The Pakistan Development Review
Vol. XXVI, No. 4 (Winter 1987)

Intercensal Change and the Indirect Estimation of Mortality: The Case of Pakistan

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In a country such as Pakistan, where there is no vital registration system, estimating mortality levels and trends can be difficult. One way we can learn about mortality is to use indirect estimation techniques on census age distributions. This paper applies some of these techniques and evaluates the quality of the census data in the process.

Various researchers have found evidence of a mortality pattern unique to South Asian populations, (Heligman 1985). They find that the expectation of life for females is less than that for males where values of e(O) range between 40 and 50 years, but that the opposite is true where e(O) is between 60 and 70 years. This suggests that as South Asian mortality declines, the sex differential disappears, and the pattern is more like that found in the rest of the world.

Consistently high sex ratios above age 10 are characteristic of Pakistan (see Table 1); the sex ratio at birth varies but tends to stay above 105, the expected value for most populations (Visaria 1971). The underenumeration of females at marriageable ages is the explanation given by Krotki (1985) for the high sex ratios at ages 10–14 and 15–19. The age distribution implies greater survival to those ages than one would expect in a high fertility, high mortality population (see Table 2).

The work, summarized here, is based on the 1972 and 1981 census age distributions, with population by sex and by single years of age. The indirect methods used here follow the growth of each age group rather than cohorts, so the intercensal period of 8.45 years is not a problem. But the census interval 1972–1981 poses several other substantial obstacles to mortality estimation. As we use these data, we must take into account these three important points: first, we need to ascertain the "true" age distribution in spite of age heaping and age exaggeration; second we need to pay attention to the completeness of census coverage and third we need to estimate international migration in the period.

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Table 1

Sex Ratios (Males/Females)

Age	1961	1972	1981	Percent Change 1972-81
0–1	1.05	1.22	.99	−19
1–4	1.15	.96	.97	1
5–9	1.23	1.10	1.08	−2
10–14	1.19	1.27	1.18	−7
15–19	1.13	1.20	1.17	−3
20–24	1.09	1.06	1.11	5
25–29	1.11	1.12	1.12	0
30–34	1.17	1.08	1.07	−1
35–39	1.19	1.16	1.02	−12
40–44	1.26	1.16	1.00	−14
45–49	1.30	1.23	1.10	−11
50–54	1.26	1.33	1.23	−8
55–59	1.33	1.18	1.14	−3
60–64		1.43	1.42	−1
65–69		1.29	1.34	4
70–74		1.38	1.40	1
75+		1.32	1.33	1

In South Asia we find a distinctive pattern of age mis-statement. Age exaggeration and digit preference tend to be seen together. While the latter skews the age distribution to the right, causing it to have a more gradual slope (the 1 (x) function declines more slowly), the former creates irregularities in the age distribution so that it is not as smooth as the "real" distribution.

Several indices show the degree of preference for certain digits. The simplest, age ratios, divide the population enumerated at a given age x by the average of the populations in a group of ages centered on x (see Table 3). Almost every age ratio moves toward 1.00 (which is what the ratio would be if the population were indeed linearly distributed) between 1972 and 1981. From the series of ratios for each sex, we can see that there is somewhat greater heaping at ages 50–54 and 60–64 for males than females.

The Whipple Index shows heaping on particular digits, here on 5 and 0 (Table 4). The index varies between 100, showing no preference for zero or five, and 500, showing that only zeroes and fives are reported. A finer measure which enables us

Table 2

Unadjusted Survivorship Ratios of Males and Females in Pakistan, 1972–1981

Females					Males				
Cohort in 1972	Pop.in 1972	Cohort in 1981	Pop.in 1981	Survivorship Ratio	Cohort in 1972	Pop.in 1972	Cohort in 1981	Pop.in 1981	Survivorship Ratio
0–4	4688162	9–13	4864396	1.0376	0–4	4725325	9–13	5745811	1.2160
5–9	4814625	14–18	4129400	.8577	5–9	5316861	14–18	4783833	.8997
10–14	3451121	19–23	2938519	.8515	10–14	4384059	19–23	3291924	.7509
15–19	2423195	24–28	2815536	1.1619	15–19	2909927	24–28	3146469	1.0813
20–24	2211540	29–33	2212431	1.0004	20–24	2350945	29–33	2361975	1.0047
25–29	2196040	34–38	2107889	.9599	25–29	2450404	34–38	2195802	.8961
30–34	1903303	39–43	1953635	1.0264	30–34	2056573	39–43	1952065	.9492
35–39	1539054	44–48	1489970	.9681	35–39	1790693	44–48	1623212	.9065
40–44	1417332	49–53	1330491	.9387	40–44	1645256	49–53	1635163	.9939
45–49	1044292	54–58	770187	.7375	45–49	1283493	54–58	881850	.6871
50–54	994174	59–63	920250	.9256	50–54	1318614	59–63	1300907	9866
55–59	542682	64–68	432833	.7976	55–59	641572	64–68	563803	.8788
60–64	730718	69–73	490204	.6709	60–64	1041546	69–73	679868	.6527
65+	1111999	74+	592355	.5327	65+	1478378	74+	790062	.5344

Table 3

All Pakistan Age Ratios

Age	Females			Males		
	1961	1972	1981	1961	1972	1981
0-4	–	–	–	–	–	–
5-9	1.24	1.18	1.19	1.28	1.17	1.13
10-14	.74	.95	1.00	.78	1.07	1.06
15-19	1.02	.86	.90	1.03	.86	.92
20-24	.94	.96	.96	.93	.88	.92
25-29	1.10	1.07	1.00	1.07	1.11	1.02
30-34	1.00	1.02	.96	.98	.97	.95
35-39	.92	.93	1.00	.95	.97	.98
40-44	1.07	1.10	1.09	1.06	1.07	1.04
45-49	.89	.87	.90	.90	.87	.90
50-54	1.24	1.25	1.20	1.28	1.37	1.33
55-59	.39	.63	.67	.38	.54	.59
60-64	–	1.71	1.55	–	2.00	1.84
65-69	–	.56	.62	–	.51	.56
70-74	–	1.04	.95	–	1.10	1.01
75+	–	–	–	–	–	–

look at the heaping on each digit individually is Myer's blended method (see ble 5). The measure ranges between 0, which would show no age heaping, and 90, ich would show the entire population to be enumerated at ages ending with one it. For Pakistan, in 1972, this was almost 39; in 1981, it was between 35 and 36. s small improvement appears to have had a significant impact on the age-specific wth rates.

The exact figures are less important than the general level of and trend in the lercount (6.3 to 2.9). If these estimates are correct, we could explain why the wth rates for Pakistan's population in the period 1972–1981 were so great (see ble 6 and Figure 1).

To correct for the substantial international migration of males in the inter- sal period 1972–1981, I make a crude estimate of the age distribution of emigra- n using Rogers and Castro's 11-parameter model (1981); using this and the esti- tes of the volume of migration in the period, I adjust the age-specific growth rates nales.

Table 4

Table 4

Whipples Index of Digit Preference

	Male Ages				Female Ages			
	23	72	43	72	23	72	43	72
	0 or	0	0 or	0	0 or	0	0 or	0
1972	353.1	317.5	411.7	344.1	350.6	318.8	405.9	354.0
1981	337.8	312.2	394.3	339.7	333.3	313.1	392.9	360.5
Difference	15.3	5.3	17.4	4.4	17.3	5.7	13.0	-6.4

Table 5

Myer's Index of Digit Preference

Percentage Distribution at each Digit

	Males				Females			
Ages →	10–69 Years		40–69 Years		10–69 Years		40–69 Years	
Census →	1972	1981	1972	1981	1972	1981	1972	1981
Digit								
0	32.47	29.79	48.98	45.35	33.07	30.30	47.15	43.54
1	2.45	3.05	1.37	1.75	2.28	2.65	1.06	1.38
2	9.09	9.31	4.57	4.51	8.58	9.53	3.96	5.33
3	3.80	4.81	1.60	3.37	3.73	4.24	1.73	2.27
4	4.28	4.79	1.35	1.56	4.44	4.76	1.48	1.66
5	25.91	24.67	31.83	31.76	25.43	24.51	32.64	33.11
6	6.23	6.39	2.49	2.61	5.90	6.16	2.50	2.61
7	3.63	3.81	1.66	1.82	3.52	4.02	1.78	1.84
8	9.69	10.58	4.91	6.02	10.58	11.12	6.27	6.89
9	2.45	2.78	1.24	1.26	2.47	2.71	1.44	1.37

Index of Preference			Difference	Index of Preference			Difference
Ages 10–69	38.378	35.047	3.331	Ages 10–69	39.081	35.937	3.144
Ages 40–69	60.814	57.107	3.707	Ages 40–69	59.786	56.655	3.131

Table 6

Age-Specific Growth Rates

Age	Males 1961-72	Females 1961-72	Males 1972-81	Adjusted Males 1972-81	Females 1972-81
0–4	.0309	.0341	.0322	.0322	.0363
5–9	.0371	.0403	.0293	.0294	.0324
10–14	.0636	.0605	.0343	.0344	.0426
15–19	.0360	.0349	.0432	.0449	.0459
20–24	.0313	.0365	.0390	.0431	.0344
25–29	.0375	.0354	.0196	.0242	.0194
30–34	.0375	.0396	.0177	.0216	.0187
35–39	.0400	.0408	.0200	.0229	.0355
40–44	.0395	.0420	.0193	.0215	.0364
45–49	.0363	.0382	.0268	.0284	.0401
50–54	.0402	.0382	.0257	.0268	.0342
55–59	.0309	.0364	.0346	.0354	.0381
60–64	.0412	.0391	.0261	.0267	.0269
65–69			.0384	.0388	.0382
70–74			.0305	.0308	.0286
75+			.0410	.0412	.0397
Total			.0302		.0347

ESTIMATING MORTALITY

Using the five-year age distributions from the 1972 and 1981 Population Censuses of Pakistan, I indirectly estimate mortality with the Preston-Bennett Method (1981), and the Integrated Method (Preston 1983). With the single-year age distributions, I will also apply Coale's cohort interpolation method (Coale 1984).

All three methods use the 2 age distributions to get age-specific growth rates rather than looking at the survival of each cohort over the period. This reduces the problems caused by age misreporting, assuming the pattern of error is the same in the two censuses. The kind of age distortion that goes on in the Pakistani age distribution is not symmetrical about true ages, but is always "uphill", making the age distribution slope more gently than it should, and giving the impression of lower mortality than there is.

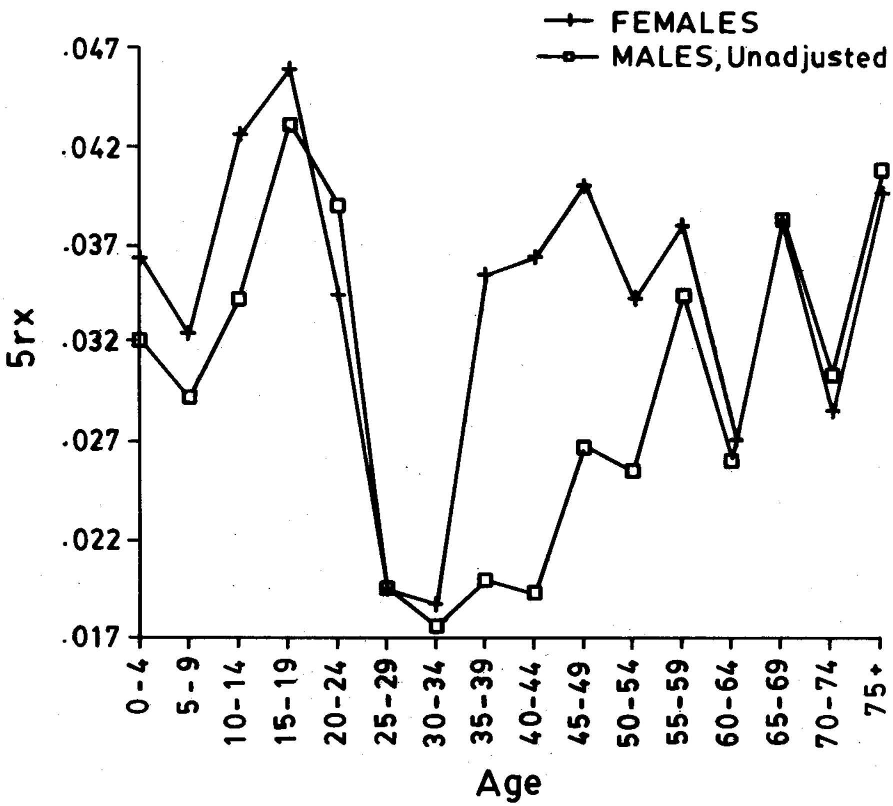

Fig. 1. Intercensal Growth Rates (Pakistan 1972–1981)

The Preston-Bennett method, perhaps the best known and simplest of the variable-r methods, uses the average intercensal age distribution and the growth rates of each age group during the period, to create a stationary population age distribution.

Like the two other intercensal techniques used here, Coale's cohort interpolation method is based on the two age distributions and growth rates. The difference lies in the fact that in this method, we follow cohorts rather than looking at the number at each age in the two enumerations. The method takes advantage of the fact that people at every age x to x +T (T being the length of the intercensal interval) in the second census have passed through age x in the intercensal interval. To calculate the person-years lived at each age, weights for each of 18 age groups, 9 enumerated in the first census, and 9 enumerated in the second, are calculated using a model life table. The model chosen to create our weights is the U.N. South Asia model in which expectation of life is 55.00 years. The results in Table 7 show that when age-specific growth rates are extremely distorted, their effects may outweigh the normalizing effects of smoothing using cohorts and life table weights.

The Preston Integrated Method combines Brass's one-parameter logit transformation system relating members of life table families, with stable population generalized equations. With logits, one life table parameter can be manipulated into producing the values of the same function for other life tables. Because both the "shape" and level of mortality can be adjusted in this relationship, we are not limited to the estimation of life tables of the same family. Any logit can be linearly related to the logit of any standard life table function.

The results from the three methods are shown in Table 7. Most of the estimates of e(x) do not seem reasonable, with the exception of those found using the Coale method. The only way I can explain the Coale method results is to suggest that the single-year growth rates cancel themselves out in their extreme variation.

GROWTH RATES AND DIGIT PREFERENCE

Because most of the mortality estimates seem improbable, I examine the age distributions and age-specific growth rates as sources of error. The fact that growth rates result from changes in cohort size, changes in mortality, and changes in coverage has been studied quite a bit. But this study underlines the importance of changes in proportion reporting at a particular digit.

From the Myer's index (1940), we can see clearly the overwhelming preference for ages ending in zero and five, so great that the percentage at each of those ages is two to three times greater than the percentage at the next most popular age, eight. The digits listed in order of least to most favoured are first the odds 9, 1, 7, 3 then the evens 4,6,2,8, then 5, and finally, of course, 0.

Table-7

Various Estimates of Expectation of Life

Age	Preston-Bennett				Integrated Method			Age*	Coale's Cohort Interpolation				
	Females	Unadjusted Males	Adjusted Males 485505	Adjusted Males 1900000	Females	Unadjusted Males	Adjusted Males 485505		Females 5r(x)	Females (p1-p2)/py	Unadjusted Males (p1-P2)/py	Unadjusted Males Moving	Adjusted Males r(x) 5r(x)
0–4	–	–	–	–	–	–	–	0	57.24	54.13	50.77	56.71	60.21
5–9	69.90	66.81	71.36	88.15	70.25	63.44	69.41	5	55.86	54.14	50.33	54.55	58.08
10–14	61.99	54.49	58.52	73.51	65.71	59.19	64.79	10	55.00	53.05	46.41	50.15	53.81
15–19	63.58	54.04	58.32	74.06	60.89	54.50	59.94	15	53.32	51.51	44.17	47.69	51.59
20–24	60.84	54.89	59.06	74.26	56.14	49.83	55.11	20	48.39	47.71	42.41	44.83	48.21
25–29	52.73	48.26	51.30	62.15	51.41	45.19	50.29	25	42.25	42.00	37.91	39.55	41.53
30–34	47.45	42.91	44.97	52.25	44.69	40.58	45.50	30	38.00	37.80	33.92	35.60	36.52
35–39	43.65	40.62	41.94	46.67	41.99	36.03	40.73	35	34.41	34.34	31.18	32.59	32.91
40–44	36.65	36.12	36.85	39.68	37.31	31.56	36.01	40	29.11	29.27	27.73	28.83	28.81
45–49	31.31	32.45	32.82	34.56	32.67	27.25	31.39	45	24.75	24.71	24.03	24.62	24.77
50–54	26.38	26.90	27.01	27.92	28.10	23.13	26.88	50	20.64	20.80	19.89	20.32	20.17
55–59	24.01	25.15	25.14	25.17	23.68	19.29	22.55	55	18.14	17.94	16.92	17.19	17.38
60–64	19.99	20.52	20.39	20.64	19.48	15.74	18.41	60	13.58	13.88	12.22	11.93	11.89
65–69	15.25	14.74	14.57	14.72	15.60	12.62	14.59	65	10.68	10.51	8.29	8.25	8.36
70–74	14.32	14.21	13.95	14.01	12.07	9.91	11.10	66+	9.71	9.71	7.40	7.40	7.37
75+	5.96	5 79	5.71	5.72	9.08	7.69	8..05						
					6.79	5.78	5.27						
					5.21	5.22	5.86						

*Values extracted from a single-year life table; not exactly comparable with other values.

The problem with Myer's index is that it shows us the deviation at each age relative to the expected ten percent, giving us, in effect, an absolute measurement of change. It matters less what proportion of the total population has been redistributed at the second census than *where,* in which age groups they have been distributed, because the sizes of the age groups vary.

Table 8 shows a slice of single-year growth rates and sex ratios. Combining the information on growth rates and on digit preference, I calculated digit-specific growth rates for the population 10–69, and for the population 40–69 (see Table 9 and Figure 2). The digit-specific growth rates make it clear why we can't use single-year age-specific growth rates for estimating mortality, particularly the rates at the older ages.

Change over time in preference for certain digits is emphasized here because of the effects of this change on the age-specific growth rates. In this way, improvements in age reporting (or increased efforts by enumerators to distribute population away from preferred ages) can create such high growth rates that we are unable to estimate mortality with any degree of confidence.

Table 8

Segment of Single-Year Sex Ratios and Age-Specific Growth Rates

			ASGRs	
Age	1972	1981	Males	Females
25	1.07	1.10	.0200	.0169
26	1.31	1.28	.0163	.0189
27	1.30	1.24	.0204	.0269
28	1.04	1.02	.0194	.0214
29	1.19	1.15	.0245	.0281
30	1.04	1.04	.0084	.0084
31	1.13	1.25	,0650	.0536
32	1.22	1.05	.0145	.0323
33	1.25	1.28	.0636	.0612
34	1.08	1.21	.0644	.0510
35	1.20	1.10	.0140	.0240
36	1.28	1.18	.0293	.0391
37	1.19	.65	.0399	.1124
38	.95	.88	.0346	.0430
39	1.08	.78	.0299	.0682
40	1.16	1.06	.0210	.0227

Table 9

Average of Age Ratios at Each Digit, and Digit-specific Growth Rates

Digits	Ages 10–69						Digits	Ages 40–69					
	Males			Females				Males			Females		
	1972	1981	DSGR	1972	1981	DSGR		1972	1981	DSGR	1972	1981	DSGR
0	2.973	2.847	.0203	2.981	2.813	.0255	0	3.962	3.805	.0170	3.892	3.659	.0252
1	.248	.292	.0464	.231	.262	.0463	1	.114	.156	.0652	.095	.126	.0674
2	.795	.800	.0321	.727	.822	.0452	2	.385	.399	.0288	.344	.494	.0820
3	.367	.502	.0505	.376	.420	.470	3	.216	.428	.1061	.237	.286	.0698
4	.347	.381	.424	.372	.388	.0437	4	.163	.179	.0436	.175	.182	.0528
5	3.309	3.116	.0236	3.307	3.194	.0298	5	4.111	3.862	.0273	4.088	4.017	.0377
6	.504	.503	.0332	.478	.478	.0399	6	.279	.278	.0349	.264	.257	.0441
7	.300	.313	.0351	.294	.328	.0483	7	.173	.185	.0393	.176	.174	.0406
8	.671	.757	.0395	.739	.802	.0395	8	.347	.453	.0525	.450	.519	.0474
9	.180	.196	.0434	.180	.198	.0444	9	.088	.92	.0308	.105	.108	.0305

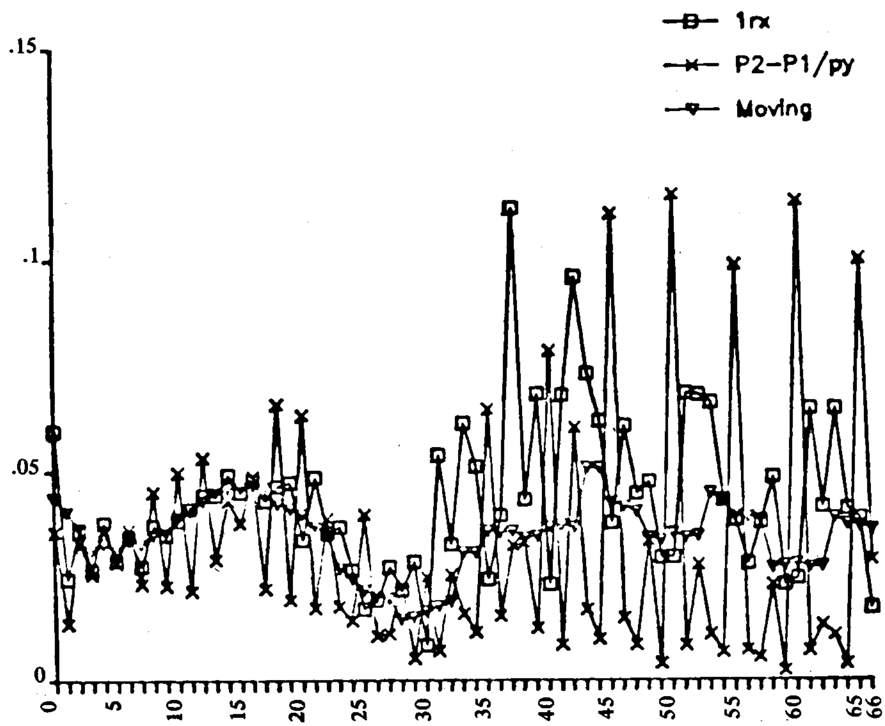

Fig. 2. Single-year Growth Rates (Pakistan Females 1972–1981)

When we use age-specific growth rates for single-year or five-year age groups, we cumulate them regardless of the sizes of the age groups to which they refer. Small *numbers* moving between one digit and another can have a great impact on the growth rates at digits where there are initially few people, because they may comprise a large proportion of the population at their digit of destination.

CONCLUSIONS

In this paper, I have applied various indirect methods of mortality estimation to Pakistani data based on the 1972 and 1981 census age distributions. There were several problems with this interval. One obstacle to indirect estimation which was not anticipated was the erratic growth rates, particularly peaking at ages ending in 5–9. Using indices to evaluate heaping at different digits, I found that there was a *change* in age heaping.

In countries with poor data, we would like to see an improvement in the accuracy of age reporting. But a change in age mis-statement, even in the direction of an improvement is yet another intercensal "event" which we must look out for. If enumerators are responsible for redistributing people on less favoured digits, the precision of the data comes to exceed their accuracy.

REFERENCES

Coale, Ansley J. (1984). *Rapid Population Change in China, 1952–1982.* National Research Council, Committee on Population and Demography. Washington, D.C.: National Academy Press. pp. 77. (Report No. 27)

Heligman, Lawrence (1985). *The Modelling of Age Patterns of Mortality and the Use of Such Models to Evaluate the Quality of Recorded Census Age Distributions* Dissertation Presented to the University of Pennsylvania.

Krotki, Karol J. (1985). "Reported Masculinity Ratio in Pakistan". *Pakistan Development Review.* Vol. XXIV, Nos. 3 & 4, Autumn-Winter. pp. 267-297.

Myers, R J. (1940). "Errors and Bias in the Reporting of Ages in Census Data". *Transactions of the Actuarial Society of America.* Vol. 41, Pt. 2 (104). pp. 411-415.

Preston, Samuel H. (1983). "An Integrated Method for Demographic Estimation from Two Age Distributions". *Demography.* pp. 213-226.

Preston, S.H., and N. G. Bennett (1983). "A Census-based Method for Estimating Adult Mortality". *Population Studies.* Vol. 37. pp. 91–104.

Rogers, Andrei, and Luis J. Castro (1981). *Model Migration Schedules.* Laxenburg: International Institute for Applied Systems Analysis. pp. 81–30.

Visaria, Pravin M.(1968). *The Sex Ratio of the Population of India.* Bombay: Department of Economics, University of Bombay.

Comments on "Intercensal Change and the Indirect Estimation of Mortality: The Case of Pakistan"

The paper is very interesting, primarily, because the author has made an attempt to examine the utility of the census data for working out some mortality indicators for Pakistan. In doing so, she has actually thrown light on some of the limitations and inadequacies of the data.

The author has used female age-specific growth rates to work out, from the 1972 Census age distribution of the male population, and the expected population at the time of the 1981 Census, which in comparison to the actually reported population, indicates the existence of male emigration. She has also discussed the problems of relative coverage in the two censuses and changes in the age reporting preferences. The author has estimated the flow of male migrants to the Middle East in order to adjust for their absence in the 1981 Census count as otherwise their exclusion would lead to inflated estimates of mortality. Similarly, use of the Preston-Bennet method, Coale's cohort interpolation method and the integrated method to estimate life expectancy from the age-sex distribution of 1972 and 1981 Censuses, provide a useful analytical example to look at the inadequacies of census data. These methods also provide some indirect estimation for mortality indicators which as the author herself mentions in the paper, were improbable. But what the study does underline is, the importance of changes in age reporting at a particular digit through the use of some of the well-known indices, and its effect on the age-specific growth rates.

It is well known that working with inadequate demographic data is a great problem and the application of any of the modern demographic techniques to these data, often leads to frustrating results. Such problems exist for almost all the developing countries, but the extent of inadequacy of data varies across developing countries depending on their levels of development. Thus there is greater utility of indirect techniques to provide demographic estimates in countries where the relevant data sources are extremely limited. For a country like Pakistan, the application of indirect techniques should not be done in isolation from other important, independent evidence, available from the direct sources of demographic data and from other research efforts.

Coming to the 1972 and 1981 Censuses, it has to be kept in view that inspite of the slight improvement in the coverage and reporting in the 1972 Census data, as compared to the previous census, it (they) suffered from over-enumeration/duplication in some parts of the country. The same could also be true, to some extent, for the 1981 Census. It may be mentioned here that the methodology adopted in the 1972 Census Evaluation Survey could not detect the over-enumeration of the households as a whole, since its scope was limited to see only the variations in the number of persons within a household. The exceptionally high intercensal growth rates, observed over 1961-72, were partly due to the over-enumeration in the later of the two censuses. Such over-enumeration in 1972 and possibly in the 1981 Census would obviously have affected their age distributions as well.

The paper, from the very outset gives an impression that the age distributions and cohort survival ratios from 1972 and 1981 Censuses can be used to provide the levels of mortality, which according to the author, would fill the gap in our knowledge about Pakistan. I think the author's outright rejection of a number of currently available survey-based estimates for Pakistan, is not justified. The real concern about the direct data sources in Pakistan is how to improve their precision so that they can provide a basis for working out more sensitive indicators of the demographic conditions in Pakistan. The fact that a number of alternative survey-based data sources have become available in the country since the last few decades has put Pakistan somewhat ahead in terms of data development, as compared to many less developed countries (especially in Africa) where only one or two population data sources exist. However, for demographers in Pakistan, who have been dealing with census data for a long time, the latter's limitations as a source for indirect estimation of mortality are obvious.

The author's remark that the conditions within the households and the social structure in Pakistan has not changed over the last 50 years, is not true. Those who are old enough to have observed changes in social life over the last 40 years (after Independence) would not agree with this statement. Similarly, her statement that the females often fail to appear in the census count because of the observance of *purdah,* is also not true. The census questions are often asked from one respondent who answers on behalf of all the household members and such respondents are often males. The appearance of the female members of the household before the census enumerator is not required as such. Moreover, *purdah* (as it is considered in the West) is observed now only by a very small fraction of the Pakistani society.

The author has mentioned in her paper that the basic problems in the censuses are their coverage and reporting. Many people (especially the illiterate) do not know their ages exactly, and also do not keep record of their children's ages. So ages are reported approximately or in some cases are left to the enumerators for guess-work. Such limitations of data perhaps occur less in sample surveys, where enumerators are better trained and supervised.

On the whole, the paper acts as a guide to researchers especially to those who are fresh in the field of demography. It also shows how the author has endeavoured to check and evaluate the internal consistency of data and made efforts to make these more meaningful for use as an input for the application of different methods.

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The Pakistan Development Review
Vol. XXVI, No. 4 (Winter 1987)

Migration and Fertility in Pakistan

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The phenomena of migration and fertility has not drawn much attention in Pakistan. A few studies based on census data, the National Impact Survey 1968-69 and the Population Growth Survey 1968–71 showed higher crude birth rates for rural areas than for urban areas. However, recent studies showed higher urban fertility in Pakistan.

In view of the increasing rate of rural migration to the urban areas it is important to understand the contribution of migration to population growth. The main objective of the present study is to explore differentials in fertility between migrants and non-migrants along with the socio-economic and proximate determinants and to investigate whether these show statistically significant variation in fertility between migrants and non-migrants.

The primary source of data for this study is the Population Labour Force and Migration Survey (PLM) 1979-80. Migration and fertility questionnaires were merged to determine the migration status of husband and wife to relate it to the fertility of women. A total of 335 female migrants in urban areas and 480 in rural areas were identified.

Some basic characteristics of migrant women, covered by the survey, showed that in the sample population migrant females were younger in age with higher age at marriage and shorter duration of marriage. Migrant females were relatively better educated while their husbands have even better education than non-migrants. The differentials by mean children ever born suggest that urban migrant females have lower mean children ever born compared to non-migrants.

However, in the rural areas the differentials were not substantial. This shows that non-migrant females are more fertile while migrant females tend to retard fertility and prefer a smaller family size. Migrant females showed a slight increase in age at marriage compared to non-migrants both in urban and rural areas. The younger cohorts of females aged less than 25 were married at an early age compared with older cohorts above age 35. Since the fertility module comprises only of ever married females, therefore, younger females show less increase in age at marriage. The

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duration of marriage also showed that females who had been married less than 20 years have fewer children ever born in the urban areas as compared to females who had been married longer than 20 years. The rural females have not shown substantial differences in fertility due to duration of marriage. The lower levels of fertility in urban female migrants is due to the disruptions caused by migration. In rural areas short distance migration and less educated females may be attributed for lesser effect of disruptions on fertility.

In terms of education, migrant females with 1–8 years of schooling showed substantially less mean children ever born compared to non-migrants both in urban and rural areas. Less children ever born for migrants may be due to their changes in aspirations or the sense of self-efficiency on the basis of which couples decide to migrate. Thus, education affects the attitude and contributes to lower fertility. Husband's economic status being a more meaningful factor when related to the wife's economic status, showed that migrants in each occupation were having less mean children ever born than non-migrants both in urban and rural areas. Migrants engaged both in white and blue collar occupations demonstrate substantially smaller family size than non-migrants. The lower level of fertility among white and blue collar occupations may be due to more educated people engaged in these occupations and these have greater aspirations for goal achievements and thus represent more mobile segments of the population.

The proximate determinants included in the study were duration of breast-feeding, attained and desired family size, knowledge of family planning and contraceptive use.

Duration of breast-feeding showed that urban migrant females who breast-fed more than 24 months demonstrate higher proportions in the 25 and above age groups. In the rural areas migrant females who also breast-fed for more than 24 months show similar patterns as the urban migrant females. The differentials in fertility suggest that migrant females both in urban and rural areas who tend to prolong the duration of breast-feeding includes either selective females or that the migration process itself affects their attitude or behaviour to prolong their durations of breast-feeding. The attained and desired family size vary between migrants and non-migrants. The younger migrants in both urban and rural areas showed desire for smaller family size than non-migrants. Knowledge of family planning methods among migrant females is greater than non-migrants. This suggests that migrant females were more exposed to family planning methods and were better informed. The use of contraceptive methods was also analysed. Even though the number of migrant users of contraceptive methods were very small both in urban and rural areas, the overall use of contraceptive methods was higher for migrants.

To assess whether any variable has influenced migrant fertility more strongly, multiple classification analysis was performed in two parts for urban and rural areas separately. The results in part 1 of the analysis showed that education, migration status and province of destination emerged as major determinants of fertility in urban areas while province of destination, migration status and partners occupations showed significant effect on fertility for rural areas. The above determinants showed a negative impact on fertility both in urban and rural areas while province of destination, migration status and partners occupations showed significant effect on fertility for rural areas.

In part two of the analysis, the relative role of some determinants of fertility have been examined for migrants and non-migrants separately. Length of breast-feeding showed a significant negative association with children ever born. This shows that migrant females with two or more years of breast-feeding had lowest fertility even though the number of cases were very small. The other determinants did not show any significant association with fertility for migrants. However, differences across categories showed considerable variation. The overall analysis suggests that urban migrants who were younger, better educated, and come from distant areas have more of an effect on fertility in urban areas, but rural migrants have a lesser impact on fertility.

In conclusion, the above findings do indicate that migrants show a greater desire for controlling fertility than non-migrants. Since this study is based on a relatively small sample, the conclusions may be interpreted with care.

The Pakistan Development Review
Vol. XXVI, No. 4 (Winter 1987)

An Energy Input-Output Table of Pakistan for 1979-80 and Some Applications

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1. INTRODUCTION

In order to enhance the indigenous supply of energy, Pakistan has launched various investment programmes as a consequence of which 28 percent and 43.2 percent of total public investment has been invested in the energy sector, respectively, in the Fifth and the Sixth Five Year Plans. However, despite the sharp increase in investment for indigenous exploration and production, the domestic supply of energy has registered an insignificant increase.

Despite substantial increases in energy prices, the growth of the commercial primary energy consumption has increased from 6.8 percent per annum in 1973-74 1979-80 to 7.8 percent per annum in 1979-80 – 1984-85. In fact, Pakistan's energy policies have not succeeded in delinking the growth rate of GDP from primary energy consumption, which has partly been achieved in industrialized countries and in many developing countries. For the period of 1973-74 to 1979-80, the primary energy/ GDP elasticity was 1.20, whereas, it has increased to 1.24 for 1979-80 to 1984-85.

The lack of impact on the mobilization of domestic energy sources and on the curtailment of demand for energy, has also resulted in the continuation of import dependence, especially of oil, over time. With oil consumption growing at a rate of 5.3 percent per annum, the energy imports equalized almost 60 percent of the merchandise export earnings, during the first half of the Eighties. It is noted that this 60 percent compares unfavourably with the average of 28 percent of oil-importing developing countries.

The above mentioned developments as well as social and environmental considerations evoked an awareness in recent years that Pakistan requires a more rigorous integrated supply-demand energy sector planning, which allows for the

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inter and intra-sectoral linkages in the economy, as the production of goods and services depends, in whole or in part, on energy inputs.

The energy input-output model provides us an appropriate analytical tool for this approach, because it makes explicit use of the inter and intra-sectoral linkages. Furthermore, in its analytical application, it considers, not only, the direct effect of energy use, but also, it indicates the indirect use of energy by taking into account all rounds of production.

This paper will demonstrate the usefulness of energy input-output analysis for the planning of energy flows. In Section 2, the first disaggregated energy input-output table of Pakistan will be presented together with the description of compilation procedures. Some preliminary applications regarding the costs, requirements, balances and conservation potentials of energy are taken up in Sections 3, 4, 5 and 6. In Section 7, the main findings will be summarized.

2. THE ENERGY INPUT-OUTPUT TABLE FOR 1979-80[1]

An appropriate analytical tool to analyse the total energy requirements in order to produce the final demand for energy is the energy input-output model. Apart from the direct energy requirements, the indirect energy requirements, which are measured through the energy embodied in non-energy goods and services, are also used in the production process of the final demand.

An appropriate impact analysis of the energy requirements is guaranteed, if the classical Leontief input-output is extended and modified. The extension lies in the distinctions between primary and secondary energy sectors. The latter receives primary energy as an input and converts it into secondary energy sources. This process allows us to trace back the primary energy content in the secondary energy flows which must be equal, if we take into account the energy losses in converting energy from primary to secondary energy forms.

The modification results in the compilation of inter-industry energy flows in physical units while the non-energy flows are reported in monetary values. This modification ensures that the energy conservation condition is met. This condition implies that the total primary energy intensity of a product equals the total secondary intensity of the product plus the amount of energy lost in energy conversion. The compilation of the energy input-output flows in physical units can only be relaxed with the occurrence of uniform inter-industry energy prices. However, the condition of the uniform inter-industry prices is not applicable in Pakistan, as prices differ across sectors. Therefore, whereas the classical model includes inter-industry activities only in monetary values, the appropriate model for energy analysis depicts

[1] A copy of the entire table can be obtained from the authors.

the energy flows in physical terms (i.e. TJ; BTU; TOE or any other common denomination) and the non-energy flows in monetary values. Hence, we obtain a transaction table which is constructed in 'hybrid' units.

A common approach to obtain energy flows in physical units is to compute the total monetary flows in a conventional transaction table first and then convert the data to physical units by means of prices (Subba Rao *et al.* 1981). In this paper, however, the table of physical energy flows has been compiled directly, as in Pakistan they are documented more accurately.

The two main sources used to compute the physical energy transactions of the Pakistan's economy in 1979-80 were, the Energy Year Book (EYB) of the DGER (Energy Year Book 1985), and a study conducted by IED-consultants for the Sixth Five-Year Plan (1983). Additional figures were taken from the annual reports of Water and Power Development Authority (WAPDA) and Karachi Electricity Supply Corporation (KESC), the National Transport Research Centre (NTRC) and the Census of Mining Industries (CMI), (Federal Bureau of Statistics 1983, KESC Annual Report 1982; NTRC 1985; WAPDA 1979-80. All figures were converted to Terajoules (1 TJ = 10^{12} Joules) as the common denomination.

In an attempt to generate maximum insight in energy consumption, given the present data base, the intra-industry sectoral disaggregation has been pursued by taking the total consumption of industry from the EYB and using the shares of the sectors from the IED study. However, a few adjustments were required, due to, for example, unreported coal mining and under-rating kerosene consumption in the EYB. Also, in the agricultural sector, diesel consumption had to be adjusted, as the reported EYB data do not include diesel consumption of tractors, which is reported under the transport sector. In addition, several corrections were required for the energy consumption reported for the 'commercial', 'other/government' and 'domestic final demand' sectors, as these sectors are reported quite inaccurately in the EYB.

With the physical flows calculated, the values of monetary flows can, in principle, be obtained by means of prices. Due to data unavailability or inadequacy, however, several adjustments and recalculations had to be made. Apart from the sources already mentioned, the annual report of the Attock Refinery (Attock Refinery Ltd 1980) was also used. At this stage, the monetary flows of the non-energy sectors have to be updated to 1979-80, given the fact, that the most recent input-output table of Pakistan is for 1975-76 (Saleem *et al.* 1985). For this purpose the well-known RAS-method (modified) has been applied. Techniques, described in the SAM-compilation (Havinga *et al.* 1985) have been used to generate the updated intermediate inputs and outputs of the sub-sectors. Among other things, this implies that the imports have been reported competitively with domestically produced goods.

3. DIRECT AND INDIRECT ENERGY COSTS (IN VALUES)

As discussed earlier, the focal point of the use of an energy input-output table is its property to quantify not only the direct but also, the indirect energy consumption of an economy. The theoretical basis for the calculation of total energy requirements of the various economic sectors is the well-known classical input-output model given as:

$$X = AX + Y \qquad \dots \qquad \dots \qquad \dots \qquad \dots \qquad (1)$$

and

$$X = (I - A)^{-1} Y \qquad \dots \qquad \dots \qquad \dots \qquad \dots \qquad (2)$$

X denotes the vector of total output, Y the vector of final demand for domestic and imported goods and services minus total imports, A the coefficient matrix of domestic and imported inputs, and $(I - A)^{-1}$ the Leontief-Inverse. The coefficients of $(I - A)^{-1}$ quantify the total additional supply of sector i, if the final demand of sector j increases by one unit. This model underlies the well-known restrictions, e.g. the fixed proportions production functions, and the assumption that domestic and imported goods are produced with identical input coefficients, etc.

For the analysis of the energy costs (ECO), an extended version of the classical model is required. The extended model can be used not only for the analysis of the energy sectors but also for various other purposes. Its general equation is

$$Z = B(I - A)^{-1} Y \qquad \dots \qquad \dots \qquad \dots \qquad \dots \qquad (3)$$

where B stands for the coefficient matrix of any economic variable (energy, labour, capital, etc.). $\hat{Y}$ is the diagonal matrix of the final demand. By using Equation (3), a split is provided between intermediate demand and final demand, as Z only comprises intermediate demand. We therefore obtain the total demand as

$$X = B(I - A)^{-1} \hat{Y} + \hat{Y} \qquad \dots \qquad \dots \qquad \dots \qquad (4)$$

For the analysis of the total energy costs, matrix B has to be split in two components. The first part, comprising the coefficients of energy sectors, is required for the pre-multiplication of the inverse. The other part comprising the non-energy sectors, is equated to zero. The final demand is split accordingly as

$$ECO = \left(\frac{A_1}{0}\right) \left[I - \left(\frac{A_1}{A_2}\right)\right]^{-1} \left(\frac{\hat{Y}_1}{\hat{Y}_2}\right) + \left(\frac{\hat{Y}_1}{0}\right) \qquad \dots \qquad \dots \qquad (5)$$

Where index 1 indicates energy sectors and index 2 non-energy sectors. When determining energy costs for the production of goods and services, it should be kept in mind that only the direct costs of energy sources are applicable. For instance, for the production of shoes, only the costs of electricity should be treated and not the costs of producing electricity through conversion from coal and/or gas as its primary energy sources. Therefore, Equation 5 should be slightly modified to control the aspect of double counting of primary and secondary energy sources. When the modification is incorporated in Equation 5 the equation reads as follows:

$$ECO = \begin{pmatrix} A_{11} & A_{12} \\ 0 & 0 \end{pmatrix} \left[I - \begin{pmatrix} 0 & A_{12} \\ A_{21} & A_{22} \end{pmatrix}\right]^{-1} \begin{pmatrix} \hat{Y}_1 \\ \hat{Y}_2 \end{pmatrix} + \begin{pmatrix} \hat{Y}_1 \\ 0 \end{pmatrix} \quad \ldots \quad (6)$$

Equation 6 differs from that applied in Beutel and Murdter (1975) wherein the Leontief-Inverse, apart from the energy-energy transactions (A_{11}), is shown to have equated the energy-industry transactions (A_{12}) to zero also. Their application, however, leads to underreporting of the energy costs because they do not allow for energy-industry interactions in their impact analysis.

As we are, here, interested in the monetary values of energy costs, the energy flows in the input-output table, like the non-energy flows, are denoted in Rupees. The results are presented in Table 1.

Column 8 indicates that the overestimation of total energy costs due to double counting of the primary and the secondary energy sources lies between 1.62 percent and 4.33 percent for the non-energy sectors and between 7.12 percent and 53.63 percent for the energy sectors. As expected, the largest overestimations are found in the primary sectors i.e., crude oil and coal, because it is there where the double counting accumulates, given the primary to secondary energy conversions. Furthermore, the total energy costs by sectors reported in Column 6, give an increase of 100 Rupees in final demand, which correspond with those found for other developing countries. Given the state of industrial development, the most energy-intensive sectors are transport, iron and steel, cement, brick and glass, fertilizer and petroleum products. These results are obtained due to the direct consumption of energy sources. As regards the other sectors, like construction, agriculture and agro-based industries, Column 7 shows that they become more energy intensive due to the energy embodied in the non-energy inputs.

4. DIRECT AND INDIRECT ENERGY REQUIREMENTS IN PHYSICAL UNITS

For a consistent analysis of energy requirments and forecasts, it is essential that the inter-industry energy flows are denoted in physical units. Similarly, the formulation of the energy model must allow for the energy conservation condition. Therefore, it is fundamental to apply the hybrid-unit energy model instead of the

Table 1

Direct (DE), Indirect (IE) and Total (TE) Effects of Energy Costs

Sectors	Equation 5 DE (1)	Equation 5 IE (2)	Equation 5 TE (3)	Equation 6 DE (4)	Equation 6 IE (5)	Equation 6 TE (6)	Indirect/Total (5) : (6) = (7)	Overestimation (percent) (8)
Crude Oil	6.94	4.63	11.57	6.94	0.59	7.53	0.08	53.63
Coal	1.37	2.77	4.14	1.37	1.90	3.28	0.58	26.42
Gas	0.10	1.65	1.75	0.10	1.53	1.63	0.94	7.12
Power	16.59	2.65	19.25	16.59	0.42	17.01	0.02	13.12
Petrol Products	54.70	12.80	67.50	54.70	5.75	60.46	0.10	11.66
Non-energy Petrol	38.05	8.31	46.36	38.05	6.63	44.68	0.15	3.76
Mining + Quarry	0.45	9.33	9.78	0.45	8.97	9.42	0.95	3.81
Agriculture	2.05	7.71	8.76	2.05	7.38	9.43	0.78	3.53
Iron + Steel	10.75	6.51	17.26	10.75	6.20	16.95	0.37	1.83
Cement	21.23	8.74	29.97	21.23	8.25	29.48	0.28	1.67
Brick + Glass	21.97	16.53	38.51	21.97	15.82	37.80	0.42	1.88
Chemicals	5.94	3.01	8.94	5.94	2.86	8.79	0.33	1.71
Fertilizer	20.26	11.75	32.01	20.26	11.17	31.43	0.36	1.84
Textile	1.50	6.52	8.02	1.50	6.30	7.80	0.81	2.82
Pulp + Paper	6.39	3.53	9.92	6.39	3.33	9.72	0.34	2.02
Sugar Refining	1.23	5.99	7.22	1.23	5.77	6.99	0.82	3.16
Metal Products	2.60	1.77	4.37	2.60	1.68	4.29	0.39	1.98
Equipment + Machinery	1.85	4.64	6.50	1.85	4.47	6.32	0.71	2.81
Leather + Footwear	0.28	6.55	6.83	0.28	6.35	6.63	0.96	3.01
Food + Beverage	0.62	6.23	6.85	0.62	6.02	6.64	0.91	3.26
Ind. Nec. + Constr.	0.87	11.24	12.11	0.87	11.00	11.86	0.93	2.07
Road Transport	18.85	17.45	36.29	18.85	15.98	34.83	0.46	4.21
Rail Transport	24.86	20.34	45.20	24.86	18.53	43.39	0.43	4.18
Air Transport	24.43	18.66	43.09	24.43	16.87	41.30	0.41	4.33
Water Transport	22.35	18.99	41.33	22.35	17.28	39.62	0.44	4.31
Commercial	1.61	3.56	5.17	1.61	3.40	5.01	0.68	3.22
Government	3.89	4.23	8.11	3.89	3.94	7.83	0.50	3.58

alternate energy model. Without going into a theoretical exposition about the differences between the two models [see Miller and Blair (1985)], the hybrid-unit energy model will be presented

$$A^* = Z^*(\hat{X}^*)^{-1} \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (7)$$

$$\delta = F^*(\hat{X}^*)^{-1} A^* \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (8)$$

$$\alpha = F^*(\hat{X}^*)^{-1} (I - A^*)^{-1} \quad \ldots \quad \ldots \quad \ldots \quad (9)$$

Equations 8 and 9 reflect the direct and total energy requirement coefficient matrix, respectively. Following the construction of an inter-industry transaction matrix in hybrid-units, we define a new transaction matrix Z^*, a corresponding total output vector X^* and final demand vector Y^* for which the energy rows are measured in energy units and the non-energy rows in rupees. To isolate the energy rows, the matrix product $F^*(\hat{X}^*)^{-1}$ is constructed of which (1) F_k^* is equal to X_k^* for the primary energy sectors and (2) F_k^* refers to the total energy of type K to the production process, and X_k^* refers to total energy output for secondary energy sectors. The ratio of F_k^* to X_k^* is the conversion efficiency.

When calculating the total energy requirements, only the coefficients of the primary or the secondary energy sources should be summed up. The summation of both primary and secondary energy sources leads to double counting. For that matter, by definition, the separate summation of the total primary and secondary energy requirements must equal when the energy model reflects the energy conservation condition.

In the case of the power sector, an additional refinement can be considered. On the one hand, electricity is a primary energy source when it is generated by hydel power, but on the other hand, it is a secondary energy source when it is generated from oil products and gas. In Pakistan 58.21 percent of all electricity was generated by hydel power stations and 41.79 percent by thermal units in 1979-80. Taking this distinction into account as a rough method we added the respective share (58.21 percent) of total power requirements to total primary energy requirements of other primary energy sources (crude oil, coal, gas).

Table 2 presents the direct, indirect and total physical requirements for Pakistan in 1979-80. When reading the table, we have to keep in mind that the energy requirements of the energy sectors are given in TJ/TJ, and those of non-energy sectors in TJ/1 million Rupees. Thus the textile industry, for example, requires directly 0.5 TJ to deliver goods worth 1 million Rupees to final demand and indirectly 2.2 TJ. The total of 2.7 TJ is equivalent to the cumulated quantity of all energy sources. It is, however, not equivalent to the primary energy content of the products which is only 1.7 TJ (2.0 when including hydropower).

Table 2

Direct and Indirect Energy Requirement in Pakistan 1979-80 in Physical Units[1,2]

Sector	Energy Requirement (Primary and Secondary Energy Sources)			Primary Energy Requirement				Primary Energy Requirement including Hydel			
	Direct Col. 1	Indirect Col. 2	Total Col. 3	Direct Col. 4	Indirect Col. 5	Total Col. 6	Share Col. 7	Direct Col. 8	Indirect Col. 9	Total Col. 10	Share Col. 11
Crude Oil	0.011	1.015	1.026	0.011	1.002	1.013	14.1	0.011	1.004	1.015	25.0
Coal	0.006	1.021	1.027	0.006	1.008	1.015	56.8	0.006	1.010	1.016	61.4
Gas	0.000	1.004	1.004	0.000	1.002	1.003	92.1	0.000	1.003	1.003	92.8
Power	0.804	1.119	1.923	0.804	0.048	0.852	5.7	0.804	0.630	1.434	5.7
Petrol. Products	1.123	1.131	2.254	1.123	0.057	1.180	4.8	1.123	0.067	1.191	5.6
Non-energy Petrol	11.289	1.321	12.609	11.289	0.572	11.861	4.8	11.289	0.676	11.965	5.6
Mining + Quarrying	0.080	2.534	2.615	0.080	1.393	1.474	94.5	0.080	1.526	1.606	95.0
Agriculture	0.465	2.316	2.781	0.465	1.141	1.606	71.0	0.465	1.399	1.864	75.0
Iron + Steel	3.910	2.693	6.603	3.910	0.811	4.721	17.2	3.910	1.715	5.625	30.5
Cement	11.717	3.204	14.921	11.717	0.754	12.471	6.0	11.717	1.665	13.381	12.4
Brick + Glass	8.313	5.200	13.513	8.313	3.352	11.666	28.7	8.313	3.646	11.960	30.5
Chemicals	2.393	1.538	3.931	2.393	0.374	2.767	13.5	2.393	0.953	3.347	28.5
Fertilizer	7.796	4.109	11.905	7.796	1.182	8.978	13.2	7.796	2.246	10.042	22.4
Textile	0.528	2.189	2.717	0.528	1.159	1.687	68.7	0.528	1.512	2.040	74.1
Pulp + Paper	3.512	1.841	5.353	3.512	0.655	4.167	15.7	3.512	0.924	4.435	20.8
Sugar Refining	0.510	1.732	2.242	0.510	0.960	1.470	65.3	0.510	1.120	1.631	68.7
Metal Products	1.201	0.744	1.945	1.201	0.239	1.441	16.6	1.201	0.433	1.634	26.5
Equipment + Machinery	0.643	1.540	2.183	0.643	0.749	1.392	53.8	0.643	1.008	1.652	61.1
Leather + Footwear	0.125	2.110	2.235	0.125	1.301	1.425	91.3	0.125	1.532	1.657	92.5
Food + Beverage	0.279	1.794	2.073	0.279	1.068	1.347	79.3	0.279	1.229	1.508	81.5
Ind. Nec + Constr.	0.262	4.349	4.611	0.262	3.251	3.513	92.5	0.262	3.656	3.918	93.3
Road Transport	2.400	4.453	6.854	2.400	1.482	3.882	38.2	2.400	1.618	4.018	40.3
Rail Transport	6.482	9.385	15.867	6.482	2.153	8.635	24.9	6.482	2.439	8.921	27.3
Air Transport	2.650	3.904	6.554	2.650	0.861	3.511	24.5	2.650	0.939	3.590	26.2
Water Transport	6.124	8.782	14.906	6.124	2.052	8.176	25.1	6.124	2.154	8.278	26.0
Commercial	0.270	0.965	1.235	0.270	0.455	0.725	62.7	0.270	0.572	0.842	67.9
Government	0.584	1.266	1.850	0.584	0.374	0.958	39.0	0.584	0.620	1.204	51.5

Notes : [1] In TJ/TJ for energy sectors and TJ/1 mill. Rs for non-energy sectors.
[2] The direct energy requirement is the summation of primary and secondary energy sectors.

In the coal industry, e.g., the total primary energy requirement (including hydel) to produce one TJ of final demand is 1.0162 TJ. This quantity consists of one unit primary energy which is delivered to final demand and 0.0162 TJ primary energy consumed at all stages of production.

A more general observation which can be ascertained from the results is, that in more than half of the industries, the direct energy requirements are larger than the indirect requirements. This observation is contradictory to the experiences of industrialized countries, where most of the industries have larger indirect than direct energy requirements. These findings for Pakistan prove the low level of linkages of its economic sectors.

To complete the analysis of the results, we compare the figures calculated in this section with those for West Germany in 1978. Table 3 gives the results.

As the values for Germany were given in DM, they had to be converted into Rupees. The official exchange rate was used for this purpose. As many services and goods are not traded and the exchange rate is influenced by other factors than trade, the official exchange rate might not reflect the difference in purchasing power of the two currencies accurately. Furthermore, we have to consider that the structure of goods of a sector differs from one country to the other. We, therefore, have to read the results of Table 3 only as orders of magnitude and not as exact results.

Table 3

Total Primary Requirements in the FRG (1978) and Pakistan (1979-80)[1]

Sector	FRG	Pakistan
Crude Oil	1.065	1.015
Coal	1.075	1.016
Gas	1.039	1.003
Petrol Products	1.116	1.191
Agriculture	1.277	1.864
Cement	3.620	13.381
Brick + Glass	2.754	11.960
Chemicals	4.070	3.347
Textile	1.667	2.040
Pulp + Paper	2.159	4.435
Food + Beverages	1.271	1.508
Road Transport	1.296	4.018
Rail Transport	3.145	8.920
Air Transport	4.107	3.590

Note : [1] For energy sectors in TJ/TJ; for non-energy sectors in TJ/1 mill Rs output.

The comparison of the total primary energy requirements between the two countries shows that on the one hand, some sectors (e.g. Cement; Brick and Glass) show a substantially higher total primary energy demand per unit of output in Pakistan than in West Germany. This directly proves the inefficient manner of energy use in these sectors. On the other hand, for sectors with a similar requirement of total primary energy use, per unit of output (e.g. Textile; Food; Chemicals; Agriculture), one has to consider the fact that in Pakistan, these sectors and the economy in general, are far less equipped with energy consuming appliances. The almost equal quantities can be accounted for only by the lack of energy efficiency of the existing stock of equipment.

Summarizing the above observations, one can state that there is ample scope for energy conservation in Pakistan. For that matter, increasing energy efficiency will lead to energy conservation without reducing the level of economic activities.

5. ENERGY BALANCE OF FINAL DEMAND

On the basis of the total impact multipliers of energy requirements (i.e. Column 10 of Table 2), a world-wide total primary energy requirement, for the production of the final demand, can be obtained. This estimation allows the assessment of Pakistan's self-sufficiency in energy in all rounds of production, domestic and foreign. Therefore, we apply Equations 10 and 11,

$$E_d^p = F(X^*)^{-1} (I - A^*)^{-1} Y_d \quad \ldots \quad \ldots \quad \ldots \quad (10)$$

$$E_f^p = F(X^*)^{-1} (I - A^*)^{-1} Y_f \quad \ldots \quad \ldots \quad \ldots \quad (11)$$

where Equation 10 denotes the demand for domestic and imported primary energy of domestically produced final demand of consumption, investment and exports. Equation 11 denotes the demand for primary energy required abroad for the production of imported final demand. Table 4 gives the results.

From Table 4, it is observed, for instance, that the textile industry, consumed world-wide 45794 TJ of which 40510 TJ was required for final demand met by the domestic products and 5284 TJ for the final demand met by the imported products. For total domestic and imported final demand of consumption, investment, exports and change in stocks, a production of 762 798 TJ primary energy is required the world over. As only 347 232 TJ is produced indigenously (including hydel power), the overall self-sufficiency is only 45.5 percent. This figure, however, is substantially lower than the domestic share of total energy supply (domestic primary energy production plus imported primary and secondary energy) which is 57.4 percent. These results show that Pakistan depends on foreign energy sources to a larger extent than estimated by the official data, due to the fact, that the national accounts data do not include the indirect demand for primary energy embodied in imported goods.

Table 4

Primary Energy Requirement of Domestic and Imported Final Demand (in TJ)

Sector	Col. 1	Col. 2	Grand Total
Crude Oil	0.0	0.0	0.0
Coal	619.9	0.0	619.9
Gas	14513.4	0.0	14513.4
Power	35666.0	0.0	35666.0
Petrol. Products	66646.3	21820.1	88466.4
Non-energy Petrol	7986.0	0.0	7986.0
Mining + Quarrying	439.1	2923.3	3362.4
Agriculture	117026.1	4590.2	121616.3
Iron + Steel	448.0	0.0	448.0
Cement	466.7	0.0	466.7
Brick + Glass	7249.7	1971.8	9221.5
Chemicals	10754.9	5190.2	15945.1
Fertilizer	383.9	4142.3	4526.2
Textile	40509.8	5284.5	45794.3
Pulp + Paper	3576.3	1647.8	5224.1
Sugar Refining	10821.1	18.6	10839.6
Metal Products	2025.5	951.9	2977.5
Equipment + Machinery	6698.3	19712.6	26410.9
Leather + Footwear	6446.6	36.2	6482.8
Food + Beverage	45561.2	4977.9	50539.1
Ind. Nec. + Constr.	148844.6	1721.9	150566.4
Road Transport	63463.7	0.0	63463.7
Rail Transport	11942.9	0.0	11942.9
Air Transport	11158.0	0.0	11158.0
Water Transport	6382.1	0.0	6382.1
Commercial	31088.2	0.0	31088.2
Government	37090.7	0.0	37090.7
Total	687808.7	74989.3	762798.1

Notes : Col. 1 = Total domestic and imported primary energy requirements of domestic final demand (i.e. consumption, investment, exports).
Col. 2 = Total primary energy requirement of imported final demand (i.e. consumption, investment, exports).

When talking about energy self-sufficiency and dependence, one has to consider that the total energy requirement calculated above is partly used for the production of goods for export. Additional conclusions can, therefore, be drawn from a comparison of direct trade of energy and total primary energy requirements of foreign trade.

As the direct imports of primary and secondary energy sources in Pakistan amount to 257 191 TJ and the exports to 49 955 TJ, the direct energy deficit of the country is 207 236 TJ. However, the direct and indirect deficit of primary energy, that is including the primary energy embodied in imported and exported goods, is substantially larger. Estimations show that the total imports based on intermediate and final demand products require 415 566 TJ for their production and the total exports 126 144 TJ, which results in a deficit of 289 721 TJ (an increase of 40 percent). This again indicates that Pakistan is far more dependent on foreign primary energy than reflected by the direct requirements alone.

6. ENERGY CONSERVATION: COMPARISON OF DIRECT AND TOTAL IMPACTS

Energy conservation, as part of a rational energy policy, means a more efficient use of available energy sources. That it does not adversely affect the level of economic activities and social well-being has been shown by the "energy service" approach (Pintz 1986).

For Pakistan, only few data are available regarding the potential for energy conservation. These data include only direct conservation, since the estimations do not apply energy input-output models. It is, however, obvious that there is also an indirect contribution to conservation. Assuming, for instance, a conservation of petroleum products in one of the industrial sectors, the total output of the oil-refining sector decreases. Therefore, not only less primary oil is required, but also less input from all other sectors. As the production of these inputs requires energy, the lower quantity of inputs demands less energy and less intermediate inputs at the backward round of production. Again, these reduced quantities mean less energy consumption and less input of other intermediate products. This process can be traced back to primary inputs. To sum up, the conservation occurs in all rounds of backward production.

Here, the total primary energy conservation potential is demonstrated for industry, as it has been surveyed best in Pakistan. We assume the following direct conservation potential of the various sectors which is technically feasible and financially profitable (USAID 1985).

Sector	In Percent	Sector	In Percent	Sector	In Percent
9	22.4	14	29.9	19	14.2
10	39.9	15	14.9	20	24.0
11	24.9	16	20.0	21	14.8
12	22.6	17	24.5		
13	30.0	18	19.5		

The direct energy conservation in industry can be assessed: it amounts to 54454 TJ.

When calculating the total impact, we find that instead of 658254 TJ, only 580195 TJ had been required, which brings the total conservation to 78059 TJ. This validates that the direct energy conservation alone underestimates the conservation potential; the total impact is substantially higher (in our example by 43 percent). We have to undestand, however, that part of total conservation had occurred abroad so that Pakistan's energy consumption had not been reduced by the overall difference. A calculation of this effect is, unfortunately, not possible with the presently available data.

7. CONCLUDING REMARKS

This paper has demonstrated that the energy input-output model can be applied as an appropriate tool for integrated supply-demand energy planning in Pakistan, given the present data available. The first (disaggregated) energy input-output table of Pakistan for 1979-80 has been compiled and has been presented so that the hybrid energy input-output model could be developed. By means of various applications it has been shown that this energy model is suitable for integrated energy planning. Apart from the direct energy requirements for the production of goods and services, the indirect energy requirement can also be quantified, because the model explicitly allows for the inter-industry energy and non-energy flows in all stages of production.

The findings of the various applications of the energy model confirm that the indirect effects have a considerable impact on the quantification of the energy costs and physical energy requirements for production and, hence, should be accounted for. Moreover, the findings indicate that the average energy self-sufficiency of Pakistan is much lower than the official data describe. Finally, it has been shown in a preliminary analysis that the energy input-output model is suitable for the quantification of the energy conservation potential.

REFERENCES

Attock Refinery Ltd (1980). *Annual Report 1979-80*. Rawalpindi.

Beutel, J. H. Mürdter (1984). *Input-Output-Analyse der Energiestrome 1975.* München.

Directorate General of New and Renewable Energy Resources (1985). *Energy Year Book.* Islamabad

Havinga, I. *et al.* (1985). "Social Accounting Matrix of Pakistan for 1979-80". Islamabad: Pakistan Institute of Development Economics.

IED Consultants (1983). *Report on the Sixth Plan 1983-88 - Energy*. Islamabad.

KESC, (1982). *69th Annual Report 1980-81*. Karachi.

Miller, R. and P. Blair (1985). "Input-Output Analysis: Foundations and Extensions" Cliffs, Englewood.

National Transport Research Centre (1985). *Transport Statistics* Vol. II, 1984. Islamabad.

Pakistan, Government of (1983). *Census of Mining Industries 1979-80*. Karachi: Federal Bureau of Statistics.

Pintz, P. (1986). "Demand-side Energy Policy as an Alternative Energy Strategy for Pakistan". *Pakistan Development Review*. Vol. XXV, No. 4, pp. 631-644.

Saleem, M. *et al.* (1985). "Final PIDE Input-Output Table of Pakistan's Economy 1975-76". Islamabad: Pakistan Institute of Development Economics. (Research Report Series No. 144).

Subba, Rao S. *et al.* (1981). "Determination of Energy Costs and Intensities of Goods and Services in the Indian Economy – An Input-Output Approach". In M. Chatterji (ed.), *Energy and Environment in Developing Countries*. Chichester pp. 205–221.

USAID (1985). "National Energy Conservation Programme". Islamabad. (Mimeographed).

WAPDA: *Annual Report 1979-80*. Lahore.

Comments on "An Energy Input-Output Table of Pakistan for 1979-80 and Some Applications"

This paper develops the methodology using the energy input-output model for setting up a disaggregated energy input-output table for Pakistan for the year 1979-80. The paper also shows use of the table as an aid to integrated energy planning. My comments are in two parts. First, the classical (Leontief) input-output model is extended to incorporate the distinctions between the primary and secondary energy supplies, and the relevant matrices are developed. This is a significant step to prevent double counting of certain energy inputs. Since industrial production involves energy as well as non-energy quantities, so a hybrid system is adopted: the energy flows are given in energy units of Terajoules (10^{12} Joules), while the non-energy flows are given in monetary terms.

In the case of Pakistan, the monetary flows of the non-energy sectors have been updated from 1975-76 by the RAS-method, while the energy flows have been compiled directly (instead of through the monetary transactions) on the assumption that direct energy data is available more accurately from, (i) the Energy Year Book of the DGER, (ii) a study conducted by IED Consultants for the Sixth Five-Year Plan, and (iii) other subsidiary reports. This assumption is open to some question (for example, the EYB data on non-commercial energy consumption seems too low), and deduction of the energy consumption from the corresponding costs may be more reliable.

Secondly, the effects of total costs are studied in Table 1, which shows the extent of the overestimation due to double counting in the un-modified equations. From the Input-Output table, the authors have derived several other tables viz. Table 2 for direct and indirect energy requirements and Table 3 for total primary energy requirements of domestic and imported final demand. This paper provides valuable insights into the mechanisms of various interactions between sectors, the direct and indirect energy requirments, the overall primary energy requirement and the possible avenues for energy conservation.

The authors have shown that the primary energy requirments in the Cement, Brick and Glass industries in Pakistan were considerably higher than those in West Germany, thus indicating considerable inefficiency in their use of energy. This reflects inefficient burning and the use of obsolescent technologies. They have also stressed the ample scope for the improvement of energy conservation in Pakistan viz.

from 20 percent to 40 percent. In the end, they have made a thought-provoking remark saying that, the average energy self-sufficiency of Pakistan was much lower than that described in the official documents: this is probably in line with a general ostrich-like attitude of officials here and elsewhere.

In conclusion, I, as a Physicist, do not mind a few matrices here and there, but I feel that this paper is highly mathematical, and I doubt if the average energy technologist, or even consultant, in Pakistan can successfully grapple with it. I quote a colleague with an overseas Ph.D., who has been a University Professor of Electrical Engineering; "the paper suggests certain mathematical models which may prove interesting to the economists but are a little too involved for practicing engineers". I wonder if a simpler presentation could be developed to take care of this aspect. After all, mathematics is only a tool for achieving our purpose, which should be operated with a basic understanding.

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The Pakistan Development Review
Vol. XXVI, No. 4 (Winter 1987)

Modelling the Prospects of Economic Growth and Social Development: Results of Circular Flow Planning Models Applied to Pakistan 1980–1993

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1. INTRODUCTION

This paper presents for Pakistan an analysis of the country's recent economic growth and social development, and medium-term prospects covering the period of the Seventh Plan. The meaning of economic growth is self-evident. In contrast, by social development we shall mean the pace of progress as regards the distribution of income, the satisfaction of essential needs, balanced development and employment of human resources.

The paper has two purposes (i) to provide valuable information for policy making in the area of growth and development, and (ii) to demonstrate the attractiveness and usefulness of working with the models we have developed. We shall rely exclusively on the results obtained from the planning models which were developed in collaboration with the Pakistan Institute of Development Economics, Islamabad and Erasmus University, Rotterdam Netherlands.

Most of the past models which were developed for Pakistan served analytical purposes, were demonstrative in nature or were not updated. As a result, they are practically irrelevant for today's appraisal of future prospects. More recently, since 1980, a few models which have been updated regularly may turn out to have a future. In particular, among the macro models, PIDE's econometric model is the most widely publicised, cf. Naqvi *et al.* (1983). In the category of activity models one simple but handy model is available in Cohen, Havinga and Saleem (1985). In

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the category of activity/factor models a regularly updated and used manpower planning model which elaborates on the labour force matrix of Pakistan, is in Cohen (1985). Finally, two recently completed reports at the PIDE have been treating the circular flow models. these are of the social accounting type SAM (PIDE 1985), and of the consistency type COM (PIDE 1986).

The presentation in this paper will be based on the latter two circular flow models: partly on a simplified analysis of SAM multipliers (Section 2) and partly on the consistency model COM (Section 3) and its extension to the planning of manpower balances, i.e. extended COM (Section 4).

2. SAM

One of the first lessons in a textbook of economics is on the circular flow (Figure 1). In the lower bound, *households* supply labour and capital to *firms* who are organizers of *production activities* (i.e. sectors), and the latter paying back for the use of factors. In the upper bound, households spend their incomes on products which are delivered by the firms/activities. In the centre is a government which is involved in transfers to and from households and firms/activities. Furthermore, there are the economic relations between the country and the rest of the world.

The first published application of a social accounting matrix, SAM, to developing countries dates from 1977.[1] In fact, the SAM is nothing more or less than the transformation of the circular flow of Figure 1 into a matrix of transactions between the various agents, as in Table 1. In the rows of such a matrix we find the products,

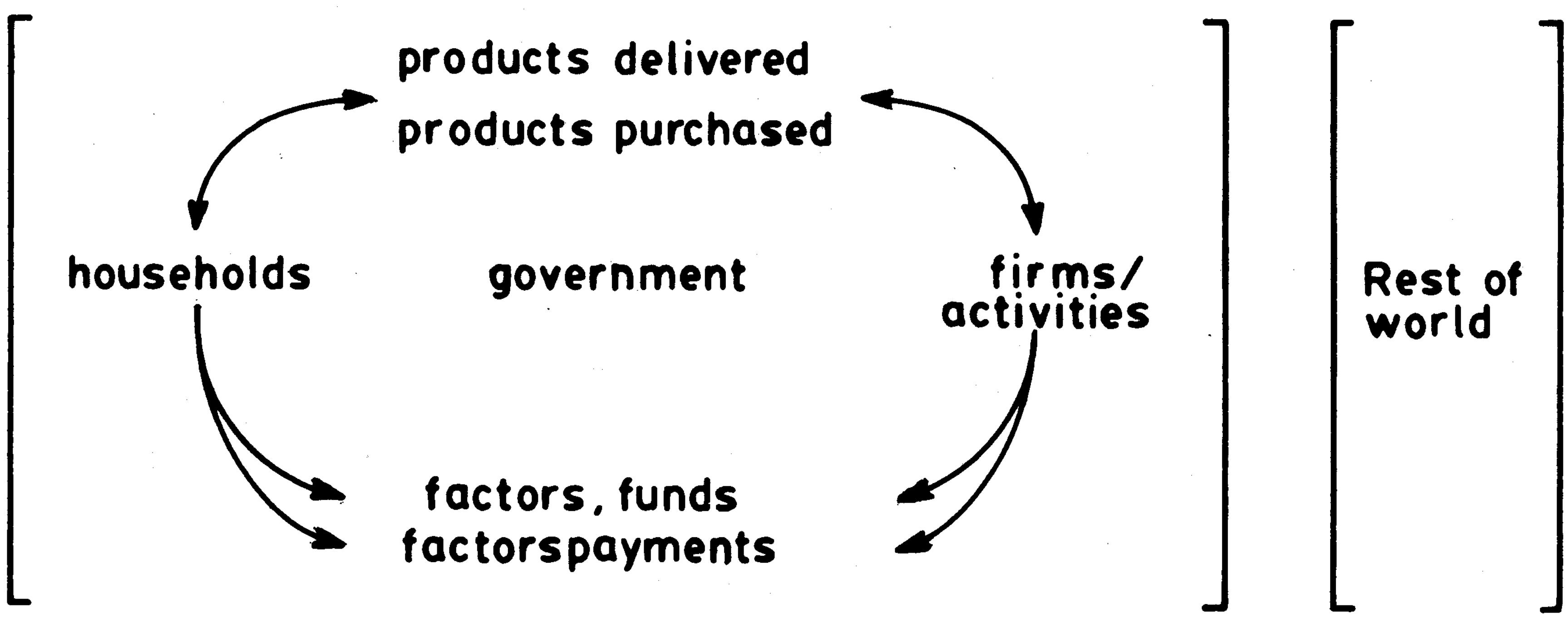

Fig. 1. Circular flow

[1] The first applications to countries of the Third World are in Pyatt and Roe (1977). There are presently SAMs of different shapes for more than 30 countries. Of course, several models in the Seventies had the shape of a SAM and appropriate SAMs were often constructed in the process of estimation of these models, see for instance, Cohen (1975).

Table 1

Aggregate SAM, Pakistan 1979-80

(billion rupees)

	1. Prod.	2. Fact.	3. Househ.	4. Firms	5. Govt.	6. Funds	7. Activ.	8. Rest of World	Total
1. Products			199						199
2. Factors							213	18	231
3. Households		214			1				215
4. Firms		16			1			–3	14
5. Government		2	2	4			24	–2	30
6. Funds			14	10	5			11	40
7. Activities	199				22	41	213	–25	450
8. Rest of World									0
Total	199	232	215	14	29	41	450	–1	1179

the factors, the institutions consisting of households, firms and government as well as the institutions capital account, the activities and the rest of the world. The columns are ordered similarly. Transactions between these actors take place at the filled cells and in correspondence with the circular flow. A particular row gives receipts of the actor while columnwise we read the expenditure of the actor. Various data from national accounts, household surveys etc. are utilised to estimate the filled cells. Table 1 gives, for instance, the aggregate SAM for Pakistan in 1979-80. This SAM has been disaggregated further into 8 products, 12 activities and 10 household groups, resulting into a matrix of 37 rows by 37 columns, as reported in PIDE (1985).

The required data for a SAM are not readily available for a later year than 1979-80, so that it is difficult to state with reliance the kind of growth and distributional changes which have taken place in the last 5 or 6 years. However, with appropriate handling, the SAM can be turned into an instantaneous circular flow model whose impact multipliers are able to reflect on the inner mechanisms of Pakistan's economy in the medium run, i.e. for years which are directly before and after 1980.[2] As such the SAM can be employed to tell us what has most probably

[2]The appropriate handling of the SAM referred to above consists of three steps which can be summarized as follows:

(1) A separation between independent variables, also called exogenous variables, (These are public or foreign demands for goods and services, and public or foreign transfers to institutions, together these are found in columns and rows 5, 6 and 8 of the SAM in Table 1; and dependent variables, also called endogenous variables, (these are the remaining columns and rows in the SAM).

(2) A calculation of a coefficient matrix for the endogenous variables.

(3) The inversion of the coefficient matrix to give the so-called impact multipliers of a million rupees addition in the exogenous on endogenous variables. The procedure is explained at length in a paper presented in a recent PIDE seminar, c.f. Cohen (1986).

been happening in the past few years, and how. In particular, the impact multipliers give an insight on two issues:

(a) What is the effect of additional demand for sectoral activities, on *growth* and *distribution;*
(b) What is the effect of *institutional transfers,* i.e. public transfers, private transfers and foreign remittances, on *growth* and *distribution.*

For purposes of presentation, Table 2 gives the impact multipliers of the SAM for 13 selected exogenous impulses. The impact of exogenous additions to sectoral activities on the functioning of the whole economy are found in Columns S10 to S13, while the impact of exogenous additions to institutional transfers are found in Columns I3 to I9.

Let us first consider growth effects. Column S10 would imply that an additional million rupees of purchases of wheat and rice (through government purchases and/or exports) ultimately leads to an additional 1.574 million rupees of production of wheat and rice, 1.8 of other agriculture, 5.9 of non-agriculture, and .5 of services, giving a total of 9.7. The contribution of an expansion in wheat and rice to the overall growth of output is highest, followed by other crops, industry and services. Note that while the narrower input-output framework, laying emphasis on interactivity relationships, gives higher values of multipliers for industry than for agriculture, and in fact has had the effect of encouraging investment in industry at the cost of agriculture; we have here different results from the broader SAM framework which considers the whole circular flow including interactivity relationships. The SAM would recommend expansion of agriculture at the cost of industry. Of course, both the input-output and the SAM frameworks consider the demand side only. Realistic planning requires considering both demand and supply sides.

Secondly, we consider the income distributionary effect. Wheat and rice lead with an income impact multiplier of 4.4. The rural small/no holdings group gains, collecting 1.6 out of the 4.4, or 36 percent. This is a higher share than the actual share of the income of this group in 1979-80 which amounted to 31 percent. As a result, it can be concluded that additional demand for wheat and rice is progressive in its income redistribution effect. The same applies to other agriculture. These progressive effects are partly due to (1) the persistence of a strong link between the agricultural factors of production and factor income for rural households at the lower end of the income scale, and (2) the ability of these households to plough back their consumption expenditures and those of other households to their benefit. In several countries where such an analysis has been made it was found that the consumption pattern of poorer households is inefficient in the sense that it leads to an income leakage to richer households. In this respect, Pakistan is better off.