.143	0.61×10^{10}	0.61×10^{7}	0.61×10^{-2}	1.46×10^{9}	1.46×10^{6}	5.8×10^{6}	5.8*
5. TOE	1.461	1.46	1.46×10^{-6}	6.99	1	4.28×10^{10}	4.28×10^{7}	4.28×10^{-2}	10.23×10^{9}	10.23×10^{6}	40.59×10^{6}	40.59**
6. Joule	34.5×10^{-9}	34.5×10^{-12}	34.5×10^{-18}	1.64×10^{-10}	0.23×10^{-10}	1	10^{-3}	10^{-12}	0.239	$.239 \times 10^{-3}$	9.478×10^{-4}	9.478×10^{-10}
7. Kilo Joule	34.5×10^{-6}	34.5×10^{-9}	34.5×10^{-15}	1.64×10^{-7}	0.23×10^{-7}	10^{3}	1	10^{-9}	0.239×10^{3}	0.239	0.9478	9.478×10^{-7}
8 Terra	34.5×10^{3}	34.5	34.5×10^{-6}	1.64×10^{2}	0.23×10^{2}	10^{12}	10^{9}	1	0.239×10^{12}	0.239×10^{9}	9.478×10^{8}	947.8
9. Cal	0.142×10^{-6}	0.142×10^{-9}	0.142×10^{-15}	0.68×10^{-9}	0.1×10^{-9}	4.18	4.18×10^{-3}	4.18×10^{-12}	1	10^{-3}	3.968×10^{-3}	3.968×10^{-9}
10. K Cal	0.142×10^{-3}	0.142×10^{-6}	0.142×10^{-12}	0.68×10^{-6}	0.1×10^{-6}	4.18×10^{3}	4.18	4.18×10^{-9}	10^{3}	1	3.968	3.968×10^{-6}
11. Btu	0.036×10^{-3}	0.036×10^{-6}	0.036×10^{-12}	0.17×10^{-6}	0.025×10^{-6}	0.105×10^{4}	1.055	0.105×10^{-8}	0.25×10^{3}	0.25×10^{6}	1	10^{-6}
12. MM Btu	36	0.036	0.036×10^{-6}	0.17	0.025	0.105×10^{10}	0.105×10^{7}	0.105×10^{-2}	0.25×10^{9}	0.25×10^{6}	10^{6}	1

* As adopted by the U. S. Bureau of Mines.

** Assuming a specific gravity of 6.99 bbl/mt.

Table I.4: THREE-DIGIT ISIC CODES

31		
	311	Food Processing
	312	Other Food Products
	313	Beverages
	314	Tobacco
32		
	3211	Spinning and Weaving
	Other 321	Textiles Except 3211
	322	Wearing Apparel
	323	Leather and Leather Substitutes
	324	Leather Footwear
33		
	331	Wood and Wood Products
	332	Wood Furniture
34		
	341	Paper and Paper Products
	342	Printing and Publishing
35		
	351	Basic Chemicals
	352	Other Chemical Products
	355	Rubber
	356	Plastic Wares
36		
	361	Ceramic and Porcelain
	362	Glass and Glass Products
	363	Cement and Cement Products
	364	Structural Clay Products
	369	Other Nonmetallic Metal Products
38		
	381	Fabricated Metal Products
	382	Machinery
	383	Electrical Machinery
	384	Transport Equipment
	385	Measuring and Optical Equipment

Table I.5: FUEL ELASTICITIES
SECTOR: FOOD PROCESSING
NO. OF OBSERVATIONS: 1808

Price / Quantity	Electricity	Gasoline	Fuel Oil	Diesel	Kerosene
Electricity	-1.3388	-.0168	.3813	.6138	.3487
	.1149	.3440	.2030	.1974	.2383
Gasoline	.1088	-2.3020	-.1602	.8987	.9502
	.1558	.4168	.2592	.2442	.2962
Fuel Oil	.6944	.3694	-.8084	.3345	.7517
	.0671	.1840	.1098	.1056	.1284
Diesel	-.1922	3.4725	-.3936	-4.0597	.5228
	.2468	.6739	.4130	.3604	.4745
Kerosene	.1896	.9904	1.1603	.8318	-3.5536
	.1554	.4256	.2561	.2457	.2747

Table I.6: FUEL ELASTICITIES
SECTOR: OTHER FOOD PRODUCTS
NO. OF OBSERVATIONS: 906

Price / Quantity	Electricity	Gasoline	Fuel Oil	Diesel	Kerosene
Electricity	-1.5627	-.1621	.3328	.6217	.2921
	.1429	.4277	.2524	.2454	.2963
Gasoline	.1542	-2.0959	-.0841	.8543	.8999
	.1380	.3894	.2297	.2164	.2625
Fuel Oil	.7542	.4911	-.6528	.4629	.8006
	.0543	.1490	.0887	.0855	.1040
Diesel	-.2692	3.9740	-.5024	-4.5894	.5587
	.2858	.7803	.4782	.4173	.5495
Kerosene	.1854	.9964	1.1886	.8358	-3.5928
	.1574	.4310	.2595	.2489	.2782

Note: In each column of Tables I.5 - Table I.52, the first number represents the elasticity (or cross-price elasticity) and the second number, the standard error; e.g., in Table I.5 the own-price elasticity for electricity is -1.3388 and the standard error is 0.1149.

Table I.7: FUEL ELASTICITIES
SECTOR: BEVERAGES
NO. OF OBSERVATIONS: 93

Quantity \ Price	Electricity	Gasoline	Fuel Oil	Diesel	Kerosene
Electricity	-.9725	.2488	.5222	.6619	.4998
	.0790	.2363	.1395	.1358	.1637
Gasoline	.2413	-1.7932	.0441	.8208	.8584
	.1142	.3057	.1901	.1790	.2172
Fuel Oil	.6078	.1591	-1.0863	.1110	.6867
	.0926	.2540	.1512	.1457	.1772
Diesel	-.3448	4.6458	-.6190	-5.2498	.6289
	.3361	.9177	.5625	.4909	.6463
Kerosene	.1981	.9792	1.1450	.82425	-3.4779
	.1518	.4151	.2498	.2397	.2680

Table I.8: FUEL ELASTICITIES
SECTOR: TOBACCO
NO. OF OBSERVATIONS: 318

Quantity \ Price	Electricity	Gasoline	Fuel Oil	Diesel	Kerosene
Electricity	-.9132	.2939	.5497	.6991	.5288
	.0739	.2211	.1305	.1269	.1532
Gasoline	.3289	-1.5449	.1623	.8183	.8502
	.0965	.2582	.1606	.1512	.1835
Fuel Oil	.5822	.0899	-1.2103	.0149	.6726
	.1057	.2901	.1727	.1664	.2024
Diesel	-.3025	4.2455	-.5524	-4.8611	.5849
	.3063	.8363	.5126	.4473	.5890
Kerosene	.1524	1.0653	1.2590	.8845	-3.9747
	.1772	.4851	.2919	.2801	.3131

Table I.9: FUEL ELASTICITIES
SECTOR: SPINNING & WEAVING
NO. OF OBSERVATIONS: 2130

Price Quantity	Electricity	Gasoline	Fuel Oil	Diesel	Kerosene
Electricity	-.7572 .0567	-.9473 .1789	1.3548 .1207	1.0340 .1225	1.3558 .1184
Gasoline	.9801 .1859	.0402 .5592	-.5852 -.4018	-.9708 -.4068	-.2197 -.3962
Fuel Oil	.3583 .1407	3.4918 .4251	-2.8157 .2690	.1745 .2865	-1.1719 .2969
Diesel	.3903 .2679	7.0368 .8172	-1.9038 .6123	-5.3467 .5317	-.9354 .5774
Kerosene	1.2326 .1638	-.5563 .4999	1.1676 .3581	.7971 .3579	-3.3197 .3139

Table I.10: FUEL ELASTICITIES
SECTOR: TEXTILES
NO. OF OBSERVATIONS: 487

Price Quantity	Electricity	Gasoline	Fuel Oil	Diesel	Kerosene
Electricity	-.9502 .0708	-1.4356 .2233	1.4377 .1507	1.0374 .1527	1.4142 .1478
Gasoline	.9124 .1879	-.0332 .5052	-.5018 .3628	-.8499 .3673	-.1714 .3579
Fuel Oil	.4122 .1222	3.1345 .3693	-2.4766 .2337	.2525 .2489	-.9173 .2580
Diesel	.4227 .3048	7.8761 .9300	-2.1980 .6968	-5.9782 .6051	-1.0961 .6571
Kerosene	1.2395 .1650	-.5626 .5036	1.1942 .3807	.8008 .3605	-3.3391 .3162

Table I.11: FUEL ELASTICITIES
SECTOR: WEARING APPAREL
NO. OF OBSERVATIONS: 144

Price Quantity	Electricity	Gasoline	Fuel Oil	Diesel	Kerosene
Electricity	-.1768	-.2489	1.2448	1.0565	1.2324
	.0368	.1161	.0783	.0794	.0768
Gasoline	.8294	-.1247	-.3633	-.6572	-.0848
	.1416	.4262	.3061	.3099	.3019
Fuel Oil	.2821	4.3795	-3.5486	.0492	-1.7084
	.1838	.5549	.3512	.3740	.3876
Diesel	.4819	9.0301	-2.5109	-6.6847	-1.2610
	.3458	1.0549	.7904	.6861	.7454
Kerosene	1.7435	-.9187	1.6765	1.0954	-4.5430
	.2438	.7440	.5329	.5326	.4871

Table I.12: FUEL ELASTICITIES
SECTOR: LEATHER AND LEATHER SUBSTITUTES
NO. OF OBSERVATIONS: 83

Price Quantity	Electricity	Gasoline	Fuel Oil	Diesel	Kerosene
Electricity	-1.0181	-1.6132	1.4703	1.0408	1.4452
	.0754	.2396	.1617	.1638	.1586
Gasoline	.8628	.0878	-.4263	-.7439	-.1253
	.1531	.4608	.3308	.3349	.3263
Fuel Oil	.4915	2.7515	-2.0765	.3589	-.6121
	.1015	.3066	.1940	.2067	.2142
Diesel	.4029	7.2328	-1.9668	-5.4807	-.9704
	.2758	.8409	.6300	.5472	.5942
Kerosene	1.5228	-.7798	1.4648	.9622	-4.0496
	.2109	.6435	.4609	.4807	.4040

Table I.13: FUEL ELASTICITIES
SECTOR: LEATHER FOOTWEAR
NO. OF OBSERVATIONS: 65

Price Quantity	Electricity	Gasoline	Fuel Oil	Diesel	Kerosene
Electricity	-.9824	-1.5185	1.48527	1.0388	1.4285
	.0732	.2309	.1558	.1579	.1528
Gasoline	.7939	-.1651	-.2740	-.5371	-.0247
	.1268	.3615	.2740	.2774	.2703
Fuel Oil	.3978	3.2187	-2.5594	.2323	-.9798
	.1266	.3827	.2422	.2530	.2673
Diesel	.4223	7.9629	-2.1940	-5.9695	-1.0939
	.3043	.9284	.6956	.6041	.6560
Kerosene	1.4494	-.7293	1.3945	.9.90	-3.8769
	.1995	.6088	.4361	.4359	.3823

Table I.14: FUEL ELASTICITIES
SECTOR: WOOD AND WOOD PRODUCTS
NO. OF OBSERVATIONS: 856

Price Quantity	Electricity	Gasoline	Fuel Oil	Diesel	Kerosene
Electricity	-1.1154	-.0498	.5528	-.4407	.3802
	.4438	.7397	.4582	.6627	.7486
Gasoline	.1234	-1.0133	-.3456	.2220	.8890
	.2528	.3288	.2303	.3082	.3217
Fuel Oil	.7615	.6730	-.2735	.6361	.5628
	.0914	.1238	.0831	.1134	.1199
Diesel	-.0823	1.9458	-.2293	.3913	-2.9676
	.7803	1.0834	.6683	.8016	1.0302
Kerosene	-.5073	-.7666	.1614	.0438	.1172
	.5081	.6349	.4498	.5934	.5604

Table I.15: FUEL ELASTICITIES
SECTOR: WOOD FURNITURE
NO. OF OBSERVATIONS: 113

Price / Quantity	Electricity	Gasoline	Fuel Oil	Diesel	Kerosene
Electricity	-.7392	.2959	.6182	.0868	.5258
	.2374	.3956	.2451	.3544	.4004
Gasoline	.1226	-1.0143	-.3471	.2214	.8894
	.2532	.3293	.2306	.3087	.3222
Fuel Oil	.6002	.4570	-.4565	.3973	.2789
	.1479	.2003	.1344	.1834	.1939
Diesel	-.1038	2.6064	-.3292	.8580	-4.0249
	1.0531	1.4622	.9019	1.0819	1.3904
Kerosene	-.6396	-.9619	.1912	.0451	.3787
	.6313	.7689	.5589	.7373	.6963

Table I.16: FUEL ELASTICITIES
SECTOR: PAPER AND PAPER PRODUCTS
NO. OF OBSERVATIONS: 151

Price / Quantity	Electricity	Gasoline	Fuel Oil	Diesel	Kerosene
Electricity	-.7262	.3571	.1202	.0805	.0098
	.2146	.5056	.4125	.4484	.4098
Gasoline	-.1297	-2.3868	.7571	.4831	.8093
	.2294	.4979	.4212	.4614	.4289
Fuel Oil	.3482	1.0066	-.5073	.4504	.1921
	.1425	.3043	.2278	.2755	.2651
Diesel	-.1269	-.1021	1.0977	-1.7880	.4241
	.5299	.9656	.7947	.8750	.9096
Kerosene	.1073	.0926	.5828	.2474	-1.7076
	.2468	.5827	.4567	.5180	.4417

Table I.17: FUEL ELASTICITIES
SECTOR: PRINTING & PUBLISHING
NO. OF OBSERVATIONS: 462

Quantity \ Price	Electricity	Gasoline	Fuel Oil	Diesel	Kerosene
Electricity	-.3586	.6770	.5758	.5503	.5287
	.0916	.21598	.1761	.1915	.1750
Gasoline	-.0293	-2.0828	.7139	.4843	.7577
	.1922	.4173	.3530	.3867	.3595
Fuel Oil	-.1262	1.1313	-.8502	.0690	-.4243
	.2718	.5812	.4351	.5262	.5063
Diesel	-.3118	-.2761	1.4505	-2.2632	.4811
	.7625	1.3896	1.1436	1.2592	1.3089
Kerosene	.1086	.0941	.5804	.2476	-1.7001
	.2449	.5782	.4532	.5140	.4383

Table I.18: FUEL ELASTICITIES
SECTOR: BASIC CHEMICAL
NO. OF OBSERVATIONS: 138

Quantity \ Price	Electricity	Gasoline	Fuel Oil	Diesel	Kerosene
Electricity	-.7434	-1.3251	.4268	1.0441	.2044
	.1925	.4592	.3463	.3976	.3988
Gasoline	-.3500	-3.0726	.9244	1.6605	.2312
	.2206	.4718	.3630	.4078	.4150
Fuel Oil	.,5219	1.2893	-.8970	.5816	.6789
	.0695	.1678	.1123	.1286	.1353
Diesel	.4474	.7743	1.0831	-2.9131	.1048
	.2839	.6722	.4379	.4761	.5601
Kerosene	.3605	1.1556	1.2244	.6082	-4.1445
	.2698	.6039	.4399	.5153	.4736

Table I.19: FUEL ELASTICITIES
SECTOR: OTHER CHEMICAL PRODUCTS
NO. OF OBSERVATIONS: 393

Price Quantity	Electricity	Gasoline	Fuel Oil	Diesel	Kerosene
Electricity	-.6113 .1348	-.7185 .3214	.5092 .2424	.9400 .2783	.3522 .2792
Gasoline	-.0754 .1529	-2.2691 .3270	.8077 .2515	1.3179 .2826	.3274 .2876
Fuel Oil	.1686 .1208	1.5031 .2918	-1.5597 .1952	.2725 .2236	.4416 .2352
Diesel	.4943 .3835	.9359 .9079	1.3530 .5915	-3.6941 .6430	.0316 .7565
Kerosene	.3504 .2145	.9825 .4800	1.0372 .3497	.5473 .4096	-3.4356 .3765

Table I.20: FUEL ELASTICITIES
SECTOR: RUBBER
NO. OF OBSERVATIONS: 299

Price Quantity	Electricity	Gasoline	Fuel Oil	Diesel	Kerosene
Electricity	-.6652 .1529	-.9216 .3648	.4716 .2751	.9603 .3158	.2934 .3168
Gasoline	-.2959 .2047	-2.8943 .4378	.8966 .3368	1.5697 .3784	.2434 .3851
Fuel Oil	.3315 .0959	1.3906 .2316	-1.2466 .1549	.4139 .1775	.5481 .1867
Diesel	.4488 .2721	.7621 .6442	1.0581 .4197	-2.8134 .4562	.1205 .5368
Kerosene	.3499 .2398	1.0566 .5368	1.1178 .3910	.5701 .4580	-3.7655 .4210

Table I.21: FUEL ELASTICITIES
SECTOR: PLASTIC WARES
NO. OF OBSERVATIONS: 344

Quantity \ Price	Electricity	Gasoline	Fuel Oil	Diesel	Kerosene
Electricity	-.6635	-.9144	.4727	.9594	.2853
	.1525	.3632	.2739	.3144	.3154
Gasoline	-.3632	-3.1180	.9350	1.6849	.2288
	.2247	.4806	.3697	.4154	.4228
Fuel Oil	.4083	1.3471	-1.1040	.4814	.6003
	.0850	.2053	.1373	.1573	.1655
Diesel	.4490	.7983	1.1282	-3.0729	.0830
	.3034	.7181	.4679	.5086	.5984
Kerosene	.3719	1.2231	1.2968	.6371	-4.3801
	.2889	.6465	.4709	.5516	.5070

Table I.22: FUEL ELASTICITIES
SECTOR: CERAMIC AND PORCELAIN
NO. OF OBSERVATIONS: 22

Quantity \ Price	Electricity	Gasoline	Fuel Oil	Diesel	Kerosene
Electricity	-1.7483	1.7002	.8395	-.0312	-.6702
	.2218	.5399	.3467	.3995	.6517
Gasoline	.5438	-1.8670	-.5117	.5084	.7615
	.3072	.5148	.4338	.4597	.6909
Fuel Oil	.7058	-.2258	-.7668	.3789	.8277
	.1515	.2763	.2110	.2105	.3455
Diesel	.4998	1.2304	-.1618	-.4021	.0808
	.1752	.3883	.2951	.2080	.4088
Kerosene	.5776	2.1901	-.0420	-.3447	-2.8399
	.3661	.7187	.5266	.5000	.6926

Table I.23: FUEL ELASTICITIES
SECTOR: GLASS AND GLASS PRODUCTS
NO. OF OBSERVATIONS: 102

Price / Quantity	Electricity	Gasoline	Fuel Oil	Diesel	Kerosene
Electricity	-1.7702	1.7147	.8412	-.0424	-.6909
	.2251	.5479	.3518	.4054	.6614
Gasoline	.5593	-1.9786	-.5913	.5208	.7968
	.3349	.5809	.4729	.5011	.7531
Fuel Oil	.6661	-.4871	-.9190	.2614	.8171
	.1876	.3420	.2612	.2605	.4277
Diesel	.5277	1.2161	-.0957	-.3799	.1328
	.1651	3.659	.2780	.1960	.3852
Kerosene	.5949	2.3678	-.0941	-.4306	-3.0930
	.4070	.7990	.5857	.5559	.7701

Table I.24: FUEL ELASTICITIES
SECTOR: CEMENT AND CEMENT PRODUCTS
NO. OF OBSERVATIONS: 365

Price / Quantity	Electricity	Gasoline	Fuel Oil	Diesel	Kerosene
Electricity	-1.4434	1.5276	.8348	.1339	-.3605
	.1786	.4346	.2791	.3216	.5246
Gasoline	.5366	-1.7339	-.4140	.5046	.7326
	.2767	.4634	.3907	.4140	.6222
Fuel Oil	.7469	-.0349	-.6497	.4726	.8495
	.1272	.2319	.1771	.1766	.2900
Diesel	.1620	2.1222	-1.6133	-.5749	-.9624
	.4701	1.0419	.7917	.5581	1.0969
Kerosene	.6822	2.9468	-.1878	-.6129	-3.7124
	.5140	1.0091	.7397	.7020	.9728

Table I.25: FUEL ELASTICITIES
SECTOR: STRUCTURAL CLAY PRODUCTS
NO. OF OBSERVATIONS: 210

Price / Quantity	Electricity	Gasoline	Fuel Oil	Diesel	Kerosene
Electricity	-2.4921	2.3949	1.0285	-.3538	-1.3681
	.3521	.8570	.5504	.6342	1.0345
Gasoline	.5521	-1.9542	-.5599	.5147	.7814
	.3237	.5421	.4570	.4843	.7279
Fuel Oil	.8208	.2514	-.4680	.6210	.8954
	.0926	.1689	.1290	.1286	.2112
Diesel	.2478	1.5174	-.9019	-.5817	-.4804
	.3045	.6748	.5128	.3614	.7104
Kerosene	.5895	2.3378	-.0822	-.4104	-3.0313
	.3969	.7791	.5711	.5420	.7509

Table 1.26: FUEL ELASTICITIES
SECTOR: OTHER NONMETALLIC METAL PRODUCTS
NO. OF OBSERVATIONS: 93

Price / Quantity	Electricity	Gasoline	Fuel Oil	Diesel	Kerosene
Electricity	-2.9965	3.0805	1.2958	-.5096	-1.8345
	.4600	1.1194	.7189	.8284	1.3513
Gasoline	.5426	-1.8539	-.5022	.5075	.7580
	.3041	.5093	.4294	.4550	.6839
Fuel Oil	.9242	.6245	-.2279	.8190	.9634
	0.488	.0889	.0679	.0677	.1112
Diesel	.1690	1.9247	-1.4209	-.5953	-.8380
	.4211	.9331	.7091	.4998	.9824
Kerosene	.6731	2.8973	-.1815	-.5990	-3.6613
	.5049	.9912	.7266	.6896	.9554

Table I.27: FUEL ELASTICITIES
SECTOR: FABRICATED METAL PRODUCTS
NO. OF OBSERVATIONS: 616

Price Quantity	Electricity	Gasoline	Fuel Oil	Diesel	Kerosene
Electricity	-2.8214	.9196	.4613	.9761	.8649
	.1569	.3265	.2038	.2675	.2866
Gasoline	.2181	-1.3492	-.2028	-.3002	1.3016
	.1806	.3670	.2387	.3176	.3307
Fuel Oil	1.6326	.0739	-.7477	-.0637	.1763
	.1152	.2399	.1420	.1965	.2085
Diesel	1.2988	.8543	-.0260	-1.4636	-1.3779
	.1802	.3849	.2318	.5452	.3533
Kerosene	.3023	.6443	1.0906	1.0295	-3.7509
	.2420	.5011	.306	.4139	.4150

Table I.28: FUEL ELASTICITIES
SECTOR: MACHINERY
NO. OF OBSERVATIONS: 616

Price Quantity	Electricity	Gasoline	Fuel Oil	Diesel	Kerosene
Electricity	-1.8414	.9253	.6299	.9618	.8901
	.1012	.2105	.1313	.1724	.1847
Gasoline	.2109	-1.3721	-.2216	-.3218	1.3242
	.1855	.3771	.2453	.3264	.3399
Fuel Oil	1.8491	-.1611	-.9310	-.3385	-.0291
	.1486	.3094	.1832	.2534	.2689
Diesel	1.4924	.9669	-.0737	-1.5911	-1.6720
	.2131	.4551	.2740	.6445	.4176
Kerosene	.3024	.6464	1.0953	1.0338	-3.7686
	.2434	.5041	.3079	.4164	.4174

Table I.29: FUEL ELASTICITIES
SECTOR: ELECTRICAL MACHINERY
NO. OF OBSERVATIONS: 180

Price Quantity	Electricity	Gasoline	Fuel Oil	Diesel	Kerosene
Electricity	-2.7204 .1510	.9161 .3141	.4753 .1960	.9705 .2573	.8635 .2756
Gasoline	.2506 .1623	-1.2593 .3299	-.1277 .2146	-.2153 .2855	1.2245 .2973
Fuel Oil	1.6392 .1164	.0656 .2422	-.7543 .1434	-.0733 .1984	.1689 .2105
Diesel	1.2913 .1789	.8502 .3820	-.0234 .2300	-1.4577 .5411	-1.3650 .3506
Kerosene	.3204 .2328	.6313 .4821	1.0606 .2944	1.0019 .3982	-3.6345 .3992

Table I.30: FUEL ELASTICITIES
SECTOR: TRANSPORT EQUIPMENT
NO. OF OBSERVATIONS: 261

Price Quantity	Electricity	Gasoline	Fuel Oil	Diesel	Kerosene
Electricity	-2.6009 .1440	.9133 .2995	.4930 .1869	.9652 .2454	.8632 .2629
Gasoline	.2568 .1584	-1.2389 .3220	-.1104 .2094	-.1960 .2787	1.2093 .2902
Fuel Oil	1.6374 .1161	.0679 .2416	-.7525 .1430	-.0707 .1979	.1709 .2100
Diesel	1.5606 .2239	1.0084 .4782	-.0850 .2879	-1.6287 .6773	-1.7644 .4388
Kerosene	.3037 .2532	.6615 .5244	1.1285 .3203	1.0646 .4332	-3.8913 .4343

Table I.31: FUEL ELASTICITIES
SECTOR: MEASURING & OPTICAL EQUIPMENT
NO. OF OBSERVATIONS: 32

Price Quantity	Electricity	Gasoline	Fuel Oil	Diesel	Kerosene
Electricity	-1.7670	.9287	.6452	.9637	.8949
	.0971	.2020	.1261	.1655	.1773
Gasoline	.2040	-1.3950	-.2404	-.3433	1.3479
	.1906	.3875	.2520	.3354	.3492
Fuel Oil	2.2104	-.4305	-1.1282	-.6636	-.2570
	.1953	.4065	.2407	.3329	.3533
Diesel	2.6301	1.6886	-.1759	-2.1029	-3.0395
	.3818	.8154	.4910	1.1549	.7483
Kerosene	.3441	.5805	.8890	.8467	-2.7665
	.1673	.3464	.2116	.2862	.2869

Table I.32: PRICE ELASTICITIES FOR AGGREGATE INPUTS SECTOR 31 SUBSECTORS

	Food Processing	Other Food Products	Beverages	Tobacco
Elasticity (E,E)	-.7053 (.0244)	-.6777 (.0196)	-.7207 (.0349)	-.6899 (.0542)
Elasticity (E,L)	.7053 (.0244)	.6777 (.0196	.7207 (.0349)	.6899 (.0542)
Elasticity (L,E)	.1704 (.0059)	.2160 (.0063)	.1132 (.0055)	.0662 (.0052)
Elasticity (L,L)	-.1704 (.0059)	-.2160 (.0063)	-.1132 (.0055)	-.0662 (.0052)

Table I.33: ELASTICITY OF DEMAND FOR VARIABLE FACTORS - ISIC SECTOR 31 SUBSECTOR

	Food Processing	Other Food Products	Beverages	Tobacco
Elasticity (E,K)	.1927 (.0154)	.2329 (.0158)	.2111 (.0511)	.2041 (.0320)
Elasticity (E,Y)	.3703 (.0.53)	.3422 (.0174)	.2614 (..0557)	.5361 (.0282)
Elasticity (L,K)	.0712 (.0107)	.1290 (.0129)	.0488 (.0489)	-.0342 (.0222)
Elasticity (L,Y)	.3618 (.0105)	.3350 (.0150)	.2500 (.0536)	.5194 (.0152)

Table I.34: ELASTICITY OF TOTAL COST WRT ENERGY PRICE - SECTOR 31 SUBSECTORS

	Food Processing	Other Food Products	Beverages	Tobacco
Elasticity (TO,E)	.0184 (.0003)	.0296 (.0006)	.0136 (.0015)	.0028 (.0003)
Elasticity (TO,1)	.0038	.0032	.0050	.0011
Elasticity (TO,2)	.0019	.0044	.0030	.0008
Elasticity (TO,3)	.0090	.0173	.0037	.0006
Elasticity (TO,4)	.0013	.0010	.0002	.0001
Elasticity (TO,5)	.0024	.0036	.0017	.0002

Table I.35: PRICE ELASTICITIES FOR AGGREGATE INPUTS - SECTOR 32 SUBSECTORS

	Spinning & Weaving	Textiles	Wearing Apparel	Leather & Leather Substitutes	Leather Footwear
Elasticity (E,E)	-.5436 (.0495)	-.5902 (.0396)	-.5768 (.0427)	-.3419 (.0831)	-.5576 (.0468)
Elasticity (E,L)	.5436 (.0495)	.5902 (.0396)	.5768 (.0427)	.3419 (.0831)	.5576 (.04687)
Elasticity (L,E)	.0602 (.0055)	.0841 (.0056)	.0754 (.0056)	.0216 (.0052)	.0658 (.0055)
Elasticity (L,L)	-.0602 (.0055)	-.0841 (.0056)	-.0754 (.0056)	-.0216 (.0052)	-.0658 (.0055)

Table I.36: ELASTICITY OF DEMAND FOR VARIABLE FACTORS - SECTOR 32 SUBSECTORS

	Spinning & Weaving	Textiles	Wearing Apparel	Leather & Leather Substitutes	Leather Footwear
Elasticity (E,K)	.3758 (.0201)	.2288 (.0225)	.2152 (.0280)	.5603 (.0759)	.4472 (.0359)
Elasticity (E,Y)	.8064 (.0363)	.6575 .0508)	.6356 (.0300)	.8270 (.0419)	.6635 (.0249)
Elasticity (L,K)	.2050 (.0084)	.0884 (.0170)	.0653 (.0230)	.2859 (.0701)	.2849 (.0356)
Elasticity (L,Y)	.6209 (.0283)	.5050 (.0481)	.4728 (.0200)	.5291 (.0189)	.4871 (.0138)

Table I.37: ELASTICITY OF TOTAL COST WRT ENERGY PRICE - SECTOR 32 SUBSECTORS

	Spinning & Weaving	Textiles	Wearing Apparel	Leather & Leather Substitutes	Leather Footwear
Elasticity (TC,E)	.0145 (.0019)	.0193 (.0024)	.0147 (.0013)	.0029 (.0010)	.0187 (.0012)
Elasticity (TC,1)	.0089	.0102	.0113	.0013	.0094
Elasticity (TC,2)	.0007	.0015	.0018	.0003	.0031
Elasticity (TC,3)	.0031	.0057	.0014	.0011	.0051
Elasticity (TC,4)	.0007	.0005	.0002	.0001	.0005
Elasticity (TC,5)	.0010	.0014	.0002	.0001	.0006

Table I.38: PRICE ELASTICITIES FOR AGGREGATE INPUTS SECTOR 33 SUBSECTORS

	Wood and Wood Products	Wood Furniture
Elasticity (E,E)	-.4168 (.0440)	-.0742 (.0873)
Elasticity (E,L)	.4168 (.0440)	.0742 (.0873)
Elasticity (L,E)	.0775 (.0082)	.0064 (.0075)
Elasticity (L,L)	-.0775 (.0082)	-.0064 (.0075)

Table I.39: ELASTICITY OF DEMAND FOR VARIABLE FACTORS - SECTOR 33 SUBSECTOR

	Wood and Wood Products	Wood Furniture
Elasticity (E,K)	.2660 (.0291)	.3217 (.0544)
Elasticity (E,Y)	.4305 (.0234)	.5758 (.0556)
Elasticity (L,K)	.1352 (.0181)	.0839 (.0310)
Elasticity (L,Y)	.4234 (.0134)	.5630 (.0405)

Table I.40: ELASTICITY OF TOTAL COST WRT ENERGY PRICE - SECTOR 33 SUBSECTORS

	Wood and Wood Products	Wood Furniture
Elasticity (TC,E)	.0222 (.0005)	.0220 (.0028)
Elasticity (TC,1)	.0015	.0079
Elasticity (TC,2)	.0041	.0039
Elasticity (TC,3)	.0159	.0101
Elasticity (TC,4)	.0004	.0000
Elasticity (TC,5)	.0002	.0001

Table I.41: ELASTICITIES FOR AGGREGATE INPUTS - SECTOR 34 SUBSECTORS

	Paper and Paper Products	Printing & Publishing
Elasticity (E,E)	-.4923 (.0416)	-.3724 (.0656)
Elasticity (E,L)	.4923 (.0416)	.3724 (.0656)
Elasticity (L,E)	.1107 (.0093)	.0491 (.0086)
Elasticity (L,L)	-.1107 (.0093)	-.0491 (.0086)

Table I.42: ELASTICITY OF DEMAND FOR VARIABLE FACTORS - SECTOR 34 SUBSECTORS

	Paper & Paper Products	Printing & Publishing
Elasticity (E,K)	.3543 (.0356)	.4313 (.0396)
Elasticity (E,Y)	.3861 (.0360)	.4426 (.0412)
Elasticity (L,K)	.1592 (.0291)	.1471 (.0226)
Elasticity (L,Y)	.3288 (.0283)	.3591 (.0201)

Table I.43: ELASTICITY OF TOTAL COST WRT ENERGY PRICE - SECTOR 34 SUBSECTOR

	Paper & Paper Products	Printing & Publishing
Elasticity (TC,E)	.0233 (.0010)	.0240 (.0009)
Elasticity (TC,1)	.0041	.0142
Elasticity (TC,2)	.0027	.0040
Elasticity (TC,3)	.0125	.0038
Elasticity (TC,4)	.0025	.0004
Elasticity (TC,5)	.0016	.0016

Table I.44: PRICE ELASTICITIES FOR AGGREGATE INPUTS - SECTOR 35 SUBSECTORS

	Basic Chemicals	Other Chemical Products	Rubber	Plastic Wares
Elasticity (E,E)	-.5747 (.0331)	-.5013 (.0618)	-.5679 (.0288)	-.5749 (.0357)
Elasticity (E,L)	.5747 (.0331)	.5013 (.0618)	.5679 (..0288)	.5749 (.0357)
Elasticity (L,E)	.1637 (.0094)	.0676 (.0083)	.1947 (.0099)	.1487 (.0092)
Elasticity (L,L)	-.1637 (.0094)	-.0676 (.0083)	-.1947 (.0099)	-.1487 (.0092)

Table I.45: ELASTICITY OF DEMAND FOR VARIABLE FACTORS - SECTOR 35 SUBSECTORS

	Basic Chemicals	Other Chemical Products	Rubber	Plastic Wares
Elasticity (E,K)	.2296 (.0316)	.3228 (.0316)	.3350 (.0251)	.2337 (.0238)
Elasticity (E,Y)	.4755 (.0343)	.5328 (.0345)	.4289 (.0243)	.5224 (.0302)
Elasticity (L,K)	.0941 (.0293)	.0994 (.0213)	.2120 (.0212)	.0905 (.0257)
Elasticity (L,Y)	.4078 (.0312)	.4212 (.0212)	.3674 (.0212)	.4509 (.0257)

Table I.46: ELASTICITY OF TOTAL COST WRT ENERGY PRICE - SECTOR 35 SUBSECTORS

	Basic Chemicals	Other Chemical Products	Rubber	Plastic Wares
Elasticity (TO,E)	.0377 (.0019)	.0134 (.0008)	.0141 (.0004)	.0289 (.0010)
Elasticity (TO,1)	.0047	.0039	.0032	.0069
Elasticity (TO,2)	.0030	.0030	.0014	.0022
Elasticity (TO,3)	.0246	.0049	.0069	.0165
Elasticity (TO,4)	.0038	.0003	.0016	.0023
Elasticity (TO,5)	.0016	.0013	.0009	.0009

Table I.47: PRICE ELASTICITIES FOR AGGREGATE INPUTS - SECTOR 36 SUBSECTORS

	Ceramic and Porcelain	Glass & Glass Products	Cement & Cement Products	Structural Clay Products	Other Non-Metallic Metal Products
Elasticity (E,E)	-.6835 (.0407	-.6047 (.0300)	-.6425 (.0342)	-.7616 (.0896)	-.6587 (.0364)
Elasticity (L)	.6835 (.0407)	.6047 (.0300)	.6425 (.0342)	.7616 (.0896)	.6587 (.0364)
Elasticity (E)	.2431 (.0145)	.3333 (.0165)	.2913 (.0155)	.1030 (.0121)	.2727 (.0151)
Elasticity (L,L)	-.2431 (.0145)	-.3333 (.0165)	-.2913 (.0155)	-.1030 (.0121)	-.2727 (.0151)

Table I.48: ELASTICITY OF DEMAND FOR VARIABLE FACTORS - SECTOR 36 SUBSECTORS

	Ceramic and Porcelain	Glass & Glass Products	Cement & Cement Products	Structural Clay Products	Other Non-Metallic Metal Products
Elasticity (E,K)	.2482 (.0551)	.2341 (.0340)	.1321 (.0263)	.1933 (.0819)	.1186 (.0590)
Elasticity (E,Y)	.5519 (.0664)	.4617 (.0778)	.5795 (.0521)	.7487 (.0691)	.6099 (.0485)
Elasticity (L,K)	.1838 (.0517)	.1797 (.0286)	.0740 (.0180)	.0746 (.0680)	.0585 (.0553)
Elasticity (L,Y)	.4039 (.0612)	(.3367) (.0777)	.4460 (.0450)	.4757 (.0418)	.4715 (.0420)

Table I.49: ELASTICITY OF TOTAL COST WRT ENERGY PRICE - SECTOR 36 SUBSECTORS

	Ceramic and Porcelain	Glass & Glass Products	Cement & Cement Products	Structural Clay Products	Other Non-Metallic Metal Products
Elasticity (TO,E)	.0892 (.0085)	.0833 (.0052)	.0799 (.0065)	.0502 (.0157)	.0653 (.0031)
Elasticity (TO,1)	.0156	.0160	.0271	.0022	.0005
Elasticity (TO,2)	.0062	.0047	.0101	.0036	.0060
Elasticity (TO,3)	.0275	.0204	.0386	.0320	.0541
Elasticity (TO,4)	.0322	.0366	.0022	.0082	.0032
Elasticity (TO,5)	.0077	.0056	.0019	.0041	.0017

Table I.50: PRICE ELASTICITIES FOR AGGREGATE INPUTS - SECTOR 38 SUBSECTORS

	Fabricated Metal Products	Machinery	Electrical Machinery	Transport Equipment	Measuring & Optical Equipment
Elasticity (E,E)	-.5127 (.0518)	-.5279 (.0489)	-.5498 (.0446)	-.4939 (.0551)	-.5262 (.0493)
Elasticity (E,L)	.5127 (.0518)	.5279 (.0489)	.5498 (.0446)	.4939 (.0551)	.5262 (.0493)
Elasticity (L,E)	.0572 (.0058)	.0627 (.0058)	.0724 (.0059)	.0514 (.0057)	.0620 (.0058)
Elasticity (L,L)	-.0572 (.0058)	-.0627 (.0058)	-.0724 (.0059)	-.0514 (.0057)	-.0620 (.0058)

Table I.51: ELASTICITY OF DEMAND FOR VARIABLE FACTORS - SECTOR 38 SUBSECTORS

	Fabricated Metal Products	Machinery	Electrical Machinery	Transport Equipment	Measuring & Optical Equipment
Elasticity (E,K)	.3043 (.0279)	.3765 (.0368)	.2311 (.0300)	.3781 (.0984)	.3695 (.0935)
Elasticity (E,Y)	.5478 (.0769)	.6587 (.0748)	.4546 (.0361)	.4616 (.0359)	.4323 (.0454)
Elasticity (L,K)	.1393 (.0163)	.2195 (.0302)	.0862 (.0228)	.2038 (.0960)	.2116 (.0911)
Elasticity (L,Y)	.4370 (.0727)	.5532 (.0707)	.3573 (.0270)	.3444 (.0256)	.3262 (.0382)

Table I.52: ELASTICITY OF TOTAL COST WRT ENERGY PRICE - SECTOR 38 SUBSECTORS

	Fabricated Metal Products	Machinery	Electrical Machinery	Transport Equipment	Measuring & Optical Equipment
Elasticity (TO,E)	.0112 (.0020)	.0206 (.0023)	.0106 (.0013)	.0085 (.0016)	.0129 (.0010)
Elasticity (TO,1)	.0033	.0106	.0031	.0028	.0071
Elasticity (TO,2)	.0016	.0026	.0018	.0016	.0015
Elasticity (TO,3)	.0049	.0057	.0043	.0035	.0019
Elasticity (TO,4)	.0007	.0005	.0006	.0002	.0000
Elasticity (TO,5)					

THE DEMAND FOR ENERGY BY INDONESIAN INDUSTRY: THE MODEL AND ITS ESTIMATION

The theoretical model used in deriving energy demand relationships in this study parallels that of Fuss (1977) and Pindyck (1979). First, it is assumed that the production function is weakly separable in the major kinds of energy inputs. Thus, the cost-minimizing mix of these energy inputs is independent of the mix of other factors - capital, labor and materials. Furthermore, if the energy aggregate is homothetic in its components (electricity, gasoline, fuel oil, diesel and kerosene), cost-minimization becomes a two stage procedure: optimize the mix of fuels which make up the energy aggregate and then optimize the mix of the energy aggregate, labor, capital and materials. Finally, it is assumed that materials are weakly separable from the labor, capital and energy inputs. This assumption is required because the data required to construct a materials price index are not available. These assumptions on the structure of production can be summarized by the following production function:

$$Q = F\left[\left\{K,\ L,\ E\ (E_1,\ E_2,\ E_3,\ E_4,\ E_5)\right\};\ M\right] \tag{1}$$

where K, L, and M are capital labor and materials respectively, and E is the energy aggregate which is a homothetic function of the five fuels.

If factor prices and output levels are exogenously determined and if the stock of capital is fixed in the short run, duality implies that cost-minimization given the production function (1) can be uniquely represented by a short-run cost-function of the form.

$$C = G\ [g\ \{P_L,\ P_E(P_{E_1},\ P_{E_2},\ P_{E_3}, P_{E_4}, P_{E_5}),\ K, Q\};\ M] \tag{2}$$

where P_E is an aggregate price index for energy.

In Fuss (1977) and Pindyck (1979), the price of energy P_E, which is also unit energy cost to the optimizing firm, is represented by an arbitrary unit cost function such as the translog. Estimation of this cost function provides estimates of the elasticities of substitution among alternative fuels as well as their own and cross-price demand elasticities. In addition, estimates of the parameters of the translog aggregate price index can be used to calculate $\hat{P}_E$, an estimate of the price index, up to an arbitrary scaling factor. In the second-stage, the cost of output is represented by a nonhomothetic translog cost function, and $\hat{P}_E$ can be used as an instrumental variable for the price of energy. Estimation of this cost function provides us with estimates of elasticities of substitution and demand elasticities for capital, labor and energy.

The econometric model described above must be altered when the data used in estimation are at the level of the firm, as they are in this study. Estimation of the production structure represented by (1) and (2) in most studies does not permit a positive probability of observing zero levels of input use. In addition standard approaches of estimating systems of share equations derived from cost functions would result in biased and inconsistent estimates because the random disturbances have nonzero means and are correlated with the exogenous variables. Moreover, dropping those firms which do not use at least one of the inputs would reduce the sample size severely and still result in biased estimates.

The model developed here assumes that the homothetic energy aggregator functions are randomly distributed over the population of firms, that is

$$P_E = P_E\,(P_{E_1},\ \ldots,\ P_{E_5},\ u_1,\ \ldots,\ u_5) \qquad (3)$$

where u_i represents a random component which enters the cost function in such a way that optimal cost shares consist of both a deterministic and a random component. The cost function is non-stochastic to each firm since it knows the value of $u = (u_1, \ldots, u_5)$ and, thus, chooses the optimal energy fuel mix. However, from the investigators point of view the random component vector, u, and hence the observed shares, are random drawings from the population of firms.

Among close substitutes, such as alternative energy inputs, cost-minimization may often result in corner solutions, that is, zero levels of use for one or more fuels. Clearly, at least one input will be used. Calling this input j, it is clear that if input i is also used by the firm then the marginal rate of transformation in production between inputs i and j will equal their price ratio at the cost minimizing solution. If input is i not used, the marginal rate of transformation in production may not equal the price ratio. Furthermore, changes in the prices of inputs i or j may not affect the level of its use if it is already unused. The relationship between optimal input shares and prices depends on whether any of the shares are at a corner.

Optimal share levels may be written as

$$s_i = s_i \left\{ p,\ d\ (p,\ u),\ u \right\}, \qquad i = 1,\ 5 \qquad (4)$$

where p is a vector of inputs prices and di is a vector of dummy variables whose jth element has the value 1 if input j is consumed and zero otherwise.

Note that at most all but one elment of d can be zero. In this case, consumption of that one fuel is at the share upper-bound of unity. The elements of the vecor d are, of course, also functions of the vectors p and u. Reduced form equations for optimal inputs levels are

$$s_i = s_i\ (p, u), \qquad i = 1, 5 \tag{5}$$

It is these reduced-form equations which are estimated in the first-stage of the analysis.

Note that because the estimated equations are reduced forms, the coefficients estimated are not those of the underlying cost function. As a result, the usual symmetry restrictions of cost functions are not applicable in estimating these reduced forms. The reduced form will still be characterized by zero homogeneity in prices and adding-up.

In estimating the model (5), we assume that the vector u is additive and has a joint normal distribution with zero means and covariance matrix Σ . In addition, we estimate first-order approximations to the reduced form share equations of the form

$$s_i = \alpha_i + \sum_j \gamma_{ij} \log P_j + u_i, \qquad i = 1, 5 \tag{6}$$

The limited dependent variable model of Tobin (1958) (tobit) provides a likely candidate for estimating equations such as (6) since it permits a positive probability of observing zero input levels. However, because there are a significant number of unit shares, Nelson and Rosett's (1975) two-limit probit extension of Tobin's model is the appropriate estimator. Fully efficient estimation would require a multivariate extension of the two-limit probit model which could also take account of the adding-up restriction. The lack of such a computationally tractable multivariate estimator requires us to estimate the share equations singly. Although the resulting parameter estimates are consistent, there is no guarantee that predicted shares will add-up.

The stochastic model underlying two-limit probit regression is given by the following relationship:

$$Y_t = X_t\ \beta + u_t \quad \text{if} \quad L_1 \leqslant X_t\ \beta + u_t \leqslant L_2$$

$$= L_2 \text{ if } \quad X_t\beta + u_t > L_2$$

$$= L_1 \text{ if } X_t\beta + u_t < L_1 \tag{7}$$

$$t = 1, 2, \ldots, N$$

Where N is the number of observations, Y_t is the dependent variable, X_t is a vector of independent variables, β is a vector of unknown coefficients, L_1 and L_2 are known upper and lower truncation values and u_t is an independently distributed error term assumed to be normally distributed with zero mean and variance σ^2. The expected value of the dependent variable Y_t is nonlinear in X_t and with $L_1 = 0$ and $L_2 = 1$ is given by

$$E(Y) = \sigma zF(z) = \sigma w \{1-F(w)\} + \sigma z + \sigma \{f(z)-f(w)\} \tag{8}$$

where $z = -X\beta/\sigma$, $w = (1-X\beta)/\sigma$ and F( ) and f( ) represent the normal cumulative distribution and unit normal density functions respectively (subscripts have been omitted for simplicity).

In Fuss (1977) and Pindyck (1979), the price index for energy is just the unit translog cost function.

$$\ln P_E = \beta_0 + \sum_i \beta_i \log P_i + 1/2 \sum_i \sum_j \beta_{ij} \log P_i \log P_j \tag{9}$$

and an estimate of the price index $\hat{P}_E$ up to a scalar multiple is obtained by substituting the parameter estimates of the associated share equations into (9). In our case, we cannot identify the parameters of the cost function (9), and thus approximate P_E as proportional to some known index P_E. Deaton and Muellbauer (1980) found that Stone's (1953) index

$$\log \tilde{P}_E = \sum_i S_i \log P_i \tag{10}$$

provided a reasonably close approximation to a translog price index. This is the form of the price index used in the aggregate model as an instrumental variable for the price of energy. The shares S_i used in calculating P are the expected shares E(s) of the reduced form equations (6) calculated as in (8), normalized so that

$$\sum_i E(S_i) = 1.$$

In the second-stage, in which the demand for aggregate inputs is modelled, the cost function given by (2) is represented by a nonhomothetic translog second-order approximation of the form

$$\begin{aligned} \text{Log } C = {} & \alpha_0 + \Sigma\, \alpha_i \log P_i + \Sigma \alpha_k \log F_k + 1/2 \sum_i \sum_j \gamma_{ij} \log P_i \log P_j \\ & + 1/2 \sum_k \sum_m \gamma_{km} \log F_k \log F_m + 1/2 \sum_k \sum_i \gamma_{ki} \log F_k \text{ Log } P_i \qquad (11) \\ & + 1/2 \sum_i \sum_k \gamma_{ik} \log P_i \log F_k \end{aligned}$$

where i, j = E, L; k, m = Q, K, and F_k is the quantity of the kth fixed factor. From Shepards lemma (Diewert (1971)), the variable cost minimizing level of use of the ith variable factor $V_i = \partial C/\partial 0_i$. Therefore, input demand functions in terms of cost shares are given by

$$\partial \log C/\partial \log P_i = \frac{P_i V_i}{C} = S_i$$

or (12)

$$S_i = \alpha_i + \sum_j \gamma_{ij} \log P_j + \sum_k \gamma_{ki} \log F_k$$

Since all aggregate inputs have positive levels of use for all firms, all marginal rates of transformation in production equal their relevant price ratios at the optimal shares. Therefore, the linear structural share equations (12) can be estimated by the usual Zellner efficient continuous dependent variable techniques. Since the two variable input shares must add to 1, only one of them needs to be estimated. In order to identify the parameters α_0, α_k and γ_{km}, the cost function itself (11) must be estimated along with one of the share equations (12).

In order that the cost function and the share equations satisfy the properties of a neoclassical production structure, the following parameter restrictions are required:

$$\sum_i \alpha_i = 1, \ i = E, L \tag{13}$$

$$\sum_j \gamma_{ij} = \sum_i \gamma_{ij} = 0, \ i, j = E, L \tag{14}$$

$$\sum_i \gamma_{ik} = 0, \ i = E, L; \ k = Q, K \tag{15}$$

$$\gamma_{ij} = \gamma_{ji}, \ i, j = E, L \tag{16}$$

$$\gamma_{ik} = \gamma_{ki}, \ i = E, L; = Q, K \tag{17}$$

$$\gamma_{km} = \gamma_{mk}, \ k, m = Q, K \tag{18}$$

In summary, estimation of the complete model is accomplished with the following two-stage procedure:

1. Estimate the set of reduced form share equations (6) by two-limit probit regression, imposing zero homogeneity of prices in each equation. An estimate of an aggregate price index $\tilde{P}_E$ is obtained by using the normalized expected shares as exponential weights in (10).

2. Estimate the cost function (11) along with one share equation (12) by Zellner efficient techniques, replacing P_E by its instrumental variable $\tilde{P}_E$.

From the first-stage estimates we can obtain estimates of the price elasticity of demand, which taking into account the tobit estimator, are calculated as

$$\eta_{ii} = \frac{\gamma_{ii}\left[F(w_i)-F(z_i)\right]}{S_i} + S_i - 1, \; i = 1,5 \tag{19}$$

$$\eta_{ij} = \frac{\gamma_{ij}\left[F(w_i)-F(z_i)\right]}{S_i} + S_j, \; i,j = 1,5 \tag{20}$$

Price elasticities of demand for the aggregate variable factors can be calculated from the parameters of the second stage estimates as:

$$\eta_{ii} = \frac{\gamma_{ii}}{S_i} + S_i - 1, \; i = E,L \tag{21}$$

$$\eta_{ij} = \frac{\gamma_{ij}}{S_i} + S_j, \; i,j = E,L \tag{22}$$

The elasticity of demand for variable factors with respect to change in the quantity of fixd factors can be calculated as:

$$\phi_{i,k} = \alpha_k + \sum_m \gamma_{km} \ln F_m + \sum_i \gamma_{ki} \ln P_i + \gamma_{ki}/S_i \tag{23}$$

$$i = E,\ L;\ k = Q,\ K;\ m = Q,\ K$$

The elasticities of total cost with respect to the price of aggregate energy and each of the five fuels are calculated as:

$$\eta_{TC,E} = (\alpha_E + \sum_j \gamma_{EJ} \log P_j + \sum_k \gamma_{kE} \log F_k) \frac{VC}{TC} \tag{24}$$

and

$$\eta_{TC,i} = S_i \eta_{TC,E}, \; i = 1,5 \qquad (25)$$

where VC/TC is the share of variable costs in total costs.

Calculating standard errors for these elasticities is complicated because the elasticities are nonlinear functions of the estimated parameters. Approximate estimates of the standard errors are obtained by assuming that the shares and [F(w)-F(z)], the probability of nonlimit levels of input use, are constant and equal to their means.

THE DEMAND FOR ENERGY BY HOUSEHOLDS

Expenditure Equations for Household Fuels

Expenditure equations relating household expenditure of each combustible fuel to its price, the level of total household expenditure and a set of household characteristics are given by

$$V_i = \alpha_i + \sum_j \gamma_{ij} \log p_j + \beta_i \log m + \sum_k \theta_{ik} h_k, \quad i = K, F, C \quad j = K, W \qquad (1)$$

where p_j is the price of fuel j, m is total household expenditure, h_k is the kth household characteristic, α_i, γ_{ij}, β_i and θ_{ik} are parameters to be estimated and K, F, C and W refer to kerosene, firewood, charcoal and wood fuel respectively. Furthermore, the parameters γ_{ij}, β_i and θ_{ik} vary as follows:

$$\gamma_{ij} = \gamma^0_{ij} + \gamma^m_{ij} \log (m/s) \qquad (2)$$

$$\beta_i = \beta^0_i + \beta^m_i \log (m/s) \qquad (3)$$

$$\theta_{ik} = \theta^0_{ik} + \theta^m_{ik} \log (m/s) \qquad (4)$$

where s is household size.

Parameter Estimates

The expenditure equations for kerosene, charcoal and firewood were estimated by tobit (Tobin 1958) maximum likelihood techniques. The stochastic model underlying tobit is given by the following relationship:

$$y_t = X_t\beta + u_t \quad \text{if } X_t\beta \geq 0 \qquad (A1)$$
$$= 0 \qquad \text{if } X_t\beta < 0$$

$$t = 1, 2 \ldots N$$

where N is the number of observations, y_t is the dependent variable, X_t is a vector of independent variables, β is a vector of unknown coefficients and u_t is an independently distributed error term with zero mean and variance σ^2.

Table III.1 presents the parameter estimates and their asymptotic standard errors.

Test Statistics

Table III.2 provides test statistics for the null hypothesis that each of the underlying varying parameters (γ_{ij}, β_i, θ_{ik}) of the expenditure equations are zero. The Wald test statistics indicate that all the price parameters γ_{ij} are significantly different from zero at the .05 level. Households are sensitive to both own- and cross-prices in choosing levels of fuel expenditure for all three fuels. The location variables are significant in all cases as well, but one of the two demographic variables is not significantly different from zero in each of the equations.

A likelihood ratio test strongly supports the contention that household demand response to exogenous variables varies with household expenditure per capita. The set of interaction parameters (γ^m_{ij}, β^m_{ij}, θ^m_{ik}) are jointly different from zero at the .05 level in every expenditure equation.

Elasticities

The formula used in calculating the own-and cross- price demand elasticties presented in Table 3 are

$$\varepsilon_{ii} = \frac{[\gamma^0_{ii} + \gamma^m_{ii} \log (m/s)]\ F(z)}{V_i} - 1 \tag{A2}$$

$$\varepsilon_{ij} = \frac{[\gamma^0_{ij} + \gamma^m_{ij} \log (m/s)]\ F(z)}{V_i} \tag{A3}$$

where $F(z_i)$ is the standard normal cumulative distribution evaluated at

$$z_i - \frac{1}{\sigma} (\alpha_i + \sum_j \gamma_{ij} \log p_j + \beta_i \log m + \sum_k \theta_{ik} h_k).$$

Table III.1: PARAMETER ESTIMATES OF THE FUEL EXPENDITURE EQUATIONS
(asymptotic standard errors in parenthesis)

		Kerosene	Charcoal	Firewood
1.	Constant	-1872.0 (1779.4)	-11936.3 (2773.7)	4512.4 (4781.1)
2.	Log household size (s)	-716.58 (307.64)	-1246.6 (4589.6)	1335.7 (827.6)
3.	Log members age > 10 years	-474.86 (279.16)	512.77 (427.24)	-2150.4 (750.4)
4.	Log total expenditure (m)	669.88 (264.66)	2818.7 (409.5)	945.82 (757.50)
5.	Urban	18.082 (210.38)	-948.37 (290.41)	-1181.1 (526.6)
6.	Java	163.66 (173.44)	-223.94 (263.10)	7057.2 (495.3)
7.	Log price of kerosene	-1186.5 (390.40)	-1583.7 (634.8)	-5511.3 (977.0)
8.	Log price of wood fuels	83.875 (188.84)	-259.62 (295.49)	-320.88 (480.02)
9.	Log size * log (m/s)	97.639 (28.792)	15.260 (44.566)	-62.751 (76.64)
10.	Log members * log (m/s)	58.473 (32.320)	-55.599 (48.082)	267.71 (87.78)
11.	Log expenditure * log (m/s)	-52.432 (10.875)	-170.29 (17.60)	-184.35 (33.21)
12.	Urban * log (m/s)	-28.910 (24.143)	83.670 (32.87)	205.01 (60.55)
13.	Java * log (m/s)	5.567 (20.00)	36.262 (29.553)	-803.67 (57.73)
14.	Log price of kerosene * log (m/s)	135.47 (44.94)	161.012 (971.037)	663.77 (112.63)
15.	Log price of wood fuels * log (m/s)	-3.663 (21.80)	37.328 (33.206)	25.417 (55.632)
16.	Sigma	465.13	399.22	1036.02
	Limits	70	4737	2782
	Nonlimits	5810	1143	3098
	Observations	5880	5880	5880

Table III.2: TEST STATISTICS FOR THE FUEL EXPENDITURE EQUATIONS

Coefficients Tested	Expenditure Equation Kerosene	Charcoal	Firewood
Price of Kerosene a/	9.29	18.32	46.22
Price of Wood Fuel a/	14.17	16.07	9.11
Household Expenditure a/	25.69	93.85	61.23
Household Size a/	11.60	13.88	2.94
Household Members a/ aged 11 years and above	5.18	1.88	15.71
Rural a/ 267.22	142.38	299.67	
Java a/ 215.72	30.47	218.13	
All Interaction Parameters b/	94.45	203.59	389.81

a/ The test statistics are Wald tests. The critical values of the Chi-squared distribution with two degrees of freedom are 5.99 and 9.21 at the .05 and .01 levels respectively.

b/ The test statistics are log-likelihood ratios. The critical Chi-squared values with 7 degrees of freedom are 14.07 and 18.48 at the .05 and .01 levels respectively.

In the tobit model, $F(z_i)$ represents the probability of a household consuming a positive quantity of fuel i given z_i.

Approximate standard errors for these price elasticities were calculated by treating V_i and $F(z_i)$ as fixed and equal to their expected values.

Fuel demand elasticities with respect to total household expenditure are calculated as

$$\varepsilon_{im} = \frac{(\beta_i^0 + \beta_i^m \log m = \beta_i^m \log (m/s) + \sum_j \gamma_{ij}^m \log p_j + \sum_k \theta_{ik}^m h_k) F(z)}{V_i} \quad (A4)$$

The elasticity of the kerosene subsidy with respect to its price is calculated as

$$\varepsilon_{K,K} - \frac{P_K}{s_K} \quad (5)$$

where $\varepsilon_{K,K}$ is the kerosene own-price elasticity given by equation (A2) above P_K is the domestic price per liter of kerosene and S_K is the subsidy per liter of kerosene.

THE ESTIMATION OF COMPENSATING VARIATION

In order to evaluate the distribution of welfare among different groups of households in an economy, it is first of all necessary to know each group's utility function. Groups of households may be distinguished by observable attributes, which include the size and composition of the household; age, sex, and education of the head of household; ethnicity; and other attributes that are relevant in the determination of demand patterns.

In order to identify the utility function (up to a monotonic transformation) of each group, it is necessary to have observations of demands corresponding to different levels of prices. Without such variations in prices, the degrees of substitutability among different consumption commodities (or, what amount to the same thing, the curvatures of the indifference surfaces) can be determined only by *a priori* assumptions such as zero or unitary elasticities of substitution. This is the major drawback of most approaches based only on cross-section data. The advantage of the proposed approach, which combines both aggregate time series and individual cross-section data, lies in the fact that the degrees of substitutability are allowed to be determined empirically from the actual data. No *a priori* assumptions are necessary. Consequently, the utility function of each group can be identified to a much greater degree of reliability and correspondence with reality.

Given the knowledge of each group's utility function (up to a monotonic transformation), it is possible to perform compensating variation calculations separately for each group of households. For example, let $V(p/M,A)$ be the indirect utility function of a member of the group of households with a vector of attributes equal to A. Let P_o and M_o be the base period (before the implementation of the policy) vectors of prices and income respectively. Then, the base period utility level of the household is given by $V(P_o/M_o,A) - V_o$. Corresponding to the indirect utility function $V(\cdot)$, there is an expenditure function $M(p, V, A)$ which gives the minimum expenditure required for the household to achieve utility level V at prices p. In the base period, assuming that the household maximizes utility,

$$M(P_o, V_o, A) = M_o.$$

Now suppose that as a result of the implementation of the policy or project, the price vector changes from P_o to P_1 and the income for a household with a vector of attributes equal to A changes from M_o to M_1. Then, in order for this household tomaintain its utility at the same level V_o as before, the minimum expenditure required is given by $M(P_1, V_o, A)$. Then, the compensating variation for this household (relative to the base period) is given by

$$CV = M(P_1, V_o, A) - M_o.$$

However, since the income of the household has also undergone a change in the process, one may define a concept of net compensating variation as

$$
\begin{aligned}
CV^* &= CV - (M_1 - M_o) \\
&= M\,(P_1, V_o, A) - M_o - (M_1 - M_o) \\
&= M\,(P_1, V_o, A) - M_1.
\end{aligned}
$$

The net compensating variation measures the additional expenditure (possibly negative for some groups) that is required to maintain a household with a vector of attributes equal to A at its base period level of utility, taking into account both price and income changes.

It is, therefore, clear that if the net compensating variation for a group is positive, then the group is worse off than before. Since CV* depends on A in addition to P_1, M_1 and V_o, it is group specific, reflecting the differential tastes and needs of each group. Thus, the group-specific compensating variations can be used collectively to assess the distribution of welfare gains and losses across different groups resulting from the implementation of the policy or project. This exercise also identifies those groups of households which are most significantly affected. In addition, it is a theorem in welfare economics that if the sum of the net compensating variations across all households is negative, then it is possible to find a redistribution scheme that every household is either better off or, at least, as well off as during the base period, as a result of the implementation of the policy.

Thus, the distinguishing features of this model of aggregate consumer demand are:

(a) the ability to accept directly full or partial information on the joint distribution of incomes and demographic characteristics;

(b) the ability to identify uniquely the individual household consumer demand functions which depend on prices as well as on income of individual consumer groups distinguished by demographic characteristics;

(c) the ability to recover the utility function of individual consumer groups and, hence, to perform compensating variation calculations;

(d) full consistency between the microeconomic model of individual consumer behavior and the macroeconomic model of aggregate consumer behavior; and

(e) the ability to combine consistently time-series aggregate consumption data and cross-sectional individual household consumption data.

Thus, the group-specific compensating variations can be used to assess the relative distribution of the burdens of any policy change across different groups. In this study, alternate policy changes -- defined by varying (increased) price levels of energy and time-paths for the elimination of subsidies -- will be developed in collaboration with the Government to determine their welfare implications on the households. This exercise will, therefore, identify those consumer groups which are most significantly affected by different policy regimes. It also provides information which may be useful for targeting conservation efforts towards specific consumer groups. However, the computation of group-specific welfare impacts is not the only application of such a model. Since unique group-specific demand functions can be derived from this model, it can also be used to project group-specific consumption patterns in response to change in prices, incomes, quantity constraints, and other Government policies.

Moreover, one can also focus on the quantity of aggregate consumption. In this case, the model can be used to generate a projection of aggregate consumption, given the prices, incomes, and information on the joint distribution of household incomes and attributes. No microeconomic level simulation is required. In addition, the model can directly assimilate information of the changing demographic and income distributions which may indeed be highly relevant for medium- to long-term projections. The impact of different policies can be analyzed both in terms of their direct effects on consumption -- conservation efforts, rationing -- and in terms of their indirect effects through changes in prices and incomes. These policies may be introduced into the model at the regional, as well as the national, level.

The methodolgy can also be extended in other directions. First, it can be adapted to accommodate prices which may vary across different groups of households because of transportation costs, progressivity of the income tax, and other factors. Thus, for example, any policy which has a differential impact on the prices of different regions can be evaluated with this methodology with respect to the distribution of the welfare gains and losses. Second, the methodology can be adapted to take into account the varying "basic needs" across groups of households. This can be done, for example, through the introduction of price-dependent indices of incomes and attributes in the aggregate demand function. Third, the methodology can be extended to include an analysis of household purchase and ownership of durable consumer goods, and the effect of such ownership on the consumption pattern. This can be done, for example, by treating the quantity and type of consumer durables owned as another dimension of the vector of attributes. This approach is currently being followed in a research project, "The Welfare Implications of Eliminating Energy Subsidies in Indonesia" (672-70), which is currently underway and addresses the issues discussed in Chapter 5 in much greater depth and detail.

The Data

The data used in this study are taken from the 1976 SUSENAS survey conducted by the Bureau of Statistics of the Government of Indonesia. The surveys are conducted in three subrounds -- January-April (Subround 1), May-August (Subround 2), and September-December (Subround 3). These data are supplemented with price data also obtained from the Bureau of Statistics.

In each subround approximately 17,000 households were included in the survey. However, many of the households show a zero level of expenditure for one or more the expenditure categories distinguished in our study -- namely, food, clothing, transportation, fuel, housing and miscellaneous. These households, with the exception of those which show a zero level of expenditure for transportation, were dropped from the sample because there does not seem to be a reasonable way to adjust the data. The number of zero observations for each category of expenditures for each province (in Subround 2) is presented in Table IV.1. A total of 7,342 households remain in the sample for further analysis. The other subrounds show similar tendencies. The households included for further anlaysis are distributed as follows:

Subround	Number of Households		
	Urban	Rural	Total
1	4,776	2,565	7,341
2	4,865	2,233	7,098
3	4,720	3,305	8,025

In Table IV.2 the detailed geographical distribution is presented.

In Table IV.3 the average budget shares devoted to each of the six expenditure categories are presented. It is clear that there is a significant seasonal pattern especially with regard to food and clothing expenditures. Food expenditures dominate the average budget, constituting more than 70%. The remaining categories are approximately comparable in magnitude with the exception of transportation. Transportation accounts for such a small share of the average budget -- less than 0.3% -- that consideration should be given to aggregating it with another expenditure category in future analysis.

The Econometric Model

It is assumed that the preferences of each household, distinguished by province, urban or rural location, and size, as measured by the number of members of the household, can be represented by an indirect homogeneous transcendental logarithmic utility function of the form:

$$\ln V = \alpha_0 + \sum_{i=1}^{6} \alpha_i \ln \left(\frac{P_i}{M}\right) + \frac{1}{2} \sum_{i=1}^{6} \sum_{j=1}^{6} \beta_{ij} \ln \left(\frac{P_i}{M}\right) \ln \left(\frac{P_j}{M}\right)$$

Table IV.1: NUMBER OF HOUSEHOLDS WITH ZERO EXPENDITURES IN EACH BUDGET CATEGORY

Province	Food	Clothing	Transportation	Fuel	Housing	Miscellaneous	Total Number Observations in Province
Jakarta	0	2063	2674	19	145	2	3228
Jawa Barat	0	853	1622	3	355	19	1665
Jawa Tenga	0	1168	2094	3	684	16	2148
Yogjakarta	0	405	799	0	269	5	837
Jawa Timur	0	1068	2070	5	364	30	2158
D.I. Aceh	0	173	534	6	113	1	547
Sumatera Utara	1	379	800	45	149	10	815
Riau	0	140	302	4	86	1	319
Jambi	0	138	327	1	44	0	340
Sumatera Barat	0	225	474	3	113	2	479
Sumatera Selatan	0	161	331	15	62	8	334
Bengkulu	0	47	166	0	30	2	178
Lampung	0	104	287	0	4	1	288
Kalimantan Barat	0	136	336	3	120	1	340
Kalimantan Tengah	0	100	380	0	32	1	381
Kalimantan Selatan	0	108	416	5	39	2	420
Kalimantan Timur	0	118	251	2	33	0	252
Bali	0	79	198	0	91	0	199
Sulawesi Utara	0	117	273	2	62	2	295
Sulawesi Tengah	0	129	269	5	48	4	278
Sulawesi Selatan	0	291	651	2	110	10	659
Sulawesi Tenggara	0	112	234	4	30	7	234
Nusa Tenggara Barat	0	137	300	1	95	3	300
Nusa Tenggara Timur	0	173	369	3	110	4	376
Maluku	0	78	240	2	55	0	246
TOTAL	1	8,502	16,397	133	3,243	131	17,316

Table IV.2: GEOGRAPHICAL DISTRIBUTION OF SAMPLE HOUSEHOLDS

Province	Subround (1)	Subround (2)	Subround (3)
Jakarta	1,126	1,026	1,462
Jawa Barat	664	800	728
Jawa Tenga	714	713	564
Yogjakarta	303	374	308
Jawa Timur	953	882	944
D.I. Aceh	306	295	400
Sumatera Utara	363	401	416
Riau	134	120	150
Jambi	172	119	139
Sumatera Barat	200	216	279
Sumatera Selatan	153	143	192
Bengkulu	110	113	80
Lampung	182	115	172
Kalimantan Barat	123	135	166
Kalimantan Tengah	254	201	281
Kalimantan Selatan	288	272	298
Kalimantan Timur	121	102	131
Bali	74	48	87
Sulawesi Utara	157	144	183
Sulawesi Tengah	139	92	132
Sulawesi Selatan	328	344	470
Sulawesi Tenggara	109	112	121
Nusa Tenggara Barat	111	102	172
Nusa Tenggara Timur	128	141	66
Maluku	129	88	82
TOTAL	7,341	7,098	8,025

Table IV.3: AVERAGE BUDGET SHARES
(Percent)

	Subround (1)	Subround (2)	Subround (3)
Food	72.1	72.3	70.9
Clothing	7.4	8.3	13.6
Transportation	0.3	0.2	0.2
Fuel	4.3	4.5	4.2
Housing	6.5	6.7	7.0
Miscellaneous	9.3	8.0	4.1
TOTAL	100.0	100.0	100.0

$$+ \sum_{i=1}^{6} \gamma_i \ln \left(\frac{P_i}{M}\right) D_u$$

$$+ \sum_{i=1}^{6} \sum_{j=1}^{26} \delta_{ij} \ln \left(\frac{P_i}{M}\right) D_j$$

$$+ \sum_{i=1}^{6} \varepsilon_i \ln \left(\frac{P_i}{M}\right) N$$

where P_i is the price of the ith commodity, i=1, ...,6 (food, clothing, transportation, fuel, housing and miscellaneous), M is the total expenditure, D_u is the dummy variable for urban location (urban = 1), D_j is the provincial dummy variable, j=1,...,26 (province 13, however, is not represented in the sample), N is the number of members in the household,

$$\sum_{i=1}^{6} \alpha_i = -1; \quad \beta_{ij} = \beta_{ji}, \quad i, j; \quad \sum_{j=1}^{6} \beta_{ij} = 0, \ i=1,\ldots,6; \quad \sum_{i=1}^{6} \lambda_i = 0;$$

$$\sum_{i=1}^{6} \gamma_{ij} = 0, \quad j; \quad \sum_{i=1}^{6} \varepsilon_i = 0.$$

$$- \frac{P_i X_i}{M} = \alpha_i + \sum_{j=1}^{6} \beta_{ij} \ln P_j + \lambda_i D_u + \sum_{j=1}^{26} \sigma_{ij} D_u + \varepsilon_i N, \qquad i=1,\ldots,6.$$

Note that there are linear restrictions on the parameters, both within each equation and across the equations. These restrictions are imposed in the estimation.

The system of equations (3.2) is estimated with the individual household data for each round separately. The data are then pooled together, and a system of equations with subround effects is estimated from the pooled data. The subround effects take the form of additional dummy variables.

The system of demand equations have many parameters because of the presence of all the provincial dummy variables. The large number of parameters does not create any degree of freedom problem because of the large sample. However, it is still desirable to be able to simplify the model if possible. Thus a series of statistical hypotheses were tested with the data with regard to the provincial dummy variables.

The first hypothesis tested is that the parameters corresponding to all the provincial dummy variables are zeroes. This hypothesis is strongly rejected. The second hypothesis tested is that the parameters corresponding to the provincial dummy variables of all provinces within the same island are identical. This hypothesis is also strongly rejected with the exception of two provinces -- Nusatenggara Barat and Timur — whose parameters for the provincial dummy variables are not statistically significantly different. Further explorations of identical parameters within smaller groups on the same island have been made. However, the overall conclusion of these explorations is that the provinces are sufficiently different, even on the same island, that it is better to let each province have its own individual set of parameters corresponding to its dummy variable.

The parameter estimates are presented together with the associated t-ratios in Table IV.4. 1/ It is clear that the estimates are highly statistically significant by any ordinary standards. Thus, a great deal of confidence can be placed on the parameter values.

1/ The parameters corresponding to the provincial dummy variables are ommitted.

Table IV.4: EQUATIONS 1/

	Food	Clothing	Transportation	Fuel	Housing
Urban Dummy	0.083 (40.363)	0.000 (0.137)	-0.002 (-6.708)	-0.014 (-22.716)	-0.337 (-24.047)
Number of Members	0.001 (3.362)	-0.002 (-7.563)	0.0003 (8.336)	-0.002 (-21.68))	-0.002 (-10.271)
Price of Food	0.016 (8.695)	-0.008 (-6.152)	0.006 (17.350)	-0.013 (-22.360)	-0.001 (-2.018)
Price of Clothing	-0.008 (-6.152)	0.011 (6.760)	-0.000 (-0.175)	-0.006 (-12.143)	-0.001 (-2.192)
Price of Transportation	0.006 (17.350)	-0.000 (-0.175)	-0.008 (-18.816)	0.002 (8.024)	0.000 (0.579)
Price of Fuel	-0.013 (-22.104)	-0.006 (-12.143)	0.002 (8.024)	0.021 (41.247)	-0.002 (-8.242)
Price of Housing	-0.001 (-2.018)	-0.001 -2.192)	0.000 (0.579)	-0.002 (-8.242)	0.001 (1.826)
Price of Miscellaneous	0.000 (.)	0.004 (.)	0.000 (.)	-0.002 (.)	0.003 (.)
Subround 1	0.000 (0.107)	0.007 (3.528)	0.000 (0.747)	0.001 (1.291)	0.003 (2.581)
Subround 2	-0.006 (-3.902)	0.060 (32.600)	-0.000 (-0.978)	0.000 (0.455)	0.001 (0.797)

1/ The parameter estimates of the "Miscellaneous" equation can be obtained by adding up the five equations and subtracting unity.

A MACROECONOMIC MODEL

Introduction

In this section we set out the model for analyzing the effect of the energy price increase. The analytical point of the exercise is to see how the energy price increase is passed on to the price of output, both directly and through effects on wages. We also want to be able to see how the answers are influenced by the existence of differences in energy use across sectors and by differences in factor shares of output. Finally, the parameters of the model should be interpretable using the Indonesian data.

The simplest model structure that meets our needs is the following. The agricultural sector supplies food at a constant price which will initially be assumed to be insensitive to the energy price. This assumption will be relaxed to see its effect. There is an industrial sector using labor L, energy E, and capital K in a Cobb-Douglas production function to produce output Q. Capital is fixed; energy and labor are variable inputs. Energy is supplied elastically by the government at a fixed price P_E. Labor is supplied to the industrial sector elastically at a given real wage. The private sector consumes food, industrial output, and energy. Their prices make up the CPI, which is the real-wage deflator. The nominal demand for the output of the industrial sector is fixed by the money supply. This makes the price elasticity of demand -1.

We will lay out the model and its solution, and then see how the reaction of the price of output is sensitive to (a) whether the agriculture price is stabilized and (b) the high share of capital in manufacturing.

The Demand Side

Since the focus is on supply relationships, we strip demand down to one equation. Assume constant velocity in the modern and industrial sector, so that

$$M = kP_Q Q,$$

where Q is industrial output, and P_Q is its price. Then changes in demand are specified by

$$\hat{P}_Q + \hat{Q} = \hat{M} , \qquad (1)$$

where a ^ means percentage change: $\hat{M} \equiv dM/M$.

The Supply Side

Initially, we take the price of agricultural output P_A as given, and the energy price P_E as fixed by the Government. The real wage in terms of the CPI is also fixed by the assumption that labor can be drawn from the agricultural sector at that wage. This means that movements in the nominal wage follow the CPI, which is a weighted average of P_A, P_E, and P_Q:

$$\hat{W} = \gamma_A \hat{P}_A + \gamma_E \hat{P}_E + \gamma_Q \hat{P}_Q, \qquad (2)$$

where γ_i is the share of sector i in the CPI.

The object is to see how the industrial sector's price and output, and demands for labor and energy input, react to an exogenous increase in P_E. The production function is assumed to be Cobb-Douglas in the inputs labor L, energy E, and capital K. The results here are not particularly sensitive to the form of the production function, so it is best to keep things simple. Thus Q output is given by

$$Q = Q(L,E,K) = L^{\alpha_1} E^{\alpha_2} K^{\beta}. \quad (\alpha_1 + \alpha_2 + \beta = 1).$$

With capital fixed, the first-order conditions for variable L and E are given by

$$MPL = \alpha_1 L^{\alpha_1 - 1} E^{\alpha_2} K^{\beta} = W/P_Q;$$

$$MPE = \alpha_2 L^{\alpha_1} E^{\alpha - 1} K^{\beta} = P_E/P_Q.$$

These can be totally differentiated to obtain thê solution for changes in L and E inputs as the prices vary. Remember that W will be replaced by the real wage expresion (2.2). The total differentials are

$$(\alpha_1 - 1)\hat{L} + \alpha_2 \hat{E} = (\gamma_Q - 1)\hat{P}_Q + \gamma_A \hat{P}_A + \gamma_E \hat{P}_E; \qquad \text{(MPL)} \qquad (3)$$

$$\alpha_1 \hat{L} + (\alpha_2 - 1)\hat{E} = -\hat{P}_Q + \hat{P}_E. \qquad \text{(MPE)}$$

The solution for $\hat{L}$ and $\hat{E}$ can be obtained by substitution. In matrix form equation (3) can be written as

$$\overset{A}{\begin{bmatrix} \alpha_1^{-1} & \alpha_2 \\ \alpha_1 & \alpha_{2-1} \end{bmatrix}} \begin{matrix} \hat{L} \\ \hat{E} \end{matrix} = \begin{bmatrix} \gamma_Q^{-1} & \gamma_E & \gamma_A \\ -1 & 1 & 0 \end{bmatrix} \begin{matrix} \hat{P}_Q \\ \hat{P}_E \\ \hat{P}_A \end{matrix} \qquad (3')$$

The determinant of the coefficient martix A is $1- \alpha_1 - \alpha_2 = \beta$. The solution for L, E can be written as

$$\begin{matrix} \hat{L} \\ \hat{E} \end{matrix} = \frac{1}{\beta} \begin{bmatrix} \alpha_2 -1 & -\alpha_2 \\ -\alpha_1 & \alpha_1 -1 \end{bmatrix} \begin{bmatrix} \gamma_Q -1 & \gamma_E & \gamma_A \\ -1 & 1 & 0 \end{bmatrix} \begin{matrix} \hat{P}_Q \\ \hat{P}_E \\ \hat{P}_A \end{matrix} \qquad (3'')$$

the separate solutions for $\hat{L}$ and $\hat{E}$ as all three prices vary are now

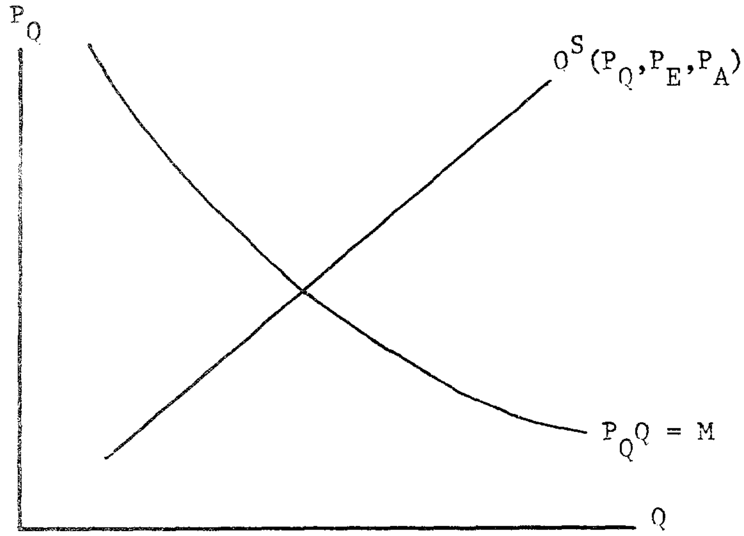
$$\hat{L} = \frac{1}{\beta} \left\{ [(\gamma_Q -1)(\alpha_2 -1) + \alpha_2]\hat{P}_Q - [\alpha_2 + \gamma_E(1-\alpha_2)]\hat{P}_E - \gamma_A(1-\alpha_2)\hat{P}_A \right\}; \qquad (4)$$

$$\hat{E} = \frac{1}{\beta} \left\{ (1-\alpha_1\gamma_Q)\hat{P}_Q - [1-\alpha_1 + \alpha_1\gamma_E]\hat{P}_E - \alpha_1\gamma_A\hat{P}_A \right\}. \qquad (5)$$

An increase in P_Q raises both inputs and output Q. An increase in P_E or P_A reduces both inputs and the output. Thus we can draw the supply cruve in Figure 1. An increase in P_Q raises output Q along the supply curve. An increase in P_A or P_E shifts it up.

The supply curve in Figure 1, along with the demand curve of equation (1) give equilibrium P_Q and Q for given P_A and P_E. An increase in P_E shifts the supply curve up, raising P_Q and reducing Q. With P_A fixed the CPI will go up by $\gamma_E \hat{P}_E + \gamma_Q \hat{P}_Q$. The central question is: What is the magnitude of the P_Q reaction?

Figure 1: INDUSTRY DEMAND AND SUPPLY



Explicit Solution for Price and Output

The change in Q resulting from changes in prices can be obtained by total differentiation of the production function for Q as $\hat{L}$ and $\hat{E}$ change, and substitution for L and E from (4) and (5). Thus, $\hat{Q} = \alpha_1\hat{L} + \alpha_2\hat{E}$ from the production function and substitution from (4) and (5) gives the explicit supply curve.

$$\hat{Q} = \underbrace{\frac{1}{\beta}\left[\alpha_1(1-\gamma_Q) + \alpha_2\right]}_{s_Q}\hat{P}_Q - (\alpha_2 + \alpha_1\gamma_E)\hat{P}_E - \alpha_1\gamma_A\hat{P}_A \tag{6}$$

The coeffecient of $\hat{P}_Q$ is the positive supply elasticity of Q, denoted by s_Q. Note that in the supply-demand diagram of Figure 1, an increase in $s_Q = \frac{1}{\beta}[\alpha_1(1-\gamma_Q) + \alpha_2]$ flattens the supply curve. It will be useful in the discussion below to remember that an increase in α_1/β, the ratio of labor share to capital share in the industrial sector, increases s_Q and flattens the supply curve.

We can now combine the demand curve in (1) and the supply curve in (6) to obtain solutions for $\hat{P}_Q$ and $\hat{Q}$. Again, this can be done by substitution or in matrix form. Using the s_Q notation, (1) and (6) can be combined in matrix form:

$$\begin{bmatrix} 1 & -s_Q \\ 1 & 1 \end{bmatrix} \begin{matrix} \hat{Q} \\ \hat{P}_Q \end{matrix} = \overbrace{\begin{bmatrix} 0 & -\frac{1}{\beta}(\alpha_2+\alpha_1\gamma_E) & -\frac{1}{\beta}\alpha_1\gamma_A \\ 1 & 0 & 0 \end{bmatrix}}^{B_{ij}} \begin{matrix} \hat{M} \\ \hat{P}_E \\ \hat{P}_A \end{matrix} . \qquad \begin{matrix} (6') \\ (1') \end{matrix}$$

The solution is

$$\begin{bmatrix}\hat{Q} \\ \hat{P}_Q\end{bmatrix} = \frac{1}{1+s_Q}\begin{bmatrix}1 & s_Q \\ -1 & 1\end{bmatrix}\begin{bmatrix}B_{ij}\end{bmatrix}\begin{bmatrix}\hat{M} \\ \hat{P}_E \\ \hat{P}_A\end{bmatrix}.$$

The solution for $\hat{P}_Q$ can be written out as

$$\hat{P}_Q = \frac{1}{1+s_Q}\left[[\hat{M} + \frac{1}{\beta}(\alpha_2 + \alpha_2\gamma_1)\hat{P}_E + \frac{1}{\beta}\alpha_1\gamma_A\hat{P}_A\right] \tag{7}$$

From the demand curve (1), movement in output is given by

$$\hat{Q} = \hat{M} - \hat{P}. \tag{8}$$

With equation (7), we are now in a position to estimate the effects of an increase in energy prices, represented by P_E, on industrial prices P_Q and the CPI. The ratio of output price increase to energy price increase from (7) is given by

$$\hat{P}_Q/\hat{P}_E = \frac{\alpha_2 + \alpha_1\gamma_E}{\alpha_2 + (1-\gamma_Q)\,\alpha_1 + \beta}. \tag{9}$$

Remember the definition of S_Q in (6) in trying to go from (7) to (9).

The numerator of (9) is the direct effect of an increase in energy prices on costs in industry. α_2 is the energy share and $\gamma_E\alpha_1$ gives the increase in labor costs through wages. The denominator is a multiplier. A large share of Q in the CPI raises the multiplier because wages rise in the Q sector. A large capital share β reduces the multiplier because profits are not assumed to be marked as P_E rises. An increase in the labor share α_1 reduces the sensitivity of P_Q to P_E in (9) because it increases the denominator more than the numerator. In terms of the supply curve of Figure 1, when P_E rises, and increase in α_1 gives a bigger shift upward but a flatter curve, with the latter effect dominating.

Table V.1: GROSS OUTPUT AND INPUTS IN MANUFACTURING, 1979
(billions R_p)

Sector	Gross Output	Output Less Indirect Taxes	Input Cost	Fuel Elec., Gas	VA at Factor Cost	VA plus Fuel, Elec., Gas	Employment Costs
31	1653.2	1398.8	965.6	21.7	433.1	454.8	82.3
32	673.5	664.9	466.7	24.0	198.2	222.2	61.6
33	188.0	186.1	126.2	3.9	59.9	186.1	19.5
34	120.2	118.1	73.3	6.2	44.7	50.9	13.4
35	886.3	872.5	647.5	16.1	224.9	241.0	57.9
36	211.0	207.0	93.8	30.1	113.2	143.3	20.1
37	68.4	67.3	50.3	5.1	16.9	22.0	2.9
38	690.1	665.3	470.2	9.9	195.1	205.0	56.2
37	19.5	18.8	14.7	0.2	4.2	4.4	1.6

Source: Biro Pusat Statistik, Industrial Statistics, 1979.

Table V.2: SHARES OF VALUE ADDED

Sector	Full VA + Fuel	Labor Share	Capital
31	.05	.18	.77
32	.11	.28	.61
33	.02	.10	.78
34	.12	.26	.62
35	.07	.22	.71
36	.21	.14	.65
37	.23	.13	.64
38	.05	.27	.68
39	.05	.36	.59
Mean	.08	.21	.71

Source: Table 1