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CAUSAL MODELS AND FERTILITY BEHAVIOUR; THE CASE OF SRI LANKA

by

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1. Introduction

The existing literature on fertility in Sri Lanka highlight the implicitly understood functional relationships between fertility and demographic, socio-economic, cultural and environmental factors.[1] These studies also provide a framework to understand determinants of differential fertility in Sri Lanka. However, the specific mechanisms through which the socio-economic, cultural and environmental factors operate through biological and behavioural factors (the intermediate fertility variables) are yet to be identified. Unlike a direct fertility determinant, an intermediate fertility variable will always bear a direct influence on fertility. The following example will clarify this contention. If a change occurs in the prevalence of contraception (which is an intermediate variable) fertility will necessarily change accordingly. A similar change is not necessarily the case for an indirect determinant such as education. This highlights the necessity to quantify the contributions of the principal explanatory factors, as a means of discriminating among competing causal hypothesis. In this situation, the choice of a suitable statistical technique becomes crucial. The importance of selecting a satisfactory statistical method for use in fertility studies was recently addressed by Schultz in the following manner.

> .... the appropriate adaptation of a constrained decision making model to the study of differential fertility is likely to rely more heavily on accumulating empirical evidence and the interdisciplinary exchange of ideas. But to have meaning, facts must be collected and studied within a coherent and appropriately designed framework. A satisfactory statistical methodology for studying fertility determinants is, therefore, almost as important as the conceptual framework that emphasize the role of resource constrained choice[2]

The technique of path analysis, which determines the specific contribution of each variable by discriminating among competing causal variables, is used here to test and interpret notions previously postulated. It may be appropriate to mention at the outset that path analysis does not lead to the discovery of determinants or causes of fertility, but only verifies a postulated causal model.[3] This technique, originally established by Sewall Wright has found support among a growing number of researchers with an interest in fertility research.[4] Furthermore, as Land observed, path analysis seems to offer a promising strategy to increase the interaction between theory and empirical researchh.[5]

Path analysis specifies the contribution of each variable and then allows its users to ask more in-depth questions relating to fertility. For instance, do Low Country Sinhalese, Sri Lanka Tamils, Christians and urban populations bear fewer children than Kandyan Sinhalese, Sri Lanka Moors, Muslims, Hindus and rural populations, because the former group has a higher educational attainment? Or do Low Country Sinhalese, Sri Lanka Tamils, Christians and urban populations really have an influence on fertility, independent of the influence of educational attainment? Similarly, we can explore whether educational attainment has any effect on martial stability and childbearing apart from their influence on age at marriage. This paper attempts to clarify such dubious questions.

The technique of path analysis is employed using the date of the 10 percent Fertility Sample Survey of 1971 to identify and measure the factors that affect fertility and, hence to discriminate among competing causal variables. Since all socio-economic variables have spatial dimensions, the researcher then can identify the strength of their dimensions within a set of areal units. Within this context, we can begin to interpret variations in reproductive behavior using the path analysis technique. The latter holds promise for accounting not only for factors affecting fertility, but also for determining the relative contribution of each factor in explaining fertility levels. The attributes of path analysis are important on an applied level since knowing what factors have the greatest effect on fertility is important in allocating scarce resources in the most efficient manner. For Sri Lanka with her problems of high fertility, limited resources and acute foreign exchange imbalances, the latter has special significance.

2. Sources of Data and Choice of Variables

Table 1 gives the average number of children per family of the major ethnic and religious groups in Sri Lanka.[6]

Table 1

The Average Number of Children per Family by Major Ethnic Group 1971

Ethnic Group	*Average Number of Children per Family*
Low Country Sinhalese	5.7
Kandyan Sinhalese	7.1
Sri Lanka Tamil	5.9
Indian Tamil	5.3
Sri Lanka Moor	6.8
Indian Moor	6.9
Malay	6.6
Burgher/Eurasian & Others	4.0

Source: Compiled by author, using an Analysis of Variance Programme on 1971 Census data.

The average number of children per family in Table 1 for the major ethnic groups in Sri Lanka permitted us to combine some of the ethnic groups. For instance, Sri Lanka Tamils, with an average of 5.9 children per famiily and Indian Tamils with an average of 5.3 children per family, were combined and entered into our model as a single variable, identified simply as Tamils. Similarly, Sri Lanka Moor, Indian Moor and Malay with an average number of children per family at 6.8, 6.9 and 6.6, respectively, were combined to form the Moor/Malay variable. Burgher/Eurasian/Others, because of their small numbers, were considered as one group. The number of children per family in that group averaged four. However, the children per family in the Low Country and Kandyan Sinhalese ethnic groups were significantly different, being 5.7 and 7.1 respectively. It would be unwarranted to combine these two groups into a single variable.

To facilitate the task of choosing the appropriate variables for the Path Models, a multiple regression analysis was done for the completed and the current fertility models using a set of 15 independent variables. The set explained 32 percent of the variance in completed fertility and 62 percent of varinace in current. These statistics can be considered high, given the constraints of variable input. None of the husband's demographic or social characterstics nor the income of either husband or wife or contraceptive prevelance entered our regression models.

Our multiple regression results revealed the impact of literacy and education on fertility levels. Education was found to be more significant than literacy in explaining the variance in fertility. Moreover, education signifies the actual educational attainment of the individuals, and was there fore the more appropriate variable for this analysis.

Finally, only selected "life cycle" variables, which were thought to be related to fertility in a logical manner, entered into the path models. The elimination of the variables previously employed in our regression analysis leaves us with the variables listed below.

Since the ethnic variable and the area of residence variable were treated as two systems of "dummys" a variable from each of the two systems had to be deleted from the path models.[7] Though entered in the regression models, Burgher / Eurasian / Others variable and the estate variable do not have path values.

Each individual woman in the sample was assigned a score on every variable. The scores were:

Ethnicity (X_1, X_2, X_3, X_4,) : Since no one belongs to more than one ethnic group, ethnicity can be treated as a point dichotomous variable. Ethnic variables are therefore entered as "dummy" variables in the path model.

Place of Residence or Sector (X_5, X_6,) : Urban, rural and estate sectors cannot be treated on an interval scale. They, too, entered our model as "dummys".

Education (X_7) : Each woman received a score for this variable equal to the number of years of schooling completed at the time of the census. Scores ranged from "00" for no schooling to "39" for professional, technical and other qualifications at the post-graduate level.

Activity (X_8) : This was treated, for our purposes, as a three-scale variable. An unemployed woman scored "1", a woman engaged in home duties scored "2", and a woman employed outside the home scored "3".

Age at First Marriage (X_9) : This variable indicates the woman's reported age at first marriage.

Migration (X_{10}) : This is interpreted from the duration of stay in the place where the respondent reported as living at the time of the census. The longer an individual lives in the same place, the less migratory that individual is and vice-versa. This is grouped and coded in the following order:

Less than one year	1
1 to 4 years	2
5 to 9 years	3
10 years and over	4
Living since birth	5

Marital Status (X_{11}) : This variable is coded as follows:

Never married	1
Marriage disrupted (widowed, separated, divorced)	2
Marriage Customary	3
Marriage Registered	4

Duration of First Marriage (X_{12}) **:** This variable indicates the number of years since the woman first married, as reported by her at the time of the census.

Mortality (X_{13}) : This is equal to the difference between the number of children born and the number of children living, again as reported by the individual.

Fertility (X_{14}) : This variable equals the total number of children born alive as reported by the woman at the time of the census.

It was hypothesized earlier that the relative influence of these varisbles on fertility levels differs according to the stage in the life cycle reached by each woman. In order to treat both completed and current fertility, we chose to examine the fertility characteristics of two age cohorts. We selected those women who were 45-49 and 25-29 in 1971 for the above purpose. By scanning the data files of the two cohorts, we selected every fourth case from the 45-49 age cohort and every fifth case from the 25-29 age cohort. This was done to obtain approximately equal sample sizes. The resulting samples were : 5235 for the former and 5008 for the latter.

The means and the standard deviations for each of the 16 variables are presented for the two cohorts in Tables 2 and 3. As expect ed, education level is higher for the younger cohort. Also the younger cohort benefited more from improved health services than the older cohort. Mean mortality of the younger cohort is .27 ; while that of the older cohort is .78. As mean values for the migration variable indicate, the younger cohort appears to be more migratory than her older counterpart. Given the number of years exposed to reproduction, the older cohort has a completed family size of 5.9 children with a standrad deviation of 3.0. The younger cohort whose reproduction is only partially completed, records a mean family size of 2.9 children and a standard deviation of 1.8. (See Tables 2 and 3) Since the younger cohort practices contraception more effectively than the older cohort, the average number of children they would have when they reach 45-49 is expected to be at a lower level than the 5.9 of the 45-49 cohort.[8]

3. The Path Analysis Technique:

The technique of path analysis begins with a-priori postulated network among the variables under consideration. Kenneth Land has shown three primary sources of information from which to derive causal assumptions.

The first of these is the time order of the variables. The second is the literature on either experimental or case study results. The third is the theoretical assumptions of the area under investigation.[9]

In general, dependent relations are assumed to be linear, additive and causal. They are represented in a path analysis diagram by straight single headed arrows, extending from each determining variable to each variable dependent on it. Correlations which are assumed to exist between "exogenous" variables but for which no causal implications can be shown are represented by two-headed curvilinear arrows. This distinguishes them from causal arrows. Residual variables are represented by unidirectional arrows leading from the residual variables to the dependent variables. Since residual variables are not measured, it is conventional to attach literal subscripts to such symbols.[10] Figure 1, which is the schematic diagram for the ordering of the variables in the models explaining demographic and socio-economic determinants of fertility in Sri Lanka, displays the characteristics of a path model.

TABLE 2

ZERO ORDER CORRELATIONS, MEANS, STANDARD DEVIATIONS AND THE NUMBER OF VALID CASES OF THE ANALYSIS VARIABLES USED IN THE PATH MODAL FOR DETERMINANTS OF COMPLETED FERTILITY

Variable Number/Name	*Zero Order Correlation*	*Mean*	*Standard Deviation*	*Number of Valid Cases*
Low Country Sinhalese (X_1)	–.1519	.585	.493	5546
Kandyan Sinhalese (X_2)	.1476	.228	.420	5546
Tamil (X_3)	.0104	.148	.356	5546
Moor/Malay (X_4)	.0454	.033	.177	5546
Urban (X_5)	–.0443	.264	.441	5546
Rural (X_6)	.0407	.714	.452	5546
Education (X_7)	–.1794	6.370	6,314	5546
Activity (X_8)	–.0218	2.163	.453	5546
Age at First Marrige (X_9)	.3895	21.237	4,623	5546
Migration (X_{10})	.0329	4.330	.922	5546
Marital Status (X_{11})	.0539	3.700	.663	5546
Duration of first marriage (X_{12})	.3403	23.896	6.420	5596
Mortality (X_{13})	.4444	.784	1.246	5299
Fertility (X_{14})	1.0000	5.857	2,986	5299

TABLE 3

ZERO ORDER CORRELATIONS, MEANS, STANDARD DEVIATIONS AND THE NUMBER OF VALID CASES OF THE ANALYSIS VARIABLES USED IN THE PATH MODEL FOR DETERMINANTS OF CURRENT FERTILITY

Variable Number/Name	*Zero Order Correlation*	*Mean*	*Standard Deviation*	*Number of Valid Cases*
Low Country Sinhalese (X_1)	- 1349	.456	.498	5618
Kandyan Sinhalese (X_2)	.0264	.304	.460	5618
Tamil (X_3)	.0475	.176	.381	5618
Moor/Malay (X_4)	.1494	.060	.238	5618
Urban (X_5)	.0140	.226	.419	5618
Rural (X_6)	-.0658	.715	.452	5618
Education (X_7)	-.2631	7.632	6.456	5618
Activity (X_8)	.0294	2.113	.493	5618
Age at First Marriage (X_9)	-.5608	20.166	3.352	5617
Migration (X_{10})	.1296	3.860	1.355	5618
Marital Status (X_{11})	.0022	3.846	.487	5618
Duration of First Marrige (X_{12})	.6007	6.837	3.486	5461
Mortality (X_{13})	.5410	.268	1.061	5078
Fertility (X_{14})	1.0000	2.920	1.821	5078

The 14 variables selected for this study are presented in Figure 1 in what is believed to be a chronological or causal sequence. As depicted in that diagram there are six "exogenous" or "independent" variables $X_1 - X_6$ They are not directly affected by any other variables included in the model. These "exogenous" variables are: Low Country Sinhalese, Kandyan Sinhalese, Tamils, Moor / Malay, Urban and Rural. Ethnicity, because of its priority in time (being determined at birth) and its instiutional significance, was taken as an "exogenous" variable. This is postulated to have only a symmetric non-causal relationship to the sector variables, which are also described as "exogenous" variables. The model includes seven "endogenous" variables, $X_7 - X_{13}$, namely: education, activity, age at first marriage duration of stay or migration history, marital stability, mortality and duration of first marriage. These variables are treated in terms of both cause and effect. All possible relationships are shown in the schematic diagram using conventional symbols and letters. (see Figure 1)

This study, which attempts to discern the causal relations among socio-economic and demographic variables that determine fertility, does not deal with women in broad age categories, such as 15-44 or 15-49. Instead as described before two cohorts are chosen for the analysis the cohort 45-49 representing completed fertility and the cohort 25-29 representing current fertility behaviour. Demographic and socio-economic determinants of fertility, differ according to stages in the life cycle reached by women in the two age cohorts.

Ordering of the variables chosen for the path models which is diagramatically presented in Figure 1, can be described as a "recursive set of simultaneous equations, dealing sequentially with each of the variables in the causal ordering and describing each in terms of the regression of its causal antecedents upon it".[11] In our path model involving 14 variables X_1 - X_6 are considered causally independent upon the rest, X_{14} is causally dependent upon the rest; X_7 - X_{13} are causally intervening. Variables X_1 - X_6, the exogenous variables, are not to be explained. They are nconnected by double headed arrows and labelled with correlation coefficients. They do not require regression equations. This allows us to write stuctural equations for the path models in the following way :

$$X_7 = P_{71}X_1 + P_{72}X_2 + P_{73}X_3 + P_{74}X_4 + P_{75}X_5 + P_{76}X_6 + P_{7a}Z_a$$

$$X_8 = P_{81}X_1 + P_{82}X_2 + P_{83}X_3 + P_{84}X_4 + P_{85}X_5 + P_{86}X_6 + P_{87}X_7 + P_{8b}Z_b$$

$$X_9 = P_{91}X_1 + P_{92}X_2 + P_{93}X_3 + P_{94}X_4 + P_{95}X_5 + P_{96}X_6 + P_{97}X_7 + P_{98}X_8 \\ P_{9c}Z_c$$

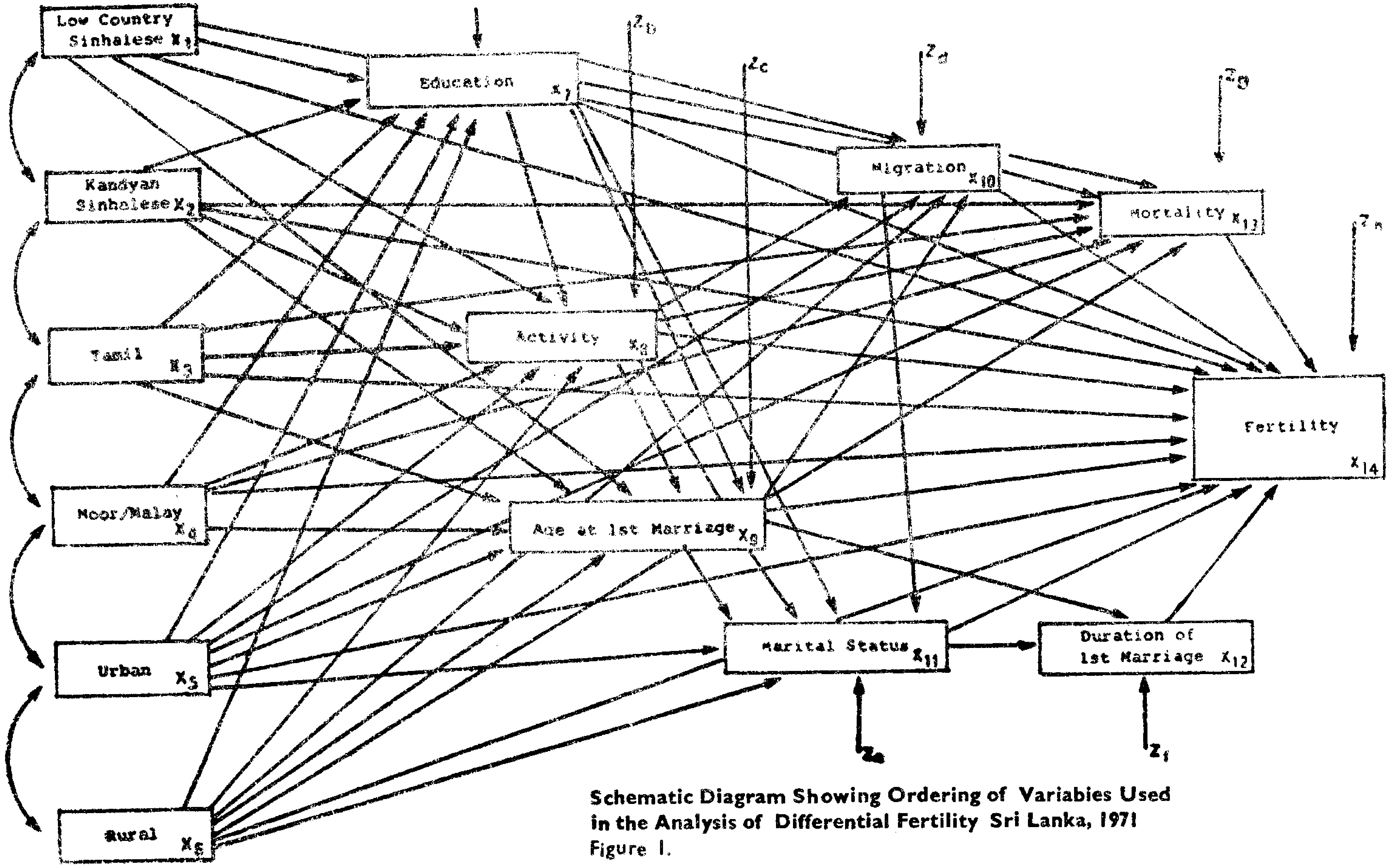
$$X_{10} = P_{105}X_5 + P_{106}X_6 + P_{107}X_7 + P_{108}X_8 + P_{109}X_9 + P_{10d}Z_d$$

$$X_{11} = P_{115}X_5 + P_{116}X_6 + P_{117}X_7 + P_{118}X_8 + P_{119}X_9 + P_{1110}X_{10} + P_{11e}Z_e$$

$$X_{12} = P_{129}X_9 + P_{121}X_1 + P_{12f}Z_f$$

$$X_{13} = P_{135}X_5 + P_{136}X_6 + P_{137}X_7 + P_{138}X_8 + P_{13g}Z_g$$

$$X_{14} = P_{141}X_1 + P_{142}X_2 + P_{142}X_3 + P_{144}X_4 + P_{145}X_5 + P_{146}X_6 + P_{147}X_7 + \\ P_{148}X_8 + P_{149}X_9 + P_{1410}X_{10} + P_{1411}X_{11} + P_{1412}X_{12} + P_{1413}X_{13} + \\ P_{14h}Z_h$$



Schematic Diagram Showing Ordering of Variabies Used in the Analysis of Differential Fertility Sri Lanka, 1971
Figure 1.

4. Path Models : Results

Examination of the path analysis statistics for the completed fertility model shows that of the 55 presumed paths, 32 were significant at the .05 level or better. (see Tables 4 and 5 and Figures 2 and 3). Based on these results, one could run a second path analysis using only the significant paths.[12] However, we must recognize the possibilities of committing either a Type 1 or a Type 11 error, the former by rejecting the null hypothesis when it is true, and the latter, by accepting the null hypothesis when it is faulse. Furthermore, studies have shown that "eliminating non-significant paths had little effect on the magnitude of significant paths".

Tables 4 and 5 present path analysis statistics for the two causal models, completed and current fertility. This information may now be used to make explicit how these variables affect fertility - both directly and indirectly. Figure 2 is the path diagram of the direct path coefficients presented in Table 4. Similarly, Figure 3 indicates the direct path coefficients of the current fertility model given in Table 5.

TABLE 4

PATH ANALYSIS STATISTICS FOR THE SYSTEM EQUATIONS SPECIFIED FOR THE COMPLETED FERTILITY MODEL.

Model	*Independent Variables*	*Path Coeff.*	*Std. Error*	*T Value*	*Sign Level*	*Total Ind.Eff.*
Education	Low Country Sinhalese	–.143	.085	– 1.68	.0890	.229
$R^2 = 3.03\%$	Kandyan Sinhalese	–.181	.074	– 2.46	.0134	.112
	Tamil ...	–.143	.063	– 2.28	.0214	.128
	Moor/Malay ...	–.146	.033	– 4.40	.0001	.083
	Uraban ...	.201	.043	4.65	.0000	–.068
	Rural ...	.068	.044	1.57	.1115	–.186
Activity (Occupation)	Low Country Sinhalese	.199	.081	2.45	.0135	–.250
	Kandyan Sinhalese	.277	.070	3.96	.0002	–.163
	Tamil ...	.124	.059	2.08	.0350	–.143
$R^2 = 12.77\%$	Moor/Malay ...	.050	.032	1.59	.1075	–.120
	Urban ...	–.615	.041	–14.96	.0000	.487
	Rural ...	–.508	.041	–12.30	.0000	.584
	Education ...	.283	.013	21.57	.0000	–.029
Age at First Marriage	Low Country Sinhalese	.140	.030	1.76	.0742	.100
	Kandyan Sinhalese	–.055	.069	– .80	.5686	–.104
	Tamil ...	–.056	.058	– .97	.6654	–.053
$R^2 = 15.88\%$	Moor/Malay ...	–.044	.031	– 1.43	.1484	–.035
	Urban ...	–.027	.041	– .65	.5216	.103
	Rural ...	–.053	.041	– 1.29	.1923	–.013
	Education ...	.317	.013	23.57	.0000	.018
	Activity ...	–.016	.014	– 1.21	.2239	.070
Migration (Duration of stay)	Urban ...	.118	.044	2.71	.0068	–.213
	Rural ...	.215	.043	4.10	.0000	–.102
	Education ...	–.086	.015	– 5.64	.0000	–.028
$R^2 = 2.63\%$	Activity ...	–.035	.014	– 2.38	.0163	–.022
	Age at First Marriage	–.028	.014	– 1.96	.0476	–.036
Marital Status	Urban ...	.236	.044	5.43	.0000	–.214
	Rural ...	.255	.043	5.90	.0000	–.245
	Education ...	.060	.015	3.95	.0003	.011
$R^2 = 2.79\%$	Activity ...	–.086	.014	– 5.94	.0000	.020
	Age at First Marriage	.086	.014	5.97	.0000	.018
	Migration ...	–.020	.014	– 1.48	.1345	–.001
Duration of 1st Marriage	Marital Status ...	.239	.011	22.29	.0000	–.064
$R^2 = 40.31\%$	Age at First Marriage	–.614	.011	–57.17	.0000	.025
Mortality	Low Country Sinhalese	–.020	.085	– .24	.8083	–.121
	Kandyan Sinhalese	.097	.074	1.32	.1836	.004
$R^2 = 3.72\%$	Tamil	.074	.062	1.19	.2316	–.015
	Moor/Malay	.042	.033	1.26	.2060	–.004
	Urban ...	.023	.044	.52	.6081	–.048
	Rural ...	.016	.044	.36	.7167	.003
	Education ...	–.135	.014	– 9.40	.0000	–.001
	Activity	.038	.015	2.58	.0096	–.028

TABLE 4 (Continued)

Model	*Independent Variables*	*Path Coeff.*	*Std. Error*	*T Value*	*Sign Lelev*	*Total Ind.Eff.*
Fertility	Low Country Sinhalese	-.159	.072	- 2.20	.0260	.007
	Kandyan Sinhalese	-.074	.062	- 1.19	.2304	.222
$R^2 = 31.65\%$	Tamil ...	-.133	.053	- 2.51	.0117	.143
	Moor!Malay ...	-.045	.028	- 1.58	.1090	.090
	Urban ...	-.029	.037	- .79	.5632	-.015
	Rural ...	-.028	.037	- .76	.5474	-.069
	Education ...	-.029	.013	- 2.28	.0213	-.150
	Activity ...	.004	.012	.29	.7661	-.025
	Age at First Marriage	-.225	.016	-14.45	.0000	-.165
	Migration ...	.008	.012	.69	5050	.025
	Marital Status ...	.078	.012	6.33	.0000	-.024
	Duration of First Marriage	.373	.012	31.57	.0000	.072
	Mortality ...	.129	.015	8.67	.0000	.212

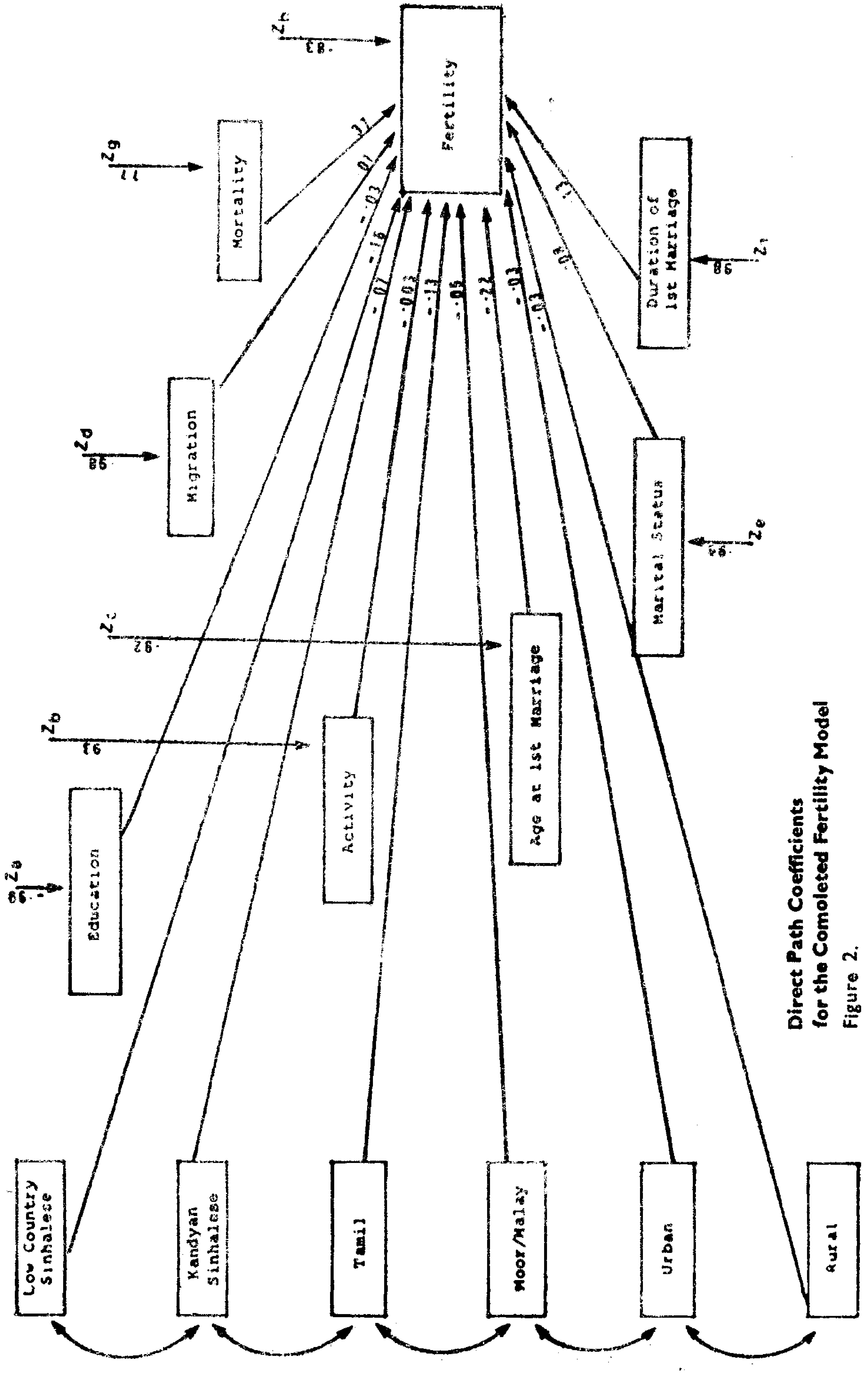
TABLE 5

PATH ANALYSIS STATISTICS FOR THE SYSTEM pF EQUATIONS SPECIFIED FOR THE CURRENT FERTILITY MODEL

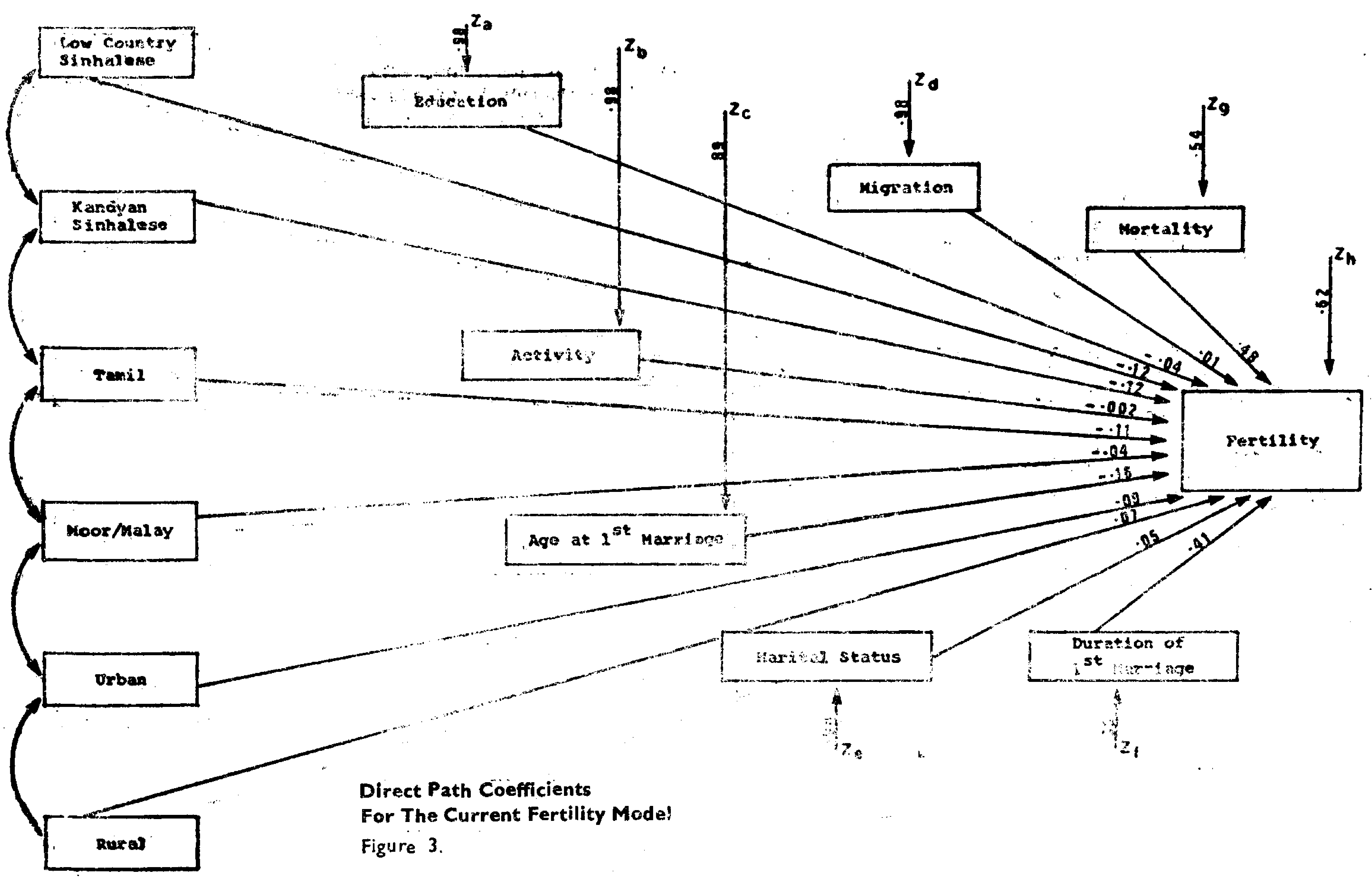
Model	*Independent Variables*	*Path Coeff.*	*Std Error*	*T Value*	*Sign. Level*	*Total Ind.Eff.*
Education	Low Country Sinhalese	-.188	.098	- 1.92	.0518	.315
	Kandyan Sinhalese	-.230	.091	- 2.53	.0111	.197
$R^2=4.69\%$	Tamil ...	-.229	.076	- 3.03	.0029	.147
	Moor/Malay ...	-.219	.048	- 4.55	.0000	.131
	Urban ...	.258	.029	8.89	.0000	-.123
	Rural ...	.138	.030	4.58	.0000	-.203
Activity	Low Country Sinhalese	-.071	.094	- .75	.5420	-.086
(Occupation)	Kadyan Sinhalese ...	.063	.088	.69	.5034	-.024
	Tamil ...	-.021	.072	- .28	.7729	.158
$R^2=12.33\%$	Moor/Malay ...	-.038	.046	- .82	.5804	-.016
	Urban ...	-.610	.028	-21.76	.0000	.479
	Rural ...	-.598	.029	-20.69	.0000	.533
	Education ...	-.020	.013	- 1.46	.1393	-.049
Age at First	Low Country Sinhalese	.185	.089	2.07	.0362	.049
Marriage	Kandyan Sinhalese	.040	.083	.49	.6320	- 124
	Tamil ...	-.038	.069	- .56	.3850	-.081
$R^2=20.78\%$	Moor/Malay ...	.065	.044	- 1.49	.1326	-.075
	Urban ...	.106	.028	- 3.82	.0003	.183
	Rural ...	-.149	.029	- 5.21	.0000	.095
	Education ...	.376	.013	29.35	.0000	.029
	Activity ...	-.033	.013	- 2.48	.0127	.032
Migration	Uraban ...	.073	.028	2.57	.0099	-.087
(Duration	Rural ...	.075	.028	2.69	.0072	-.047
of Stay)	Education ...	-.101	.015	- 6.69	.0000	-.055
$R^2=4.65\%$	Activity ...	-.021	.015	- 1.46	.1392	.004
	Age at First Marriage	-.153	.015	-10.16	.0000	-.038
Marital	Urban ...	.171	.029	5.96	.0000	-.118
Status	Rural ...	.158	.028	5.59	.0000	-.155
	Education ...	.051	.015	3.34	.0012	.056
	Activity ...	-.021	.015	- 1.46	.1403	.037
	Age at First Marriage	.078	.015	5.12	.0000	.039
	Migration ...	-.066	.014	- 4.66	.0000	-.020
Duration of						
First Marr.	Marital Status ...	.053	.008	6.84	.0000	-.020
$R^2=70.73\%$	Age at First Marriage	-.846	.008	-110.56	.0000	.006
Mortality	Low Country Sinhalese	-.060	.099	- .61	.5517	-.011
	Kandyan Sinhalese	-.026	.092	- .28	.7746	.020
$R^2=1.80\%$	Tamil ...	-.004	.077	- .05	.9572	.042
	Moor/Malay ...	.072	.049	1.48	.1348	.026
	Urban ...	.003	.031	- .10	.9174	.027
	Rural ...	-.033	.032	- 1.03	.3019	-.009
	Education ...	-.059	.014	- 4.17	.0001	-.013
	Activity ...	.027	.015	1.85	.0610	.099

TABLE 5 (Continued)

Model	*Independent Variables*	*Path Coffe.*	*Std. Error*	*T Value*	*Sign. Level*	*Total In.Eff.*
Fertility	Low Country Sinhalese	–.123	.063	– 1.97	.0446	–.011
	Kandyan Sinhalese	–.122	.058	– 2.10	.0339	.148
$R^2 = 61.13\%$	Tamil ...	–.105	.048	– 2.16	.0285	.152
	Moor/Malay ...	–.038	.031	– 1.24	.2128	.188
	Urban ...	.093	.020	4.72	.0000	–.079
	Rural ...	.072	.020	3.60	.0006	–.078
	Education ...	–.037	.010	– 3.80	.0004	–.226
	Activity ...	–.002	.010	– .24	.8020	.032
	Age at First Marriage	–.160	.017	– 9.46	.0000	–.401
	Migration ...	.005	.009	.55	.5875	.125
	Marital Stability ...	.046	.009	5.07	.0000	–.043
	Duration of 1st Marriage	.483	.009	54.46	.0000	.058
	Mortality ...	.410	.016	25.27	.0000	.191



Direct Path Coefficients for the Comoleted Fertility Model
Figure 2.



Direct Path Coefficients
For The Current Fertility Model
Figure 3.

The observed correlation coefficients of each of the multiple regression models specified in our path models are considered the effects of path coefficients on the variables. Therefore, we use the observed correlations to compute the values of path coefficients.[14] If X_j (fertility) is dependent on X_1, X_2...........X_i and, if this relationship is linear, we may then write:

$$X_j = P_{j1}X_1 + P_{j2}X_2 + P_{j3}X_3 + \dots\dots\dots\dots P_{ji}X_i$$

when X_1, X_2...........X_i are expressed in standard scores, then P_{ji} is the Path Coefficient from variable 'i' to variable 'j'. The conventional procedure in path analysis is to present the dependent variable with the first subscript - 'j'. Therefore, P_{ji} is the proportion of the standard deviation of the dependent variable for which the independent variable 'i' is directly responsible. In other words, P_{ji} is the proportion of the standard deviation of variable 'j' which would be found if variable 'i' varies to the same extent that it did in the original data while controlling for the effects of other independent variables.[15]

In path analysis, all variables are expressed in standard scores, a logical extension of multiple regression analysis. However, in a path model, the source of variation in the dependent variable can be broken down into:i) the direct effects of the independent variables, measured by *path coefficients*, *ii*) the indirect effects resulting from the intervening variables, measured by compound *path coefficients*, and iii) unaccounted for variation caused by extraneous variables, measured by the *residual path coffjicients*.[16] It is this decomposition of the variation of the dependent variable into direct, indirect and residual path coefficients that will help answer some of the questions posed at the beginning of this paper.

The results of the path analysis Model 1, for completed fertility, which is summarized and presented in Table 6 and Figure 2, indicate that the major determinant of the variation in fertility is mortality. with a path coefficient of .37 significant at .00 level. Age at first marriage, duration of first marriage and marital stability are the other variables significant at .00 level. Their path coefficients are : .22, .13 and .08, respecitively. Low Country Sinhalese (-.16), Tamil (-.13) and education (-.03) are the remaining variables with coefficients significant at .05 level, other input variables do not contribute much towards explaining variation in fertility. (See Table 6).

In the current fertility model, ten out of 13 variables were shown to be significant at .05 level or better. (See Table 7 and Figure 3). In the order of importance, they are: mortality (.48), duration of first marriage (.41), age at first marriage (-.16), Low Country Sinhalese (-.12), Kandyan Sinhalese (-.12) Tamil (-.11), Urban (.09). rural (.07), marital stability (.05) and education (.04). Moor/Malay, activity, and migration were not significant at .05 level.

In both models, residual variables introduced to represent unaccounted for variance in fertility, as well as those of the endogenous independent variables, have very large path coefficients. (See Tables 6 and 7) In the current fertility model, variation explained by residuals amounted to 38.0 percent; whereas in the completed fertility model, this statistic was 68.4 percent. Except for mortality, which had a residual path coefficient of .54 and .77 in the current and completed fertility models, respectively, all other in ndependent variables have residual path coefficients of .9 or higher level. (See Tables 6 and 7). These residual variables, which are assumed to be uncorrelated, may be thought to depict errors of measurement of the input variables and inadequacy of variables drawn into the model. Fertility, itself, had residual path coefficients of .82 and .62 for the completed and current fertility models, respectively.

TABLE 6

PATH ANALYSIS STATISTICS FOR THE CAUSAL MODEL : DETERMINANTS OF DIFFERENTIAL COMPLETED FERTILITY

Independent Variable	*Path Coeff.*	*Stand. Error*	*T Value*	*Sing. Level*	*Total Ind. Effect*	*Residual Path Coeff.*
Low Country Sinhalese	-.158	.072	- 2.20	.0260	.067	—
Kandyan Sinhalese ...	-.074	.062	- 1.19	.2304	.222	—
Tamil	-.133	.053	- 2.51	.0117	.143	—
Moor/Malay ...	-.045	.028	- 1.58	.1090	.090	—
Urban	-.029	.037	- .79	.5632	-.015	—
Rural	-.028	.037	- .76	.5474	.069	—
Education	-.029	.013	- 2.28	.0213	-.150	.985
Activity	.003	.012	.29	.7661	-.025	.934
Age at First Marriage	-.224	.016	-14.45	.0000	-.165	.917
Migration	.008	.012	.69	.5050	.025	.987
Marital Status ...	.088	.012	6.33	.0000	-.024	.986
Mortality	.373	.012	31.37	.0000	.072	.773
Duration of 1st Marriage	.129	.015	8.67	.0000	.213	.981

Variation Explained by Path Coefficient = 26.50%

Variation Explained by Correlation = 5.14%

Variation Explained by Residuals = 68.35%

Residual Path Coefficient for the Dependent Variable - Fertility .8268

TABLE 7

PATTH ANALYSIS STATISTICS FOR THE CAUSAL MODEL : DETERMINANTS OF DIFFERENTIAL CURRENT FERTILITY

Indpendent Variable	*Path Coeff.*	*Stand. Error*	*T Value*	*Sign. Level*	*Total Ind. Effect*	*Residual Path Coeff.*
Low Country Sinhalese	-.123	.063	- 1.97	.0456	.011	—
Kandyan Sinhalese ...	-.122	.058	- 2.10	.0339	.148	—
Tamil	-.105	.048	- 2.16	.0285	.148	—
Moor/Malay ...	-.038	.031	- 1.24	.2129	.188	—
Urban	.093	.020	4.72	.0000	-.079	—
Rural	.073	.020	3.60	.0005	-.079	—
Education ...	-.037	.010	- 3.80	.0004	-.226	.976
Activity	-.002	.009	- .24	.8020	.032	.936
Age at First Marriage	-.160	.017	- 9.46	.0000	-.401	.890
Migration ...	.005	.009	.55	.5875	.125	.976
Marital Status ...	.046	.009	5.07	.0000	-.043	.984
Mortality	.483	.009	54.46	.0000	.058	.541
Duration of 1st Marriage	.410	.016	25.27	.0000	.191	.991

Variation Explained by Path Coefficients = 48.65%
Variation Explained by Correlation = 12.48%
Variation Explained by Residuals = 38.87%
Residual Path Coefficient for the Dependent Variable - Fertility = .6235

Complete Determination of Variation in a path model is the sum of the direct effects, correlational effects and residual effects. In the completed fertility model, total variation explained by path coefficients amounted to 26.50 percent. Correlation explained 5.14 percent and variation explained by residuals amounted to 68.35 percent. Corresponding statistics for the current fertility model are : 48.65, 12.48, and 38.87 percent, respectively. Compared to the current fertility model, which had 48.65 percent variation explained by the paths alone, the completed fertility model had only 26.50 percent of the variation explained by the same paths. We may conclude that the input set of demographic and socio-economic variables explained more variation in current fertility than that of completed fertility. This result is not unexpected. For the regression analysis of a previous study revealed how the younger age cohort benefitted more by ongoing social and economic changes in Sri Lanka.[17]

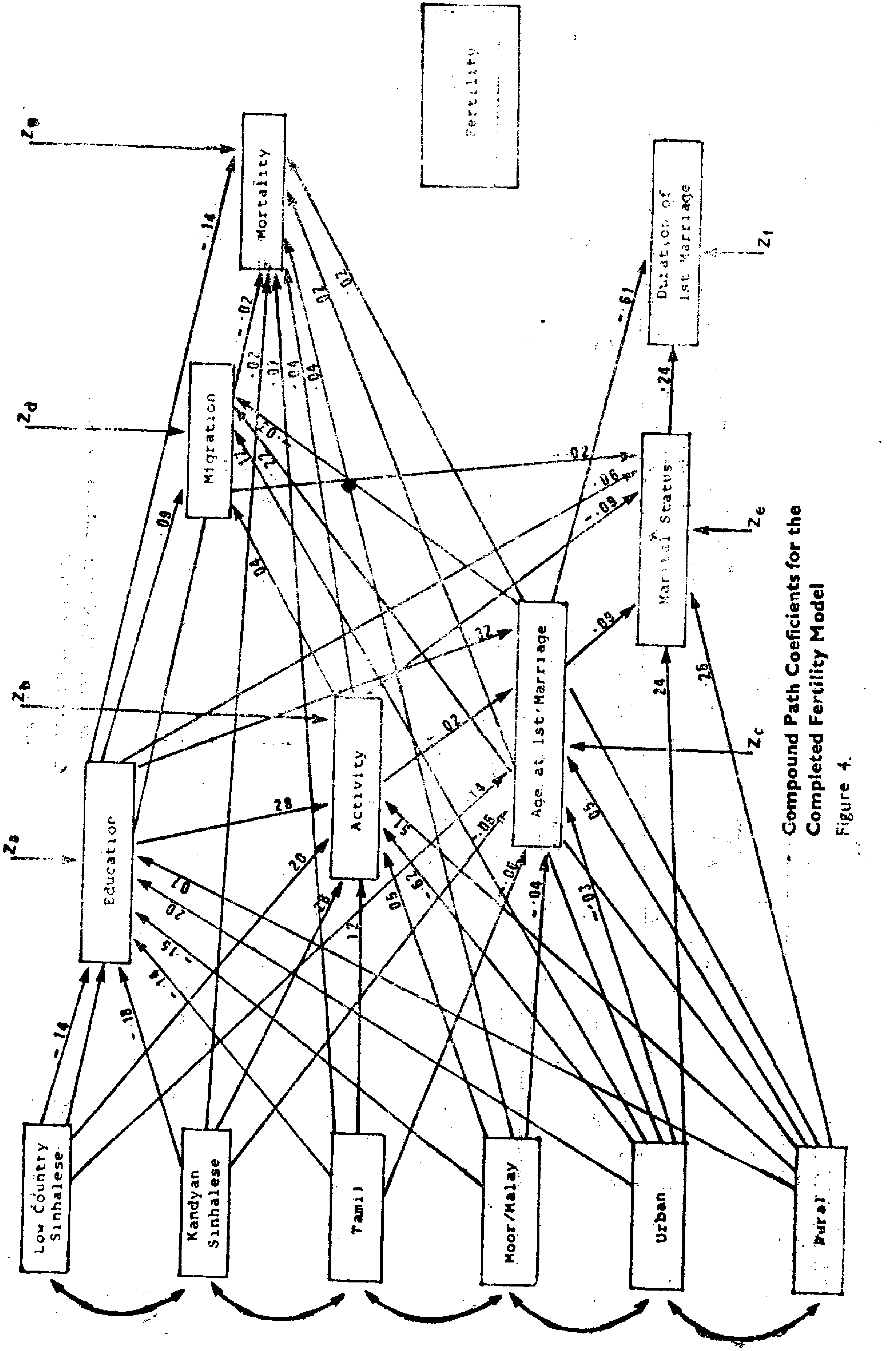
Structural equations were presented for all intervening "endogenous" variables in the two models. The path analysis outputs have direct effects, correlational effects and residual effects. All three effects are printed for each of the postulated networks in the regression models prescribed. Since percent variation explained by residuals which is not accounted for in the model, is so large, we shall not attempt to explain all compound paths. (Table 8 and Figure 4 and 5). However, for illustrative purposes, we shal explain age at first marriage whose causal network is illustrated in Figure 6l

Age at first marriage is an important life cycle variable determining. differential fertility in Sri Lanka. This has a direct path coefficient of -.224 to fertility in our completed fertility model. Age at first marriage, determined by eight other variables as depicted in Figure 6, illustrates how education with a positive path coefficient of .32 has become the most important determinant to woman's age at first marriage. An increase in the age at marriage for women tends to shorten the fecund marital period. Such an impact, especially in the early part of a woman's reproductive life when she is more fertile, is effective in lowering birth rate.

TABLE 8

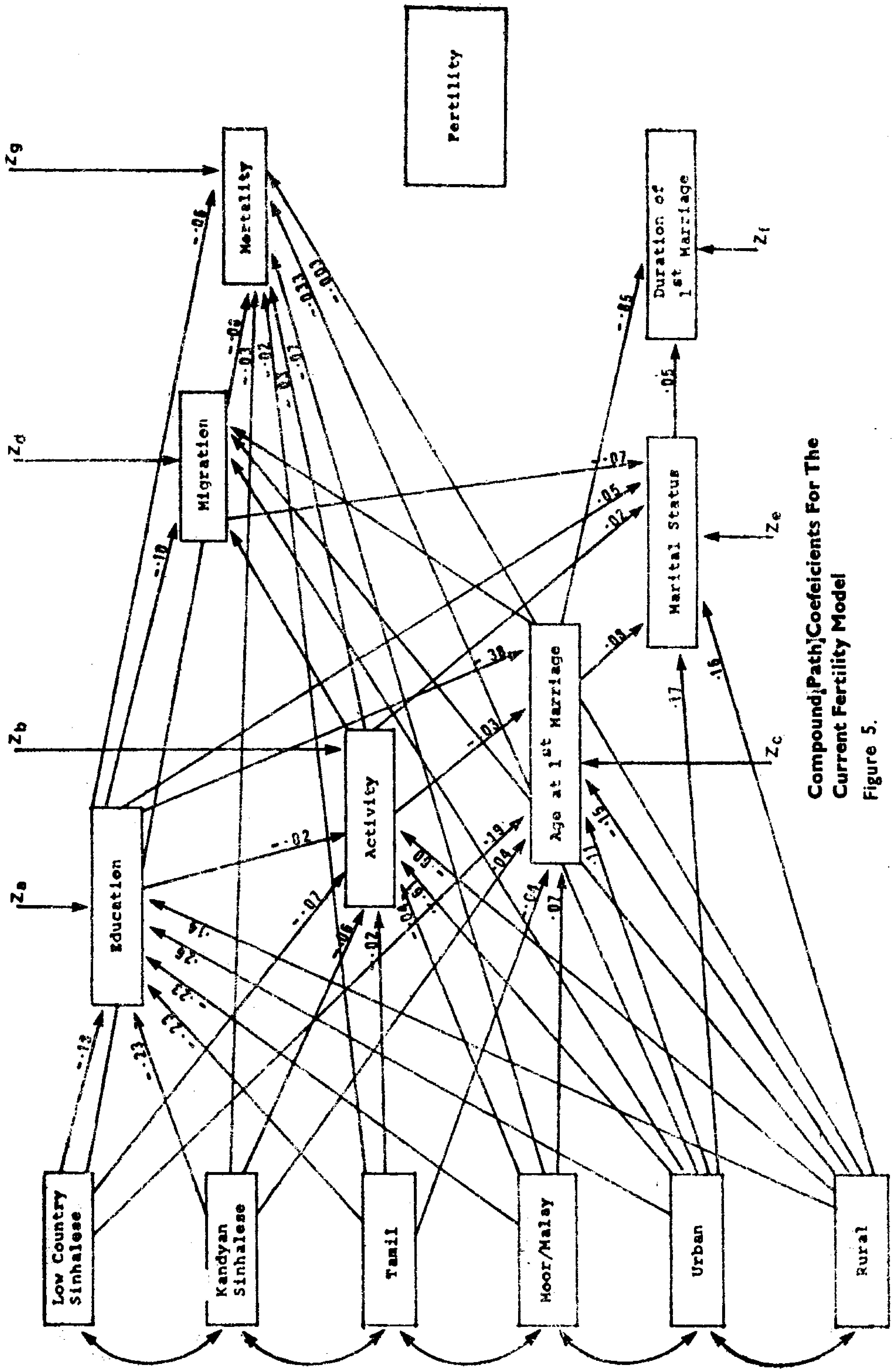
COMPLETE DETERMINATION OF VARIATION FOR EACH PATH MODEL POSTULATED FOR THE INTERVENING ENDOGENOUS VARIABLES

	Completed Fertility (Percent Variation Exp. by)			*Current Fertility (Percent Variation Exp. by)*		
Model	*Path Coeff.*	*Colre- lation*	*Resid- uals*	*Path Coeff.*	*Corre- lation*	*Resid- uals*
Education	14.02	-10.99	96.97	27.37	-22.67	95.30
Activity (Occupation)	85.05	-72.29	87.24	74.02	-61.69	87.67
Age at First Marriage	13.20	2.68	84.12	21.74	- .97	79.23
Migration	6.95	- 4.30	97.35	4.50	.15	95.35
Marital Stability	13.95	-11.15	97.21	6.76	- 3.65	96.89
Duration of 1st Marriage	43.37	- 3.06	59.69	71.77	- 1.04	29.27
Mortality	3.75	- .03	96.28	1.50	.30	98.20



Compound Path Coeficients for the Completed Fertility Model

Figure 4.



Compound Path Coefeicients For The Current Fertility Model

Figure 5.

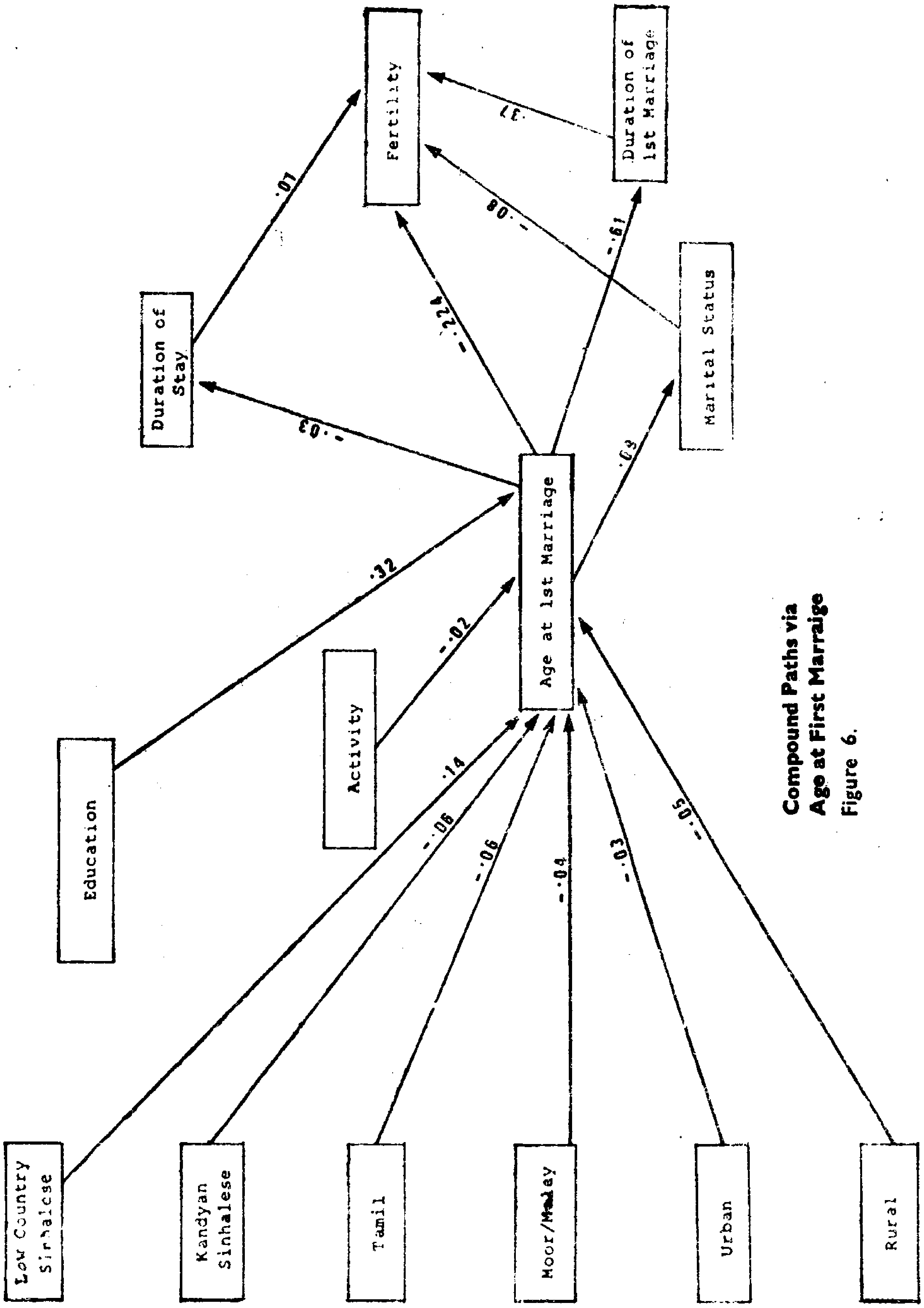


Figure 6.
Compound Paths via Age at First Marraige

Of the four ethnic groups, Low Country Sinhalese have a positive path coefficient (.14) with age at first marriage. This illustrates that being Low Country Sinhalese had a direct relationship on fertility. This result is expected since we are aware that Low Country Sinhalese tend to marry later than members of other ethnic groups. Data on mean age at marriage indicate that Low Country females marry at the average age of 23.6 years; Kandyan females marry at the average age of 21,6 years; and Muslim females marry at the average age of 18.7 years.[18] These differentials are explained by the prevailing cultural norms of each ethnic group in Sri Lanka.

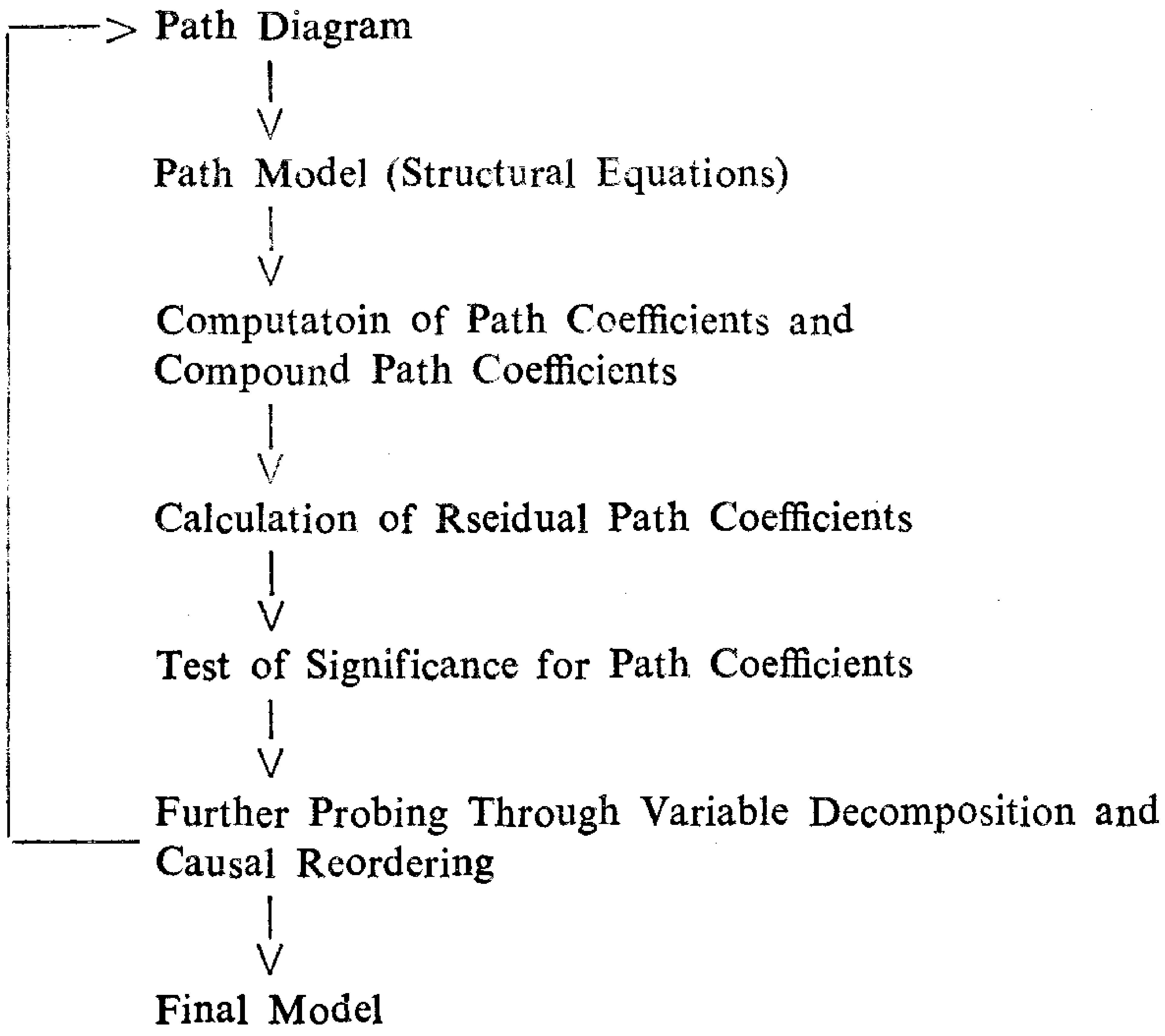
Rural / urban differential in determining age at first marriage, though small, is nevertheless made clear by their path coefficients of -.05 and .03, respectively.

Three compound paths are shown in Figure 6 for age at first marriage and fertility. They are:

(i) Age at 1st marriage - duration of stay - fertility
(ii) Age at 1st marriage - marital status - fertility
(iii) Age at 1st marriage - duration of 1st marraige - fertility

Of these, the third path with a coefficient of -.61 on duration of first marriage which, in turn, has a path coefficient of +.37 with fertility is the most significant compound path. This compound path, though self-explanatory, reveals an interesting factor. That is, the longer women are exposed to the risk of pregnancy, the more children they bear. This suggests the need for family limitations within marriage.

The results of the two path models are acceptable. However, we conclude that this analysis is more illustrative than conclusive. In order to obtain more definitive results, we recommend the introduction of a different variable space predicated upon new casual ordering of the variables. We find the model testing flow chart created by Edari to be of use in this situation.[19] The Edari chart is presented:



5. Summary and Conclusions

As a result of the previous analysis, we may now conclude that the major determinants of differential completed and current fertility are : mortality, age at first marriage and duration of first marriage. Education- which has negative path coefficients with fertility in both models though not unexpected is, nevertheless, an important variable. It is important to note two intervening effects of education on the compound paths: the positive path from education to age at first marriage which is negatively linked to fertility and the negative path from education and mortality is linked negatively to fertility. Therefore, education which is directly related to two important ferility determinants in Sri Lanka and which can be plausibly linked to policy instruments must be given higher priority over other socioeconomic variables in any attempt to place real limitations on existing ferility levels of Sri Lanka women.

Our analysis, though not conclusive in terms of explaining all or most of the variation in frertility levels of Sri Lanka women, demonstrates the potential of path analysis in analysing differential fertility. It permits one to incorporate a variety of variables and integrate them into a cohesive system. In so doing, it permits one to collapse data analysis and theory construction into one step. This is a technique which allows for explicit expression of theory and its direct evaluation through statistical procedures.

Path analysis can provide a meaningful statistical model to incorporate traditional verbal theories and current empiricial research findings on differential fertility.

Although potential benefits of this technique are many, difficulties could arise at the initial stage. The dependence on an a *a priori* causal scheme, whose conifidence level cannot be measured, poses the greatest impediment on the use of this technique. Retrospective understanding of the time order of the variables, existing literature on fertility and theoretical assumptions of the area under consideration become imperative. Since the path analysis technique helps evaluate statistically an already postulated theory, the burden lies on the researcher's ability to specify a parsimonious but, nevertheless a relatively complete model.

NOTES

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3. Sewall Wright, "The Method of Path Coefficients", Annals of Mathe matical Statistics, V, September 1934 pp. 161-215.

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6. Using the Basic Statistical Package of the Social Science Research Facility of the University of Wisconsin-Milwaukee, an Analysis of Variance was performed on data on ethnicity. The results of this program gave the average number of children per family for each ethnic group and also showed the difference of these values with their significance levls.

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10. Sewall Wright, op. cit.

11. H. M. Blalock, Jr., Editor, *Casual Models in the Social Sciences*, (Choicago, Aldine Publishing Company, 1971) pp. 73-152.

12. David R. Heise, "Problems in Path Analysis and Csaual Inference in Edgar F. Borgatta, *Sociological Methodology*, op. cit. See section on theory trimming and causal inference, pp. 59-65.

13. Hugh Gene Loebner, op. cit., pp. 177-178.

14. The program used for path analysis is the Basic Statistical Package for MULREG (multiple regression) with path Analysis option, developed by Social Science Research Facility, University of Wisconsin, Milwaukee, 1973.

15. For a better description of basic theorem of path analysis, the reader is referred to Otis Dudley Duncan, "Path Analysis: Sociological Examples, "*American Journal of Sociology* LXXXII, 1966 pp. 1-16.

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