UNIVERSITY OF SWAZILAND

MAIN EXAMINATION 2009

TITLE OF PAPER: INDIRECT TECHNIQUES FOR DEMOGRAPHIC ESTIMATION

CORSE NUMBER: DEM 303

TIME ALLOWED: 3 HOURS

INSTRUCTIONS: ANSWER QUESTION 1 AND ANY THREE QUESTIONS. ALL QUESTIONS ARE WORTH 25 MARKS EACH.

REQUIREMENTS: CALCULATOR

THIS PAPER SHOULD NOT BE OPENED UNTIL PERMISSION HAS BEEN GIVEN BY THE INVIGILATOR

SECTION A: Compulsory

Question 1

a) What is a demographic model and why is it useful?(4)

b) Distinguish between model life tables and model stable populations (4)

c) Describe briefly the characteristics of each region (family) of the Coale and Demeny regional model life tables. (8)

d) Briefly describe the United Nations model life tables for developing countries. (9)

SECTION B (answer any 3 questions)

Question 2

a) What is the use of the Brass Relational Gompertz model? (3)

b) You are given the following age specific fertility rates for country X. Fit the Brass Relational Gompertz model. (16)

Age	ASFR per 1000
15-19	137.5
20-24	256.9
25-29	247.8
30-34	194.4
35-39	146.3
40-44	68.7
45-49	30.6

c) What are the meanings of the parameters of the Relational Gompertz model obtained above? (6)

Question 3

a) Describe **any** of the following indirect estimation methods. Make sure to include the data requirements, computational procedures and interpretation of parameters (where applicable). (12)
   a. Coale –Trussel model
   b. Widowhood method
   c. P_1/F_1 Ratio method for first births

b) What are the assumptions of the Brass Growth Balance method? (8)

c) Give an interpretation of the two main parameters of the Coale-McNeil Nuptiality model. (5)

Question 4

a) With regard the orphanhood method for estimating adult mortality, state the following: the assumptions, principles and limitations. (9)

b) You are given the data below on proportion of females whose mothers were alive at the time of interview, classified by five-year age groups: (8)

Age	Proportion with mother alive, S(n)
15-19	0.9283
20-24	0.8639
25-29	0.7911

Using Hill and Trussel variant of the orphanhood method, calculate l_{45}/l_{25} and l_{50}/l_{25} assuming the mean age at maternity is 30 years.

You may find the following information useful:

l_{25+n}/l_{25} = a(n)+b(n)M+ c(n)S(n-5) where

n	a(n)	b(n)	c(n)
20	-0.1798	0.00476	1.0505
25	-0.2267	0.00737	1.0291
30	-0.3108	0.01072	1.0287

c) Find the value of ${}_4q_1$ corresponding to level 14.6 in the female South model life table. (4)

d) Find the value of ${}_3d_2$ corresponding to level 13.8 in the female North model life table. (4)

Question 5

a) Outline two uses of stable populations. (4)

b) What are the characteristics of a stable population? (6)

c) Without performing any mathematical derivation, show the formulas (with explanations) that can be used to estimate the following parameters of a stable population:
   i. intrinsic birth rate (2)
   ii. proportion of a stable population at age x –C(x) (2)
   iii. intrinsic rate of growth (2)

d) What is meant by the reverse survival technique? Give two problems associated with reverse survival estimates. (6)

e) Give any three uses of the Brass Logit model. (3)

Question 6

a) What are the assumptions of the P/F ratio method for estimating fertility based on children ever born? (4)

b) In the 1973 Sudanese census, data was obtained on children ever born and births in the last 12 months. Based on these results, attempts were made to estimate the total fertility rate (TFR) using the Trussel variant of Brass P/F ratio method. The results are shown in Table 1 and 2 below using standard symbols.
   a. Fill in the blanks in the table. (16)
   b. Estimate the adjusted TFR for Sudan. (5)

NB: Please refer to the attached Appendix for the relevant formulae and coefficients.

Table 1

i	ASFR	Φ(i)	Parity	F(i)	P(i)/F(i)
1	0.1061	0.5304	0.369	0.234	(v)..
2	0.2496	1.7784	1.792	(iii)....	1.43
3	0.2567	...(i).	3.283	2.5673	1.28
4	0.1986	4.0549	4.358	3.650	1.19
5	0.1425	4.7674	5.01	4.5173	1.11
6	0.0551	...(ii)..	4.943	...(iv).....	1.01
7	0.0312	5.1989	4.854	5.1622	0.94

Table 2

i	w(i)	1-w(i)	f+(i)	f*(i)
1	0.083	1.00	0.127	0.165
2	0.1045	0.9170	0.256	0.333
3	0..1168	0.8955	0.253	(viii)
4	0.1215	0.8832	0.193	0.251
5	0.1716	0.8785	(vii)...	0.176
6	(vi).....	0.8284	0.051	0.066
7		0.8224	0.026	0.034

APPENDIX

TABLE OF COEFFICIENTS

$$F(i) = \phi(i-1) + a(i)\,f(i) + b(i)\,f(i+1) + c(i)\,\phi(7) \qquad (1)$$

Where a(i), b(i) and c(i) have the following values:

Age group	i	a(i)	b(i)	c(i)
15-19	1	2.351	-0.188	0.0024
20-24	2	3.321	-0.754	0.0161
25-29	3	3.265	-0.627	0.0145
30-34	4	3.442	-0.563	0.0029
35-39	5	3.518	-0.763	-0.0006
40-44	6	3.862	-2.481	-0.0001
45-49	7	3.828	0.016[a]	-0.0002

[a] This coefficient should be applied to f(6) instead of f(8)

$$w(i) = x(i) + \frac{y(i)\,f(i)}{\phi(7)} + \frac{z(i)\,f(i+1)}{\phi(7)} \qquad (2)$$

Where x(i), y(i) and z(i) have the following values:

Age group	i	x(i)	y(i)	z(i)
15-19	1	0.031	2.287	0.114
20-24	2	0.068	0.999	-0.233
25-29	3	0.094	1.219	-0.977
30-34	4	0.120	1.139	-1.531
35-39	5	0.162	1.739	-3.592
40-44	6	0.270	3.454	-21.497

$$f^*(i) = (1-w(i-1))\,f(i) + w(i)\,f(i+1) \qquad (3)$$

TABLE XIV. Values of l_x by single years of age from 1 to 5 for regional model life tables (l_0 = 100,000) at mortality levels 1–24

MODEL WEST

LEVEL	Females l_1	l_2	l_3	l_4	l_5	Males l_1	l_2	l_3	l_4	l_5
1	63445	54958	51154	48696	46836	58050	50262	46851	44617	42957
2	66601	58514	54891	52549	50776	61614	54105	50817	48663	47062
3	69444	61785	58353	56135	54456	64826	57643	54497	52437	50906
4	72027	64811	61578	59488	57907	67743	60918	57929	55972	54517
5	74389	67625	64593	62634	61152	70411	63965	61142	59293	57919
6	76562	70251	67423	65596	64213	72865	66812	64160	62424	61133
7	78571	72713	70088	68391	67107	75135	69481	67004	65382	64177
8	80438	75028	72604	71037	69852	77243	71992	69691	68185	67066
9	82178	77211	74986	73547	72459	79209	74360	72237	70846	69813
10	83807	79276	77246	75933	74940	81049	76601	74654	73378	72430
11	85336	81233	79394	78206	77307	82775	78726	76953	75791	74928
12	86775	83092	81441	80374	79567	84401	80745	79144	78096	77316
13	88121	84865	83405	82462	81749	85983	82816	81428	80520	79844
14	89396	86646	85413	84616	84013	87487	84756	83560	82777	82194
15	90606	88290	87242	86559	86037	88804	86446	85414	84738	84235
16	91769	89864	88987	88407	87954	90084	88086	87208	86632	86203
17	92884	91352	90635	90153	89772	91322	89716	88976	88477	88098
18	93949	92759	92192	91806	91496	92517	91266	90662	90244	89921
19	94965	94089	93664	93372	93134	93666	92736	92266	91933	91672
20	95931	95347	95059	94859	94693	94767	94129	93791	93547	93353
21	96884	96531	96355	96231	96127	95866	95460	95236	95070	94937
22	97718	97507	97400	97324	97260	96901	96648	96501	96391	96302
23	98470	98361	98305	98264	98230	97838	97699	97616	97552	97499
24	99095	99048	99024	99007	98992	98652	98588	98548	98517	98492
25	99555	99540	99533	99527	99527	99289	99266	99252	99240	99231

MODEL NORTH

LEVEL	Females l_1	l_2	l_3	l_4	l_5	Males l_1	l_2	l_3	l_4	l_5
1	68005	59681	54557	50689	47753	62858	54755	49828	46166	43381
2	70776	62905	58061	54403	51626	66052	58313	53606	50109	47449
3	73263	65852	61290	57847	55232	68919	61570	57101	53780	51254
4	75516	68564	64285	61055	58602	71515	64572	60350	57212	54826
5	77570	71074	67074	64055	61763	73883	67354	63382	60432	58187
6	79456	73407	69683	66871	64737	76057	69943	66224	63461	61359
7	81196	75585	72130	69523	67543	78062	72362	68895	66319	64360
8	82808	77625	74434	72025	70197	79920	74631	71413	69023	67205
9	84308	79542	76608	74394	72712	81650	76764	73793	71586	69906
10	85709	81349	78665	76639	75101	83264	78777	76048	74019	72477
11	87022	83056	80615	78772	77373	84777	80679	78187	76335	74927
12	88253	84670	82464	80799	79535	86196	82479	80218	78538	77261
13	89398	86244	84302	82837	81724	87529	84247	82250	80767	79638
14	90441	87729	86046	84770	83796	88709	85835	84087	82789	81801
15	91453	89164	87717	86609	85751	89858	87367	85852	84726	83870
16	92431	90521	89291	88340	87595	90975	88909	87598	86608	85846
17	93372	91802	90773	89971	89335	92054	90376	89258	88399	87730
18	94274	93012	92170	91508	90978	93094	91759	90827	90099	89526
19	95136	94153	93487	92959	92531	94091	93061	92309	91712	91237
20	95956	95230	94729	94330	94003	95043	94286	93706	93240	92866
21	96736	96246	95904	95628	95401	95950	95437	95026	94691	94420
22	97487	97221	97032	96879	96753	96826	96534	96290	96089	95925
23	98122	97974	97867	97780	97708	97580	97408	97258	97134	97032
24	98723	98648	98593	98548	98510	98321	98230	98148	98079	98022
25	99219	99187	99163	99144	99127	98944	98904	98866	98834	98807

TABLE XIV (Continued). Values of l_x by single years of age from 1 to 5 for regional model life tables ($l_0 = 100{,}000$) at mortality levels 1 to 24

MODEL EAST

	Females					Males				
LEVEL	l_1	l_2	l_3	l_4	l_5	l_1	l_2	l_3	l_4	l_5
1	57180	49795	46656	44596	43167	49453	42922	40206	38482	37222
2	60636	53494	50458	48466	47084	53511	47063	44382	42680	41436
3	63788	56935	54022	52111	50784	57211	50920	48305	46644	45431
4	66680	60150	57375	55554	54290	60606	54530	52003	50399	49227
5	69350	63168	60540	58815	57619	63741	57920	55500	53963	52840
6	71827	66009	63536	61913	60786	66649	61115	58814	57353	56286
7	74135	68692	66378	64860	63806	69358	64135	61963	60584	59577
8	76292	71232	69081	67670	66690	71891	66997	64962	63670	62725
9	78317	73643	71657	70353	69448	74268	69715	67822	66620	65742
10	80221	75936	74115	72920	72090	76504	72302	70555	69445	68635
11	82003	78166	76585	75464	74722	78599	74819	73247	72249	71520
12	83663	80270	78828	77881	77225	80519	77144	75741	74850	74199
13	85260	82285	81020	80191	79615	82373	79387	78145	77357	76781
14	86794	84213	83117	82397	81897	84161	81547	80461	79770	79266
15	88267	86059	85120	84504	84077	85882	83626	82688	82092	81657
16	89677	87823	87035	86518	86159	87536	85624	84829	84324	83956
17	91028	89531	88885	88455	88151	89123	87544	86887	86470	86166
18	92318	91160	90650	90305	90055	90643	89406	88879	88539	88288
19	93548	92706	92328	92069	91877	92095	91200	90797	90529	90325
20	94721	94176	93927	93753	93622	93480	92897	92620	92429	92282
21	95904	95546	95380	95262	95171	94852	94462	94266	94127	94018
22	96939	96718	96614	96539	96481	96111	95868	95741	95648	95574
23	97861	97739	97681	97638	97605	97245	97110	97035	96980	96935
24	98640	98583	98555	98535	98518	98219	98154	98116	98088	98065
25	99245	99223	99212	99204	99198	98989	98963	98948	98936	98926

MODEL SOUTH

	Females					Males				
LEVEL	l_1	l_2	l_3	l_4	l_5	l_1	l_2	l_3	l_4	l_5
1	69279	55503	49161	45812	43909	66423	53927	48164	45074	43368
2	71532	58606	52655	49512	47727	68857	57056	51612	48694	47083
3	73567	61479	55913	52974	51304	71056	59951	54829	52083	50567
4	75420	64152	58964	56225	54668	73058	62645	57842	55267	53846
5	77119	66651	61832	59287	57842	74894	65163	60675	58269	56941
6	78685	68997	64537	62181	60843	76586	67526	63347	61107	59870
7	80136	71206	67094	64923	63689	78154	69750	65874	63796	62649
8	81487	73291	69518	67525	66394	79613	71850	68270	66351	65291
9	82748	75265	71820	70001	68968	80975	73838	70546	68781	67807
10	83916	77145	74028	72382	71447	82229	75650	72616	70990	70092
11	84937	78890	76106	74636	73801	83337	77434	74711	73252	72446
12	85933	80569	78099	76795	76054	84419	79153	76724	75422	74702
13	86903	82184	80011	78863	78211	85474	80809	78657	77504	76867
14	87848	83738	81845	80846	80278	86501	82405	80515	79502	78943
15	88764	85232	83606	82748	82260	87498	83941	82300	81420	80935
16	89651	86670	85297	84573	84161	88463	85419	84015	83262	82846
17	90509	88068	86936	86334	85986	89397	86841	85663	85031	84682
18	91342	89424	88523	88038	87751	90303	88235	87270	86749	86457
19	92266	90774	90064	89676	89440	91361	89859	89132	88727	88493
20	93180	92044	91496	91193	91004	92369	91237	90668	90344	90150
21	94089	93256	92849	92620	92475	93372	92551	92123	91872	91718
22	94988	94405	94116	93952	93846	94367	93799	93491	93306	93190
23	95868	95484	95292	95181	95108	95343	94973	94765	94637	94555
24	96716	96483	96365	96296	96249	96287	96064	95934	95853	95799
25	97514	97386	97321	97282	97255	97178	97057	96984	96937	96906

45

Fertility sc... Gompertz relational model with $\beta = 1.0$

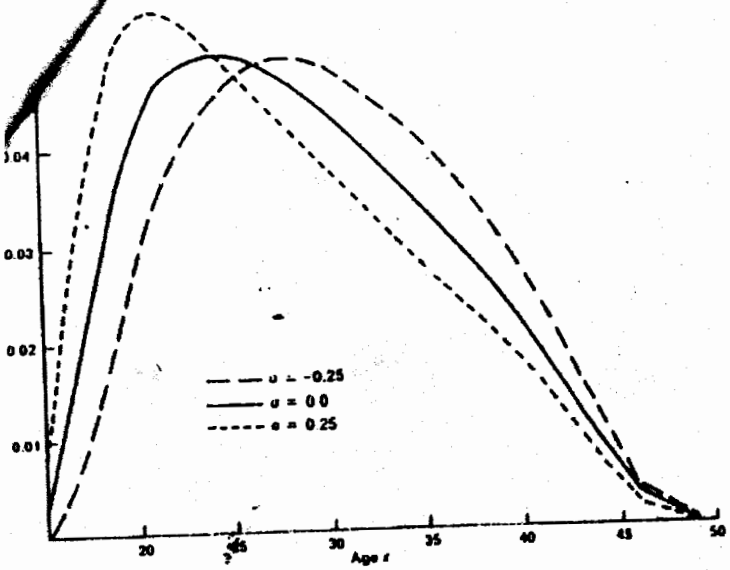
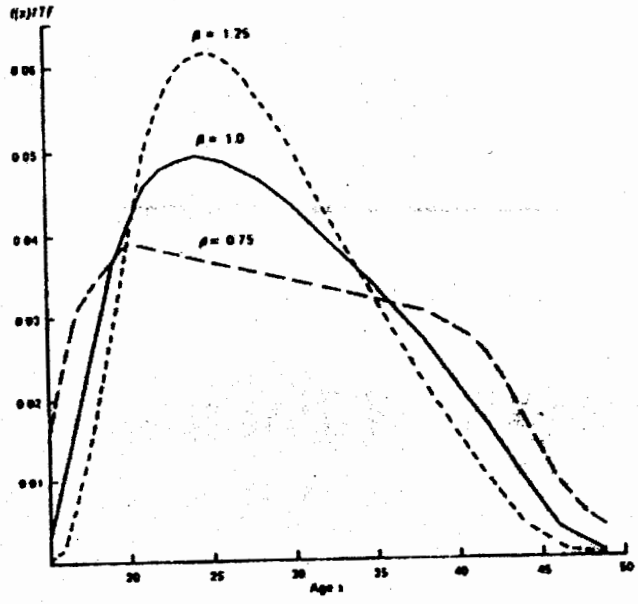


Figure 6b. Fertility schedules generated through the Gompertz relational model with $\alpha = 0.0$



usip $\eta(F(x)) = \ln[-\ln(\hat{F}(x))]$

usip $Y(x) = -\ln[-\ln(\hat{F}(x))]$

TABLE 4. VALUES OF THE η TRANSFORMATION OF A STANDARD FERTILITY SCHEDULE, $\eta(F(x))$

Age x (1)	η Transformation $\eta(F(x))$ (2)	Age x (3)	η Transformation $\eta(F(x))$ (4)
11	3.18852	31	−0.84272
12	2.70008	32	−0.99014
13	2.37295	33	−1.14407
14	2.07262	34	−1.30627
15	1.77306	35	−1.47872
16	1.49286	36	−1.66426
17	1.25061	37	−1.86597
18	1.04479	38	−2.08894
19	0.85927	39	−2.33192
20	0.69130	40	−2.62602
21	0.53325	41	−2.95500
22	0.38524	42	−3.32873
23	0.24423	43	−3.75984
24	0.10783	44	−4.25499
25	−0.02564	45	−4.80970
26	−0.15853	46	−5.41311
27	−0.29147	47	−6.12864
28	−0.42515	48	−7.07022
29	−0.56101	49	−8.64839
30	−0.70000		

Standard for Gompertz relational model

Age	$Y_s(x)$	Age	$Y_s(x)$	Age	$Y_s(x)$
11	-3.18852	24	-.10783	37	1.86597
12	-2.70008	25	.02564	38	2.08894
13	-2.37295	26	.15853	39	2.33192
14	-2.07262	27	.29147	40	2.62602
15	-1.77306	28	.42515	41	2.95500
16	-1.49286	29	.56101	42	3.32873
17	-1.25061	30	.70000	43	3.75984
18	-1.04479	31	.84272	44	4.25499
19	-.85927	32	.99014	45	4.80970
20	-.69130	33	1.14407	46	5.41311
21	-.53325	34	1.30627	47	6.12864
22	-.38524	35	1.47872	48	7.07022
23	-.24423	36	1.66426	49	8.64839