Proj. 931 0536 (4)
Ref - PD-AAF-400-E1
26

March 15, 1974

EVALUATION

of the

DEMOGRAPHIC COMPONENT

KOREAN AGRICULTURAL SECTOR STUDY

Prepared by:
John E. Craig, Jr.
Socio-Economic Analysis Staff
International Statistical Program
U.S. Bureau of the Census

AID/csd - 2975
931-17-140-536

EVALUATION OF THE DEMOGRAPHIC COMPONENT
KOREAN AGRICULTURAL SECTOR STUDY

In this report I have pursued both a narrow and a broad interpretation of the task of evaluating the demographic component of the Korean Agricultural Sector Study. In Part I, I have evaluated the projection model very narrowly in terms of its acceptability to demographic theorists and practitioners. In this section I have dealt with technical demographic relationships at more length certainly than my own interests would normally require, and probably more than will appear necessary to some readers. Hopefully my reasons for pursuing this subject so extensively will be made clear in Part I itself; in any event, this section is intended primarily for the KASS team, and had time permitted, would have been reduced to a technical appendix. In Part II we look at the assumptions regarding demographic phenomena made by KASS in employing the demographic component. In Part III we broaden our concerns to consider the actual role of population variables in KASS, and in Part IV look at the "ideal" role that population and other sectoral variables ought to play in an agricultural sector study, noting the existing gap between the two. In light of the latter, we finally examine briefly the future direction of demographic/economic research which an extended KASS project should undertake.

Before turning to these specific issues, a few general remarks are in order. First, this evaluation is like many others in that the reviewer has felt an obligation to deal at length with the unsatisfactory aspects of the KASS model, while paying hardly any attention at all to its many good points. Actually, I am impressed with what the KASS team has accomplished, and I have dealt with the model's demographic and related shortcomings at such length only because I consider it a model worth improving. Because I happen to think population variables play an important role in economic development, I have perhaps looked for more population inputs than would be regarded as necessary by those whose primary interests lie in other areas. I also appreciate the time and resource constraints under which the demographic component

was assembled. Still, it is my conclusion that more attention needs to be paid to demographic variables, and to their interaction with economic variables, in any future work done by KASS. Much the same must be said for interaction between the farm and nonfarm economic variables. KASS-I has achieved only a minimal incorporation of relevant demographic and nonfarm variables into the agricultural sector calculus; socio-economic/demographic research currently on-going in Korea and elsewhere warrants a more extensive effort in this respect, an effort which is likely to improve both KASS's understanding of agricultural development, and its relevance to policy-making exercises.

Finally, I believe the exceptionally detailed documentation of a very complicated model deserves special commendation. This factor, and the very able assistance of Tom Carroll, made the evaluation exercise much less difficult than otherwise it would have been.

I. The Projection Model*

In this technical review of the population projection mechanism of KASS, we shall be primarily concerned with the process by which population cohorts are "aged" and regenerated, given information regarding future mortality and fertility levels. We devote special attention to this aspect of the system, because it is the basis of all other population related analysis in KASS, and must therefore be the starting point for evaluation of the demographic component. Parts of this section are necessarily technically oriented, and are unlikely to be of much interest to individuals with limited backgrounds in demographic analysis. To the non-demographic specialists, some of the criticisms offered here may appear to be more, or less, serious than this evaluator intends them to be. Let me therefore preface my remarks with the following summing-up of the technical review of the projection model: in terms of demographic theory, there are some rather serious faults in

---

* In this technical review I have benefited from discussions of the model with Dr. Eduardo Arriaga and Ms. Patricia Anderson, both demographers with the International Statistical Programs Center, U. S. Bureau of the Census. The conclusions presented here are of course my own.

the projection model; on the one hand, these faults affect the final results, i.e., the population projections, in fairly insignificant ways; on the other hand, they are sufficiently serious in terms of theory to provoke negative reservations on the part of any qualified demographer, and certainly would hinder the use of the projection model by non-KASS analysts; finally, the errors are not irremediable, i.e., a relatively small program revision effort could produce a model that not only gives the "right" answers, but also is correct in terms of demographic theory.

When one approaches a computerized demographic projection model, one's first concern is with whether the model is sound in terms of demographic theory. The concern with theoretical accuracy is probably greater for computerized models than for those worked out on mechanical calculators: certain time-consuming refinements may be justifiably neglected when the projection is carried out by hand, but are nearly mandatory when a computer can incorporate them in milliseconds. Offsetting this basic concern is the fact that demographers are noted for having carried the theoretical underpinning of their science much further than the quality and quantity of available data (particularly in developing countries) often warrant. Despite the argument against leaving obvious theoretical errors in a model to add to the already burdensome data errors inherent in the projection process, there nevertheless comes a point at which the incorporation of theoretical niceties is hardly worth the effort, given the already enormous amount of possible error in the data being processed. Where this point is reached is largely a matter of taste -- to wit the multiplicity of computerized projection models, many of them differing only in small details. This reviewer, being neither a full-time demographer nor a theoretical purist has chosen a moderate or liberal standard for evaluation of the KASS projection model: 1) given the large numbers of "correct" computerized demographic projection models available, a new projection model must also be, in very broad terms, demographically correct, regardless of whether it gives the "right" answers or not; and 2) in the context of the KASS project, the particular model under consideration should be sufficiently general in its treatment of theoretical relationships to be acceptable and useful to other economic/demographic analysts in Korea.

• The method of projecting population in KASS is the cohort-survival technique frequently used,* and well documented in such basic demographic sources as Barclay** and Keyfitz.*** Where data inputs are available, even in fragmentary form, the cohort-survival technique is generally preferred because it requires explicit statement of assumptions regarding the components of demographic change -- fertility, mortality, migration rates, and patterns -- and allows for independent examination of the differential impact of alternative assumptions not only on total population growth, but also on important demographic variables such as age distribution, life expectancy, total fertility, etc. The basic principle of the cohort-survival technique is to "age" or "survive" cohorts of population (usually either five-year or single-year age groups) using survival ratios appropriate to a given level of mortality, and to regenerate the population by applying age-specific birth rates to the appropriate female population during each time period of the projection. Internal (and external) migration in the cohort-survival projection system produces special problems and indeed, no satisfactory standard treatment for internal migration exists at the present time. In models like that of KASS, where urban and rural (or farm and nonfarm) populations are projected separately (along with the male and female components of these populations), at least differences in urban and rural natural growth rates are separated out so that geographical flows may be considered independently. This attribute has made separate urban and rural projections preferable where data makes them feasible and research needs, desirable.

With this very brief background, let us now examine the actual cohort-survival model used in KASS. A difficulty presents itself at this point in that much of this discussion requires at least a rudimentary, preferably a working, knowledge of life table construction

---

* See H. S. Shryock and J. S. Siegel, The Methods and Materials of Demography, Vol. 2, U. S. Bureau of the Census, 1971, pp. 771-809.

** G. W. Barclay, Techniques of Population Analysis, John Wiley & Sons, Inc., 1958.

*** N. Keyfitz, Introduction to the Mathematics of Population, Addison-Wesley, 1968.

techniques and applications of stable population theory to the study of population dynamics. I shall attempt to keep the discussion as much as possible in layman's terms, and where this is impossible, to explain the basically simple logic underlying life table applications.

The KASS model, in very simplified form (mainly ignoring sex and regional breakdowns) may be represented as in equations 1 - 3.*

(1) $$BORN^{t,t+2} = \sum_{x=15}^{49} POPF_x^t * BR_x^t * 2 \qquad x = 15\text{-}16,\ 17\text{-}18,\ \ldots,\ 48\text{-}49$$

(2) $$POP_x^{t+2} = POP_{x-2}^t * (1-DR_{x-2})^2 \qquad x = 2\text{-}3,\ \ldots,\ 88\text{-}89$$

(3) $$POP_{o-1}^{t+2} = BORN^{t,t+2} * (1-DRI)$$

where $BORN^{t,t+2}$ = births between years t and t+2;

$POPF_x^t$ = female population at time t aged x to (but not including) x+2;

BR_x = the age-specific birth rate appropriate to the female population aged x to x+2 -- these rates vary over time;

POP_x^{t+2} = population aged x to x+2 in time t+2;

DR_x = the death rate (selected as M_x in the model life tables) applicable to the population aged x to x+2; these rates also vary over time and are sex-specific;

DRI = the "infant death rate" (selected as Q_o in the model life tables).

In this structure, the population is divided into 45 two-year age groups; this breakdown requires a two-year updating cycle, as indicated by the time superscripts t, t+2 and age subscripts x, x-2.

---

* Incidentally, while this reviewer considers KASS to be exceptionally well documented in general, the inclusion in the text of the mathematical equations formulating the projection model would assist others interested in the details of the KASS population component.

The key equation for aging purposes is equation two. Lacking specific information on death rates in Korea, the KASS team opted to use for information on mortality in Korea, the model life tabels developed by Professors Coale and Demeny*, selecting the tables corresponding to levels 17 and 19 in the "west" series. A life table is a life history of a hypothetical group or cohort of people as it is diminished gradually by deaths. Given statistically derived age-specific death rates (M_x), life tables can be constructed showing the probability of dying between any two exact ages (Q_x), the number of persons (assuming continuous replenishment of the first or infant age-group) surviving to any exact age (l_x), the mid-year population aged x to x+n (${}_nL_x$, where n is the width of the age-group interval) and remaining average life-expectancy for any given age (e_x). On the basis of statistical death or mortality rates (M_x), all of the various columns of the table are derivable from an essentially simple set of mathematical relationships. In the early 1960's Coale and Demeny made an exhaustive study of existing life tables, found the existence of strong cross-country patterns relating general indicies of mortality (life expectancy) to certain levels and age-sex specific patterns of mortality, and used this information to construct model tables on the basis of which detailed information on mortality conditions could be derived from very fragmentary available information.

Life tables, then, are based on a very precise set of assumptions and constructs, and model life tables in particular are premised on a quite specific set of assumptions as regards both their application and construction. Use of the model tables therefore requires caution: certain rules must be adhered to, else the results will not be strictly in accord with the model patterns which the user selected, presumably with good reason, in choosing a particular model life table.

The usual link between the life table and actual population data is the age-specific death rate M_x. Strictly speaking this statistic should not be used to age an age-group or cohort of population because it is a hybrid number. It is the ratio of deaths of persons aged x to x+n to the mid-period population aged x to x+n. M_x does not refer to

---

* A. J. Coale and P. Demeny, Regional Model Life Tables and Stable Populations, Princeton, 1966.

any specific cohort of people. Let us take a specific example, using single year age groups: recalling that data collectors are concerned only with age at last birthday, the deaths occurring to persons aged 10 during 1970 do not occur entirely to the cohort of infants born in 1960, represented by the mid-year population aged 10 in 1970; some of these deaths will actually belong to the cohort born in 1959; similarly all of the deaths which will eventually occur to the 1960 cohort at age 10 will not have taken place by the end of 1970 -- some of the group will still die as 10 year olds in 1971. M_x has no strict probabilistic interpretation because registered deaths and mid-year population are not exactly matched at any age and therefore do not represent the same universe. The life table uses certain assumptions to convert M_x to a probability concept Q_x, and from Q_x derives the remaining columns, the most important of which for our purposes are ${}_nL_x$ and ${}_nP_x$. These latter two entities are the only concepts in the life table which have counterparts in the census and vital registration data sources. ${}_nL_x$ may be interpreted as the mid-year population aged x to x+n. ${}_nP_x$ is simply $\frac{{}_nL_{x+n}}{{}_nL_x}$, the ratio of the mid year populations which survive to age x and then to age x+n. It is this survival ratio ${}_nP_x$ (because it can be related to an actual population count) which should be used to survive cohorts in a cohort-survival projection.

The KASS model instead uses the M_x column to survive all but the infant cohort, and, rather inexplicably, Q_o to survive infants -- (why not be consistent and use M_o?). In equation (2), the survivorship ratio is computed as $(1-DR)^2$, the term being squared to provide for a two-year age group being exposed to a death rate for two years. As it turns out (See Table I), $(1-DR)^2$ is a fairly close approximation to the correct survival ratio P_x implied by the model life table. This is due to the fact that, with certain additional assumptions regarding the distribution of deaths it can be shown that

(4) $${}_2P_x = 1-2 * M_x \quad ;$$

by expansion,

(5) $(1-M_x)^2 = (1-2 * M_x + M_x^2)$.

Since M_x is in all cases a very small fraction, the M_x^2 term in equation (5) is quite small, making $1-2 * M_x$ very close to $(1-M_x)^2$. In Table I, I have compared the correct F_x values for a five-year interval projection with the $(1-M_x)^5$ and Q_o values to be used in the KASS type projection. The KASS survival ratios overstate infant survival ratios by as much as 1.2%, understate survivorship of the first two cohorts by as much as 2.2%, and overstate the remaining survival rates by as much as 3.5%. The errors are obviously quite small and tend to balance out; over the projection period there is very little effect on population totals, and a marginal effect on age distribution. The point is that the survival ratios used by KASS do not really duplicate the pattern of mortality implied by the selection of model life tables "west" - 17 and 19. In a computerized model, there is really no reason why they should not.

Equation (2) presents additional difficulties in that it makes no provision for the aging of the final age group 88-89. The last cohort to be aged is the age-group 86-87, which in the following cycle becomes cohort 88-89. What happens to those who were already in the cohort 88-89? They simply drop out of the system; as best this reviewer can determine, they are not counted as having died. In 1970, the final age-group consists of approximately 9,500 individuals, a very small part of the population of 31.69 million. However, had all the deaths implied by dropping all previous members of the final group been included, the crude death rate would have risen from 10.1 to 10.4 in 1970. Again, the error is quite small. But in a computerized model there really is no reason for not surviving the final age group correctly, by applying the final survival ratio to it and adding the survivors of the 86-87 cohort from two-years earlier.

The final difficulty which this reviewer finds with the basic projection model is in the calculation of births. In equation (1) age-specific birth rates are applied for two-year periods to the appropriate female population present at the start of the two year cycle. The problem is that not all of the female population aged x in year t will survive to year t + 2. Some will of course die. $POPF_x^t$ is therefore not the

TABLE I -- COMPARISONS OF ${}_5P_x$ and $(1-{}_5M_x)^5$ VALUES

	West - 17						West - 19					
	Males			Females			Males			Females		
Age	${}_5P_x$		$(1-M_x)^5$	${}_5P_x$		$(1-M_x)^5$	${}_5P_x$		$(1-M_x)^5$	${}_5P_x$		$(1-M_x)^5$
Infant	.9021	<	.9138*	.9171	<	.9293*	.9300	<	.9371*	.9428	<	.9501*
0-4	.9717	>	.9561	.9744	<	.9831	.9826	>	.9737	.9851	>	.9632
5-9	.9897	>	.9880	.9902	>	.9890	.9929	>	.9920	.9939	>	.9930
10-14	.9887	<	.9910	.9895	<	.9915	.9918	<	.9940	.9932	<	.9945
15-19	.9834	<	.9861	.9855	<	.9875	.9878	<	.9900	.9904	<	.9920
20-24	.9798	<	.9806	.9822	<	.9836	.9853	<	.9856	.9879	<	.9890
25-29	.9777	<	.9791	.9795	<	.9811	.9840	<	.9851	.9859	<	.9871
30-34	.9737	<	.9762	.9763	<	.9781	.9809	<	.9831	.9833	<	.9846
35-39	.9669	<	.9708	.9722	<	.9742	.9753	<	.9786	.9795	<	.9816
40-44	.9563	<	.9627	.9660	<	.9698	.9658	<	.9717	.9735	<	.9772
45-49	.9400	<	.9495	.9550	<	.9622	.9508	<	.9597	.9635	<	.9700
50-54	.9156	<	.9291	.9378	<	.9476	.9277	>	.9408	.9480	<	.9568
55-59	.8794	<	.9000	.9097	<	.9267	.8933	<	.9127	.9228	<	.9382
60-64	.8270	<	.8540	.8652	<	.8896	.8433	<	.8700	.8815	<	.9053
65-69	.7531	<	.7897	.7968	<	.8343	.7713	<	.8081	.8158	<	.8526
70-74	.6505	<	.6957	.6969	<	.7441	.6705	<	.7166	.7182	<	.7665
75+	.4098	<	.4445	.4431	<	.4789	.4286	<	.4622	.4644	<	.4989

* Infant Survival Ratio in KASS = $(1-Q_o)$

actual population exposed to giving birth between years t and t + 2. An approximation of the actual universe is the average female population aged x over the two-year interval, $(POPF_x^t + POPF_x^{t+2})/2$. Equation (1) overestimates the female population exposed to giving births, and therefore overestimates the total number of births. The actual error is small, but there is no reason to add it to the other unknown sources of error.

What is the net effect of these shortcomings on the population projections? Lacking time to duplicate the KASS model (with corrections) as a means of comparison, I have used a standard Bureau of the Census Projection model, DEMOG3, which differs in other less important respects from KASS, but treats the above aspects of cohort-survival projections correctly. Due to other differences in the two models, the projection made by KASS and DEMOG3 would not be exactly the same in any event; however, I have duplicated the KASS inputs as closely as possible (for example, tracing the migration flow to arrive at approximately the same urban/rural proportions) in order to arrive at some approximate comparison. The results for 1985 are shown in Table II.

In Table II, it will be observed that the projections are roughly the same -- certainly well within the large margin of error expected in any projection exercise. More differences occur in the age distribution. The errors appear to be as high as 4%, but generally are much smaller. The various errors in the projection exercise, then, tend to balance out.

To conclude this technical review of the projection model, I wish to emphasize that the KASS projections, accepting for the moment the urban/rural migration treatment, are quite acceptable. I must conclude that KASS has obtained the "right" answers, since my own projection models give roughly the same answers. However, these right answers are based on some "wrong" reasons, which many demographers would find difficult to accept. I am concerned that the conceptual and theoretical shortcomings discussed here may seriously detract from the overall KASS performance. I am particularly concerned with the usefulness of the model as it now stands to other demographic analysts in Korea. It seems to me that the impact of KASS depends very much on the extent to which

TABLE II -- PROJECTED POPULATION AGE DISTRIBUTION - 1985
KASS AND BUCEN PROJECTIONS COMPARED USING
MODERATE FERTILITY ASSUMPTIONS

	URBAN SECTOR						RURAL SECTOR					
	Male			Female			Male			Female		
Age	KASS*		BUCEN	KASS*		BUCEN	KASS*		BUCEN	KASS*		BUCEN
0-4	11.0	>	10.3	10.8	>	10.1	13.5	<	17.4	14.0	<	17.1
5-9	9.6	>	9.4	9.4	>	8.9	12.3	<	12.8	13.2	<	13.9
10-14	9.6	>	9.5	9.4	>	9.0	11.0	>	10.3	11.5	>	11.4
15-19	9.6	<	10.3	9.6	<	10.1	11.8	>	9.3	11.3	>	8.5
20-24	10.9	<	12.0	10.9	<	12.2	11.4	>	8.3	9.1	>	6.0
25-29	10.7	<	10.9	10.7	<	10.9	9.8	>	8.6	8.3	>	6.7
30-34	8.0	<	8.3	7.8	<	8.1	7.3	>	6.8	6.1	<	6.3
35-39	6.4	=	6.4	6.4	>	6.1	4.5	=	4.5	3.5	<	4.4
40-44	5.7	<	5.8	5.5	>	5.3	3.6	>	3.3	3.4	<	4.0
45-49	5.3	>	5.1	5.3	>	5.0	3.0	<	3.5	4.0	<	4.5
50-54	4.1	>	3.9	4.2	=	4.2	2.6	<	3.5	3.6	<	4.3
55-59	3.1	>	2.8	3.4	>	3.2	2.0	<	3.0	3.0	<	3.6
60-64	2.4	>	2.1	2.6	>	2.5	2.0	<	2.7	2.5	<	3.1
65-69	1.6	>	1.4	1.8	=	1.8	2.0	<	2.5	2.3	<	2.4
70-74	.9	=	.9	1.2	<	1.3	1.5	<	2.0	1.9	=	1.9
75+	.4	<	.8	1.0	<	1.3	1.1	<	1.5	1.5	<	1.8
	100.0		100.0	100.0		100.0	100.0		100.0	100.0		100.0

* Reviewer converted KASS two-year distributions to five-year interval distributions, using profiles page 56, KASS Special Report No., 6, KASS distribution is therefore only approximate.

NOTE: Totals may not be exact, due to rounding error.

TABLE II -- continued

Projected Population Totals - Thousands - Moderate Fertility

Year	KASS	BUCEN
1970	31,694	31,695
1975	34,673	34,601
1980	37,608	37,577
1985	40,899	41,022

the system and its various components can be integrated with other Korean research and planning efforts. KASS does have something to offer to demographic analysts and to economists concerned with demographic phenomena in Korea, and it should make every effort to see that its package is presented as attractively as possible. Demographers are as a group oriented toward independent, individual research and often set extreme standards in their evaluation of other demographic work. It is my conclusion that the effort required to correct the shortcomings discussed above would be a fairly small one, and well worth the effort in terms of impressing any demographic critics.

II. The KASS Projections -- Assumptions and Inputs

Having briefly reviewed the overall projections model, we turn now to an evaluation of the appropriateness of the inputs used by KASS to project the farm and nonfarm populations. In the preceeding section, I did not discuss the KASS treatment of internal migration, primarily because there is in KASS no "model" for migration in the formal sense. Internal migration is dealt with on an essentially ad hoc basis; I have therefore delayed discussions of this aspect of the population component to this section, treating migration as essentially another data input.

Two of the basic inputs to the demographic component may be disposed of quickly. KASS used the population figures projected by Beegle and Kim for 1969, which were in turn based on the 1966 Census data. These figures are acceptable until they have been checked out with the actual 1970 Census data. The KASS effort to deal with farm and nonfarm populations instead of the demographer's usual urban and rural populations is commendable, and the adjustments made to arrive at the farm population estimates are highly plausible. Similarly, the model life tables (West - 17 for 1971 and West - 19 for 1991) selected as being reasonable approximations of Korea's present and expected mortality experience appear to be acceptable to most demographic experts working in Korea. This reviewer would like to see some effort at explaining mortality changes in terms of social and economic variables believed to influence mortality; but until more is known about actual mortality patterns and changes over time in Korea, this refinement probably must remain for the more distant future.

Turning to the assumptions regarding fertility used in the projection model, the total fertility values and initial fertility patterns* chosen by David Smith of the Population Council and again used by KASS as the basis for the "moderate" fertility projections appear to be concensus figures. Smith essentially made slight adjustments to the fertility pattern given by the Special Demographic Survey of 1966 (and used by Beegle and Kim in their projections), primarily increasing that part of total fertility attributable to the youngest (15-19) age-group of women. This reviewer's own opinion is that the KASS "Alternative Two" fertility assumptions, providing for greatly reduced fertility resulting from expanded family planning efforts, are excessively optimistic, or at least ought to be explained in some detail.

---

* Total Fertility is defined as the sum of the age-specific birth rates for women in the childbearing years. It can be interpreted as the average number of children born to a woman experiencing the given age-specific fertility pattern over her childbearing years. A fertility pattern is arrived at by taking the ratio of each age-specific birth rate to total fertility; the resulting vector shows what part of overall fertility is attributable to specific age groups of women.

A more important feature of the fertility rates (looking only at the "moderate" level) chosen by KASS is presented in Table III. Demographers are interested not only in the level of fertility (best represented by the Total Fertility Rate, the average number of children born to women of childbearing age) but also in the pattern of fertility by age (best shown by the ratio of age-specific fertility rates to the total fertility rate). For countries experiencing a demographic transition, we typically expect the fertility pattern to change over time, finding that as modernization proceeds, women in the youngest and older age-groups contribute less and less to total fertility. Certainly there is abundant evidence of such a phenomenon occurring in Korea: Lee-Jay Cho explains much of the decline in total fertility by the rise in average age at marriage (which reduces 15-19 fertility) and the use of contraceptives or controls by women beyond the prime childbearing ages.* We also expect fertility patterns to vary over regions in Korea; the 1966 Special Demographic Survey, as expected, shows a more traditional fertility pattern for rural areas.

In Table III, I have compared the fertility patterns used by Beegle in making his preliminary projections and those used by KASS for the present projections. It will be observed that Beegle provides urban/rural differentials in fertility patterns, but keeps the same patterns, for all of South Korea, and for both sectors, over the entire projection period. This is clearly unlikely to be the actual course of events. KASS, on the other hand, provides for the expected change of the overall fertility pattern provided by Smith, but requires that the farm and nonfarm population have the same fertility patterns regardless of their relative levels of modernization. This latter procedure is also clearly unsatisfactory in certain respects. Actually, the model could be made more realistic by combining the KASS and Beegle fertility patterns, allowing for initial urban/rural differential fertility patterns which gradually converge to the final common pattern used by Smith and KASS, probably in some year beyond 1985.

---

* Lee-Jay Cho, "The Demographic Situation in the Republic of Korea", East-West Population Institute, mimeo, 1973.

TABLE III -- FERTILITY PATTERNS -- KASS AND BEEGLE

Age	Beegle 1966			KASS 1966			Beegle 1985			KASS 1985		
	Korea	Urban	Rural	Korea	Urban	Rural	Korea	Urban	Rural	Korea	Urban	Rural
	Percent			Percent			Percent			Percent		
15-19	1.0	.5	1.2	2.3	2.3	2.3	1.0	.5	1.2	.9	.9	.9
20-24	17.4	15.6	18.6	19.3	19.3	19.3	17.4	15.6	18.6	19.1	19.1	19.1
25-29	33.3	36.7	32.6	31.4	31.4	31.4	33.3	36.7	32.6	40.1	40.1	40.1
30-34	23.6	27.5	21.8	22.9	22.9	22.9	23.6	27.5	21.8	24.0	24.1	24.1
35-39	16.3	12.2	17.5	15.2	15.2	15.2	16.3	12.2	17.4	10.5	10.5	10.5
40-44	7.3	6.2	7.4	7.8	7.8	7.8	7.3	6.2	7.4	4.5	4.5	4.5
45-49	1.1	1.1	.9	1.2	1.2	1.2	1.1	1.1	.9	.9	.9	.9
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

NOTE: Totals may not be exact, due to rounding error.

We turn now to by far the most difficult aspect of the projections made by KASS -- the treatment of internal migration. Since the subject of migration is a quite involved one in the KASS system, I shall begin by briefly describing the KASS determination of migration flows, which are important, given sectoral differential fertilities, in determining overall population growth.

The Beegle-Kim projections were based on assumptions regarding the absolute levels of migration, involving high migration rates through 1969 with a rapid tapering off to 1988. Hathaway took the Beegle-Kim projection, applied age-sex-sector-specific labor force participation rates to obtain labor force projections, then applied an assumed 5% unemployment rate to arrive at total employment projections through 1985. Working from historical growth rates, Hathaway projected urban employment by economic sector. Agricultural employment projections were then arrived at as the residual, total employment minus nonagricultural employment. The KASS group, for a number of reasons, determined to make its own population projections, the major divergence from Beegle's work being the treatment of migration. Beegle had relied on census and survey materials to conclude that regional differential migration rates exist among the three KASS agricultural regions. KASS apparently doubts that the regional differences indicated by the data are real, and instead adopted a migration approach which eliminates regional differentials. The approach of KASS was to set rural/urban migration rates so as to "track" Hathaway's agricultural employment projections.

This reviewer finds several problems with this procedure. In the first place, it is extremely complicated and difficult to explain. There are theoretical reasons for basing rural/urban migration on employment patterns and trends, but somehow they become lost in the involved explanation of exactly how KASS arrived at the migration rates it uses. If KASS has a migration model, it is lost in the efforts to match one expert's work with another's. More importantly, Hathaway's agricultural employment projections are based on Beegle's population projections, which are in turn based on assumptions of fertility lower than any used

by KASS. Similarly, KASS uses the same agricultural employment figures in all of its projections involving various possible levels of future fertility. It argues that "changes in the effects of the family planning program between 1970 and 1985 will not affect employment levels during this period because persons born during this period will not enter the labor force until after 1985". This assumption is true only if fertility has no bearing on female labor force participation;* there is a substantial body of evidence indicating that fertility and labor force participation are in fact closely related. I would argue, therefore, that changes in fertility will be accompanied by changes in labor force even before the reduced infant cohorts reach working age, and that there is therefore a basic inconsistency in having migration rates used in making one population projection depend on employment data derived from another projection using quite different fertility assumptions. To the extent that 15 is an unrealistic "first working age" in rural Korea, the different fertility assumptions will have an impact on working age population before 1985, and lead to further inconsistencies.

If I am uncomfortable with finding the same agricultural manpower available figures retained for both moderate and low fertility projections, I am even more uncomfortable with the fact that agricultural migration levels remain the same regardless of the different agricultural price and development policies pursued in Alternatives I, II, and III. This amounts to saying that "push" factors and comparisons of urban and rural opportunities do not enter into the migratory decision. This may be true, but I would like to see it demonstrated. KASS is careful to note this problem, but offers no plans for dealing with it.

It is difficult to say what the net effect of these problems is on the KASS projection. The most questionable result is that for KASS's Alternatives I, II, and III projections (involving both differential population growth rates and differential development programs, "agricultural manpower available" (See Table III - A-2, KASS Special Report No. 6, pp. 63-66) remains the same. My major concern is not so much with the results as with the overall approach to the migration question. The problems I have discussed here are certainly known to

---

* It is also true only if differential population growth rates have no impact on saving potential and thus on capital accumulation-employment generating capabilities. This remains to be demon-

the KASS team. However, it is doubtful, particularly in the area of internal migration, that the process by which the demographic results were arrived at can be explained convincingly to the inquiring laymen, and it is certain that the techniques will not stand up under any extensive professional scrutiny. The basic problem is the lack of a coherent migration model; the first step in any future work is obviously a thorough investigation of what we know about migration in Korea -- do regional differences, e.g., exist, or are those cited by Beegle and Kim simply statistical artifacts? -- followed by the construction and testing of a theoretical model. It is this reviewer's guess that such an exercise will result in a migration treatment which is not only more valid but also substantially less complicated than that of the current KASS.

III. Socioeconomic-Demographic Interactions

To this point we have dealt entirely with the technical accuracy of the demographic component in isolation from the other KASS components. The more interesting questions, at least to this reviewer, lie in the integration of the demographic component with the entire simulation system. We turn now to some of these questions: what role does population play in the agricultural sector study; have economic and demographic interrelationships been adequately treated; what remains to be done to construct a system which accounts for at least the fundamental interactions between demographic and economic variables?

Let us look first at the role played by demographic phenomena in KASS. The first thing to note is that demographic variables in KASS are "exogenous" variables: what is going on in the agricultural sectors and the urban sector has no endogenized impact on demographic variables. This is not to say that KASS ignores the likely impact of economic change on Korean population dynamics; assumptions regarding the future course of mortality, fertility, and internal migration are grounded in expectations regarding the effects of growth and modernization on these key demographic variables. But no effort is made to model these impacts so that trends in demographic components are directly related to what

is going on in the rest of the system. Farm - nonfarm migration is roughly related to growth in nonfarm employment, but the latter is itself determined exogenously, outside the KASS system. KASS is of course by no means unique in treating demographic variables exogenously: the present state of our knowledge is such that some advance has been made in modeling the effect of population variables on economic variables, while efforts at completing the circle by modeling the impact of economic variables on demographic ones are still in their early stages.* From this reviewer's point of view, however, sufficient advances have been made in this latter area to require careful examination in any new sophisticated modeling work -- e.g., in KASS.

What role does population play in KASS? Demographic variables enter into the economic calculus in only two important respects.** The first is in the determination of consumption, urban and rural, and of nutritional "evaluation" variables. Rural consumption is determined by

$$(6) \quad CON_{ijk}^{(t)} = PCCON_{ik}^{(t)} * \overline{RPOP}_{ij}^{(t)} \quad ;$$

where the variables are respectively consumption of the kth commodity in the jth region under the ith alternative, per capita consumption, and regional rural population. Per capita consumption of the k commodities is a function of rural income and price elasticities, price, and per capita rural income. Rural/urban migration obviously affects rural consumption, both directly and through per capita rural income. The total supply of individual agricultural goods to the urban sector is given by

$$(7) \quad TDSUP_{ik}^{(t)} = TOUTPT_{ik}^{(t)}[1-PFLOSS_k] - PCCON_{ik}^{(t)} * TRPOP_i^{(t)} \quad ,$$

where the variables are respectively total supply of the kth good to the urban sector, total output of the kth good, marketing losses, per capita

---

* For probably the most advanced piece of work in this area, see R. Blandy and R. Wery, "BACHUE-1, The Dynamic Economic-Demographic Model of the Population and Employment Project of the World Employment Programme", Geneva, 1973, mimeo. Advanced work with an agricultural bias is also currently underway at Purdue University.

** I am omitting here the various calculations of evaluation variables measured in per capita terms.

rural consumptions of the kth goods and total rural population

Urban consumption demand for each good is a function of income, prices, total urban consumption projections and urban population, the total for all goods being constrained to projected total urban consumption. Any differences between rural supply and urban demand are recorded as a deficit.

In describing the determination of consumption, the KASS User's Manual makes two assertions which to me are misleading, if not erroneous. On page 2-4, we read that "rural consumption by item is computed as a function of agricultural income, producer prices, agricultural population and the nutritional requirements of the agricultural population as influenced by age and sex distribution." I see no evidence -- as indicated by equation (4) -- that age/sex distribution of the population actually enters into the determination of consumption levels.* Properly, it should; indeed, it has become customary in even less sophisticated models to weight population totals according to differential per capita consumption requirements of population age-sex groups.

On page 2-22, we read that total urban consumption CONSU is "obtained from a two-sector model of the Korean economy," but find on page 2-5 that this amounts to assuming that consumption grows at 9% under the three alternatives, as is consistent with the Third Five-Year Plan. Two problems with this procedure arise in my mind. First, is the two-sector model on which the 9% growth rate in consumption is based consistent with the KASS agricultural model? Is it consistent with the population projection model? If it is not, we are in very much the same situation as with basing migration figures on a projection model inconsistent with our own. I am more concerned with the fact that urban consumption grows at the same 9% under the three policy/price alternatives for the agricultural sector;** surely the widely different policy assumptions of these alternatives will have an impact on urban consumption.

---

* Age distribution does affect the calculation of nutritional requirements (protein and caloric), but it does not enter into the determination of commodity market equilibrium.

** NOTE: KASS, p. 81, Table VI-13, that urban food/nonfood consumption varies with the three alternative strategies, but that total urban consumption does not.

The problem here, as in the urban employment projection, is that KASS operates as if the urban sector functions independently of what is going on in the farm sector. Interaction between the two sectors is at an absolutely minimal level, and is primarily in the urban to rural direction.

The second major role of population in KASS is in the determination of labor force and labor requirements. With respect to supply, we have already observed that "agricultural manpower available" (See Table III -- A-2, KASS Special Report No. 6) remains constant regardless of different assumptions regarding fertility. The less rapidly growing population is also the less urbanized one; this may in fact be the case, but the means by which it is arrived at presents the theoretical difficulties already indicated. In addition, the labor force participation rates on which the economically active population figures are based are held constant over the projection period. We know that labor force participation has shown definite age-sex sector trends as modernization has proceeded elsewhere. Korea is fortunate in having a fairly large body of data on participation rates, providing the possibility of relating trends to indices of modernization. No effort has been made in this respect.

The demand for farm labor is determined by output or land-usage levels and exogenously specified per unit labor requirements. Any difference between farm labor demands and supplies is simply recorded as the ratio $RTSLI_{ij}^{(t)}$, the "regional seasonal labor-utilization index." Ideally one would expect to find that this utilization index influences the wage rate and thus off-farm migration. In KASS it does not, because off-farm migration is unaffected by different policies pursued with respect to agricultural modernization.

These two major functions of demographic variables in KASS strike me as being absolutely minimal ones, and are unsatisfactory in the indicated respects. Indeed, one feels that much of the great demographic detail regarding regional breakdowns and age-sex distributions produced in the projection model is wasted; this is especially true of the information on age-sex distribution, which has some impact on urban labor force size (but none on rural), and none on consumption patterns.

IV. Towards a More "Ideal" Model

When one considers the "ideal" treatment of demographic phenomena in an economic model, one looks for specification of five basic types of interactions. First, the size and composition of regional and economic sectoral populations are the major determinants of the labor force available to economic sectors, and thus affect output or supply potential. Secondly, the size, demographic composition, and income levels of populations are the major determinants of the demand for economic goods and services. Thirdly, the outputs of the public and private economic sectors -- income, education, etc. -- are the prime determinants of birth and death rates. Fourthly, per capita income and employment differentials appear to be important in determining internal migration rates. Beyond these basic economic-demographic interrelationships, there is also a minimal requirement for interaction between individual economic sectors -- mainly farm and nonfarm -- if the economic inputs to the demographic (and agricultural) relationships are to have much meaning.

I view a satisfactory treatment of these five sets of relationships to be something aspired to by any sophisticated modeling effort, particularly one which hopes to base policy prescriptions on model output. I have already indicated the need for further work by KASS on the first two sets of relationships. KASS has done nothing with respect to the third; it has made a start on the fourth, but to me an unconvincing one; its contribution on the fifth is even more unsatisfactory.

I do not wish the above summary to be read as an indictment of the KASS effort. Far from it. In a relatively short time frame, KASS has put together a model which has great potential for the study of the role of agriculture in Korean development. However, if that potential is to be realized -- particularly if KASS is to have much influence within the more sophisticated Korean research efforts at, for example, the Korean Development Institute -- KASS must now turn its attention to further development in the five above areas.

Top priority, in my mind, goes to the treatment of migration. KASS has already devoted substantial resources to the migration question

-- the consulting work done by Beegle, Kim, and Hathaway; the modeling work done by Carroll; the survey work financing the dissertations of Park Kang Sik and Kim Seyeoul. However, only a very marginal payoff has been achieved from these inputs; basic questions about migration patterns remain unresolved; the Park and Kim dissertation work has not been intergrated with KASS at all.* Most importantly from this reviewer's point of view is the fact that a great deal of work is being done by Koreans on migration in Korea, yet to this point KASS has not devoted resources to tapping these sources.

I doubt very much that the questions of migration and urbanization can be handled adequately by short-term consultants: the subject is simply too complex, and too much ongoing work is likely to be skipped over. Despite the quantity of current research on demographic issues in Korea and efforts to relate this research to development problems and needs, the lack of coordination of these activities and the resulting sense of indirection in some areas are real impediments to further progress. Much could be gained, therefore, by the addition of a longer term consultant to the KASS team whose specific assignment is the construction of a thoroughly conceptualized and empirically tested migration model, with a mandate for integrating this activity with other on-going migration research in Korea. The first task for this researcher will be a thorough examination of census (including the 1970 Census) and survey materials to answer the question of regional differentials in migration rates. The second step is to conceptualize a model for determing migration rates, regional if necessary, and connecting population flows to their economic determinants; empirical testing of the model follows, with a judgement as to its validity and appropriateness to the KASS system. The final step is the revised treatment of migration in the current KASS. I am optimistic as to the

---

* I am impressed with the work of Park; less impressed with that of Kim. In both cases, a very cursory examination of their dissertations indicated that further examination of their survey data may be worthwhile. As an aside, in any future external financing of this nature, I would prefer to see KASS devote resources to a more or less full time consultant responsible for assimilating what we know about migration in Korea and synthesizing it into a coherent model. I am skeptical of the payoff of financing further dissertation work of the survey type.

prospects for endogenizing migration within KASS; if this optimism proves unjustified, at the very least a simpler migration component whose premises are clearly stated and whose parameters are easily adjusted for the expected impact of alternative development strategies should be constructed.

The additional required work on internal migration will lead inevitably to a re-examination of the labor force question. It is my hope that some attention will be given to allowing for variable labor force participation rates, making them a function of key social and economic variables if possible. Contact should be established with researchers working on these questions at the Korean Development Institute and at the Ministry of Science and Technology.

The third area of great concern to me is the question of the interaction between the farm and nonfarm sectors. The current KASS evidences an incomplete conceptualization of exactly what these interactions are and, in my opinion, an inadequate appreciation of their importance in overall agricultural sector performance. Examples of this are urban aggregate consumption and employment projections which are invariant with quite different agricultural pricing and development strategies, and with quite different rates of population growth. Particular attention needs to be given to insuring that exogenous urban sector information used by KASS is based on models consistent with the KASS system: divergent sources of information should be used in simulation exercises only to the extent that the sources are consistent in their premises.

Beyond these priority areas, it is my hope that KASS will at some point further develop its manpower component to include educational inputs and outputs so as to provide information not only on labor force by sex and age, but also by educational level. Education indicies are important not only in determining labor force participation levels, and quality manpower projections, but also in any effort at endogenizing fertility levels and migration rates. Education flow models are already available, so that the work involved in adding this feature to KASS can be kept to a fairly low level. Besides contributing to KASS directly, the addition of an educational component will enhance KASS's usefulness to the various ministries interested in manpower projections.

V. Conclusion and Recommendations

If the "further research" bill of goods briefly indicated in the preceeding section amounts to a rather tall order, it is so only because

1) the work KASS has done to date indicates to me that where concentrated resources are applied, it can produce a significant contribution in a fairly short time span; and

2) the more successfully KASS is able to incorporate the important variables affecting agricultural output, the more likely is its product to be in general demand in Korea, and the more stature its conclusions are likely to acquire; a narrowly-conceived agricultural sector study can never hope to achieve the respect and usage of a more broadly integrated sectoral approach contributed to and understood by experts with diverse interests, not necessarily all agricultural.

In my estimation, KASS has made a commendable first approximation to incorporating demographic and nonagricultural variables into a sector study. In certain respects this first approximation is technically deficient; in others it is simply inadequate. These problems may be traced primarily to simply the inability to do everything at once in a massive undertaking.

I believe that KASS has a contribution to make to the understanding of the role of agriculture in Korean development, but that that contribution is severely limited at the present time by the factors discussed in this paper -- no doubt there are others; I speak only for the demographic component. In a sense, only the initial investment has been made by KASS-I. The real payoff will be forthcoming, provided that KASS is able to branch out to invite the interest of other key Korean socio-economic researchers. Assuming that KASS will push ahead in at least the major areas discussed in this paper, I am favorably inclined to the continuation of the project.