

The New HMD-LQ Model Life Tables and Their Application to the Analysis of Census Household Deaths Data

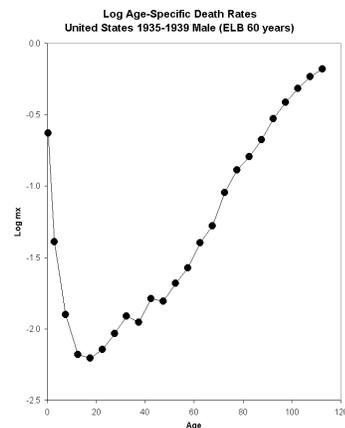
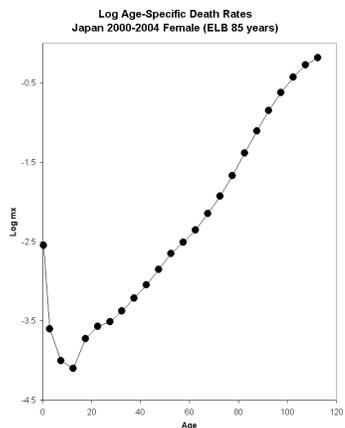
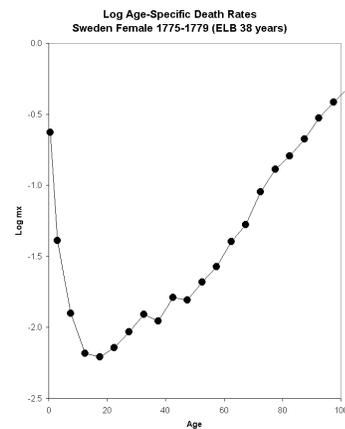
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Talk at Statistics South Africa
Friday 6 July 2012

Overview

- Age pattern of human mortality
- Model life table families
- The HMD-LQ model
- Household deaths data
- HMD-LQ analysis of HH deaths data
- Observations, Next Steps, Conclusion

Age Pattern of Human Mortality

- Age-specific death rates – Deaths in age group divided by person years lived in age group
- Primary input required for construction of life tables
- Standard age groups are 0, 1-4, 5-9, and subsequent 5 year groups



Model Life Table Families

- Parameterized collection of age schedules of mortality
- Intention is to fit empirical schedules
- Coale-Demeny 1966, United Nations 1982

The HMD-LQ Model

- New kid on the block – Will it displace Coale-Demeny?
- The Name - Human Mortality Database Log Quadratic
- Here's how it works ...
- But first, the reference - *Population Studies*, Vol. 66, Issue 12, December 2011

Population Studies

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<http://www.tandfonline.com/loi/rpst20>

A flexible two-dimensional mortality model for use in indirect estimation

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Available online: 13 Dec 2011

<http://demog.berkeley.edu/~jrw/Eprints/>

relationship between the death rate at age x , m_x , and the probability of dying between birth and age 5, ${}_5q_0$, for some population at a point in time:

$$\log(m_x) = a_x + b_x h + c_x h^2 + v_x k. \quad (1)$$

In this model, h equals $\log({}_5q_0)$ and has a quad-

of mortality. In practice, the subscript x refers to the following age groups: 0, 1-4, 5-9, 10-14, ..., 105-109, 110+. Values of h and k are held constant across the lifespan, and thus two para-

¹⁰ John Wilmoth et al.

Table 3 Coefficients for log-quadratic model of the age pattern of mortality, estimated using HMD life tables ($n = 719$)

Age	Female				Male			
	a_x	b_x	c_x	v_x	a_x	b_x	c_x	v_x
0	-0.6619	0.7684	-0.0277	0.0000	-0.5101	0.8164	-0.0245	0.0000
1-4	-	-	-	-	-	-	-	-
5-9	-2.5608	1.7937	0.1082	0.2788	-3.0435	1.5270	0.0817	0.1720
10-14	-3.2435	1.6653	0.1088	0.3423	-3.9554	1.2390	0.0638	0.1683
15-19	-3.1099	1.5797	0.1147	0.4007	-3.9374	1.0425	0.0750	0.2161
20-24	-2.9789	1.5053	0.1011	0.4133	-3.4165	1.1651	0.0945	0.3022
25-29	-3.0185	1.3729	0.0815	0.3884	-3.4237	1.1444	0.0905	0.3624
30-34	-3.0201	1.2879	0.0778	0.3391	-3.4438	1.0682	0.0814	0.3848
35-39	-3.1487	1.1071	0.0637	0.2829	-3.4198	0.9620	0.0714	0.3779
40-44	-3.2690	0.9339	0.0533	0.2246	-3.3829	0.8337	0.0609	0.3530
45-49	-3.5202	0.6642	0.0289	0.1774	-3.4456	0.6039	0.0362	0.3060
50-54	-3.4076	0.5556	0.0208	0.1429	-3.4217	0.4001	0.0138	0.2564
55-59	-3.2587	0.4461	0.0101	0.1190	-3.4144	0.1760	-0.0128	0.2017
60-64	-2.8907	0.3988	0.0042	0.0807	-3.1402	0.0921	-0.0216	0.1616

demog.berkeley.edu/~jrw/LogQuad/

- Calculate ${}_1q_0$ from ${}_1m_0$

$${}_nq_x = \frac{{}_nm_x}{1 + {}_nb_x n {}_nm_x}$$

- Calculate ${}_4q_1$ from ${}_1q_0$ and ${}_5q_0$

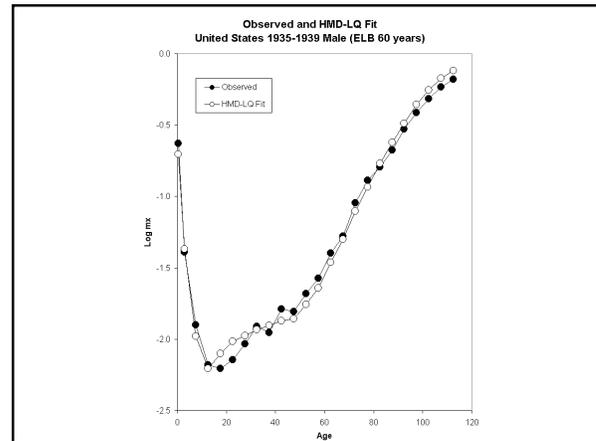
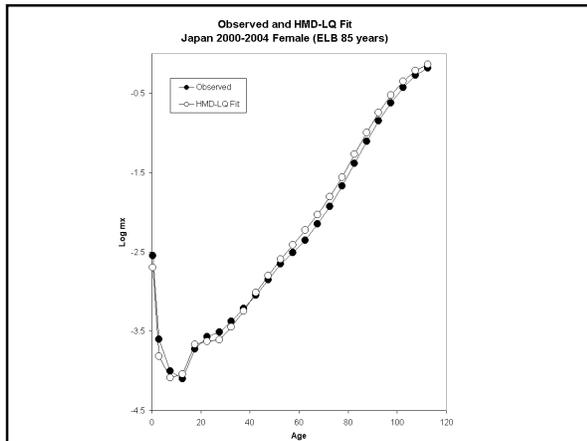
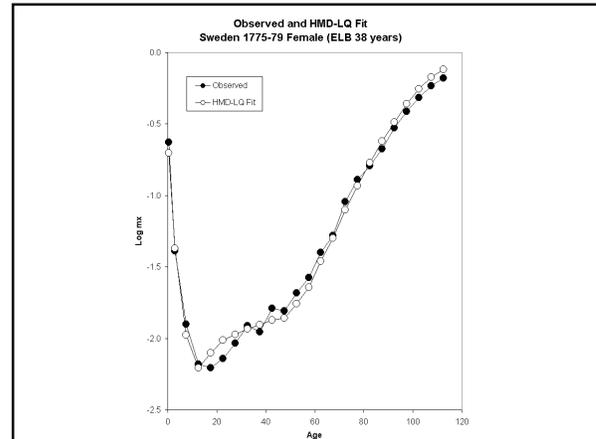
$${}_4q_1 = 1 - \frac{(1 - {}_1q_0)}{(1 - {}_5q_0)}$$

- Calculate ${}_4m_1$ from ${}_4q_1$

$${}_nm_x = \frac{{}_nq_x}{n(1 - {}_nb_x n {}_q_x)}$$

How Well Does It Work?

- What *goodness of fit* can we expect?
- Begin by fitting to 3 HMD life tables, which it was *constructed* to fit
- Can't expect better fits to non-HMD life tables
- Fit to the same three tables I showed you to illustrate the age pattern of mortality



Household Deaths Data

- HHD data – derived from population census question on deaths in households
- *E.g.*, “Any deaths in this household during the past 12 months?”
- If yes, record age (completed years) and sex of each decedent
- Tabulate deaths by sex and age (0, 1-4, 5 year groups to *old* open ended group)

South Africa 2011 Census

SECTION I: MORTALITY IN THE LAST 12 MONTHS

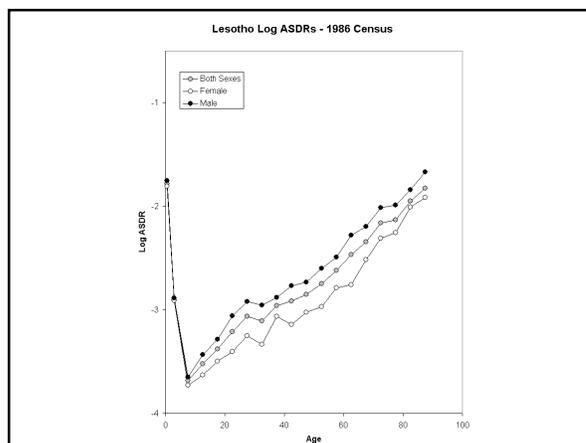
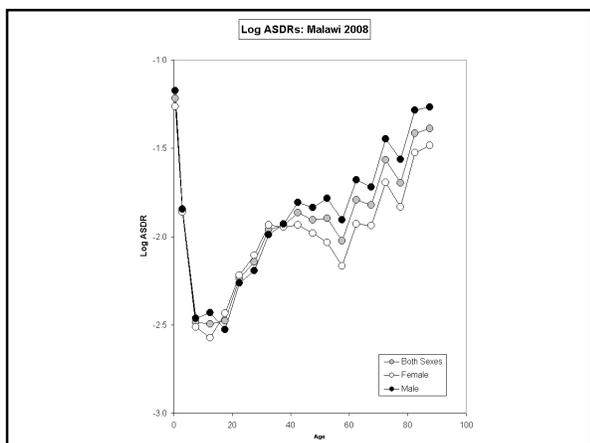
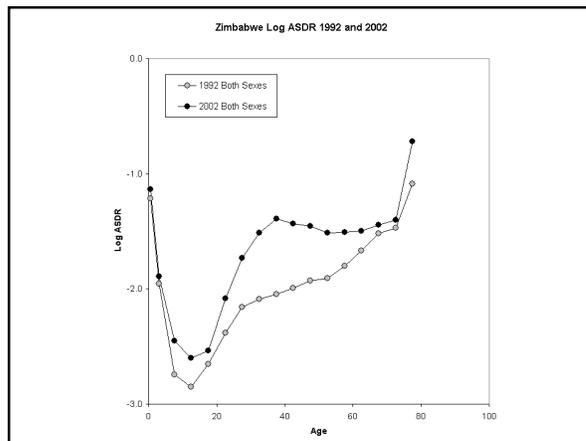
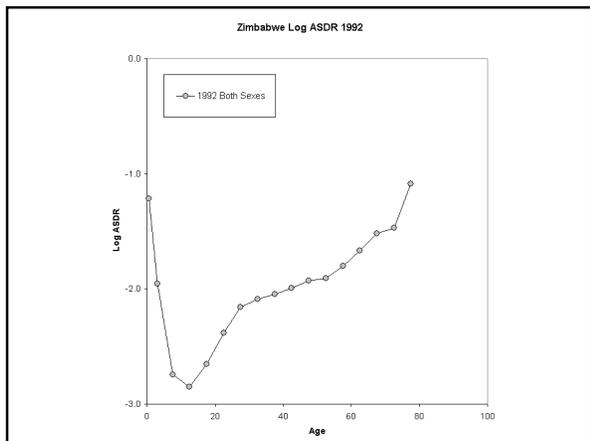
M-00 DEATH OCCURRED			M-00a NUMBER OF DEATHS		
Has any member of this household passed away in the last 12 months (between 10 October 2010 and 9 October 2011)?			How many members of the household passed away in the last 12 months (between 10 October 2010 and 9 October 2011)?		
<input type="radio"/> 1 Yes <input type="radio"/> 2 No <input type="radio"/> 3 Do not know			<input type="radio"/> 0 <input type="radio"/> 1 <input type="radio"/> 2 <input type="radio"/> 3		
Mark the appropriate circle with an X.			Mark the appropriate circle with an X.		
# 2 or 3. Questionnaire completed					
M-01 NAME OF DECEASED	M-02 MONTH AND YEAR OF DEATH	M-03 SEX OF THE DECEASED	M-04 AGE OF THE DECEASED	M-05 NATURAL OR UNNATURAL DEATH	
What was the first name of (the deceased)? <small>Use CAPITAL LETTERS only</small>	What was the MONTH and the YEAR of (the deceased)? <small>Write the month and year in the appropriate boxes.</small>	Was (the deceased) male or female? 1 = Male 2 = Female	What was (the deceased's) age in completed years at the time of death? <small>Write the age in the boxes. If age is less than 1 year, write 000.</small>	Was the death due to a natural or an unnatural cause? 1 = Natural (e.g. illness) 2 = Unnatural (e.g. accident, assault) 3 = Do not know	
<input type="text"/>	<input type="text"/>	<input type="radio"/> 1 Male <input type="radio"/> 2 Female	<input type="text"/>	<input type="radio"/> 1 Natural <input type="radio"/> 2 Unnatural <input type="radio"/> 3 Do not know	
<input type="text"/>	<input type="text"/>	<input type="radio"/> 1 Male <input type="radio"/> 2 Female	<input type="text"/>	<input type="radio"/> 1 Natural <input type="radio"/> 2 Unnatural <input type="radio"/> 3 Do not know	

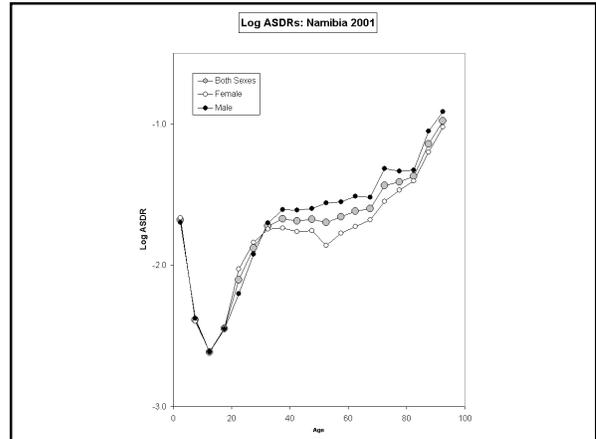
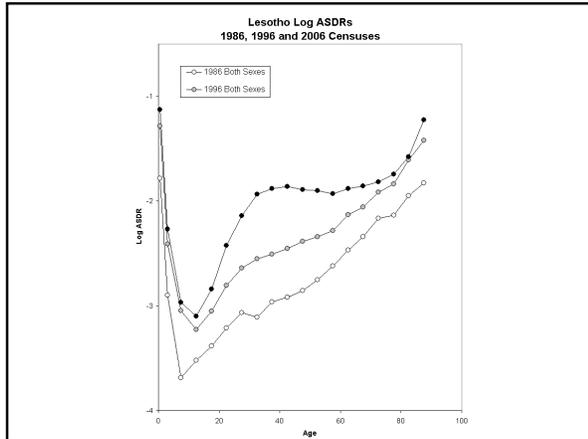
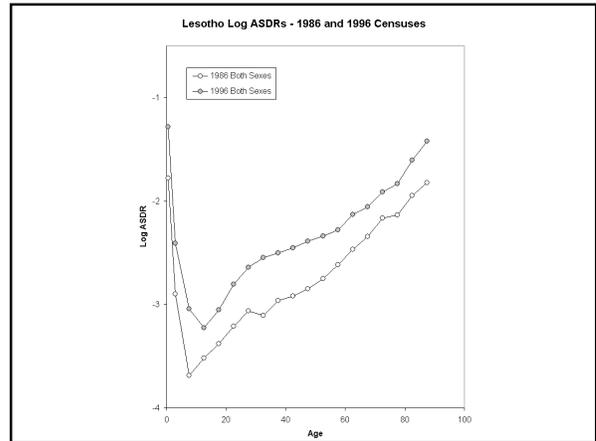
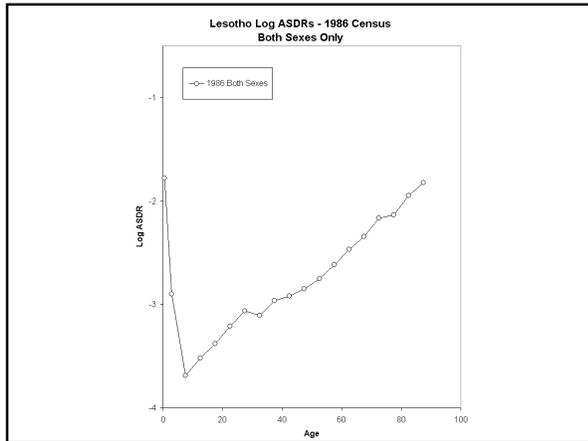
Namibia 2011 Census

MORTALITY, Deaths in the household						
The questionnaire refers to deaths in the last 12 months (September 2010 to August 2011)						
G1	G2	G3	G4	G5	G6	G7
How many deaths occurred in the household in the last 12 months?	What is the Name of the deceased household member?	Was the death registered?	Was the person female or male?	How old was the person when they died?	What was the cause of their death?	How many deaths occurred in the household in the last 12 months?
1 2 3 4 5		1 Yes 2 No 3 Don't know	1 F 2 M	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100	1 Illness 2 Accident 3 Suicide 4 Injury 5 Pregnancy related 6 Don't know 7 Other	1 2 3 4 5

Examples of HH Deaths Data

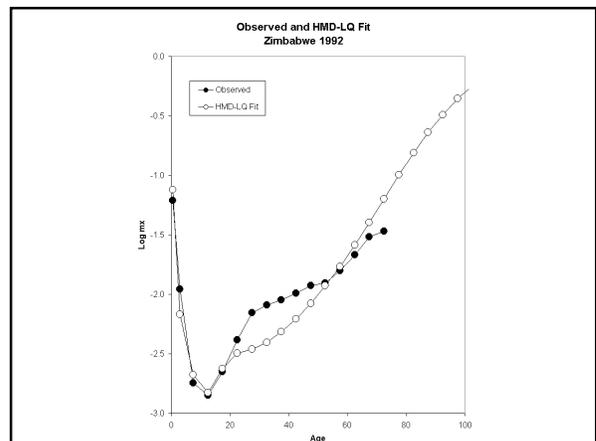
- Let's look at some examples of HHD data
- By which I mean look at Log ASDR plots
- Here are examples from 7 censuses in 4 countries
- Rates shown are calculated *without adjustment for completeness of reporting*

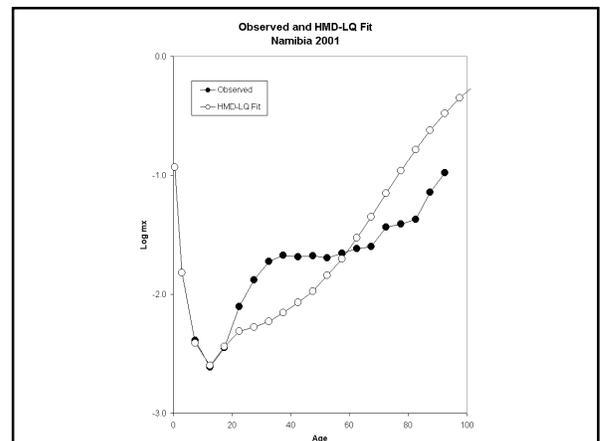
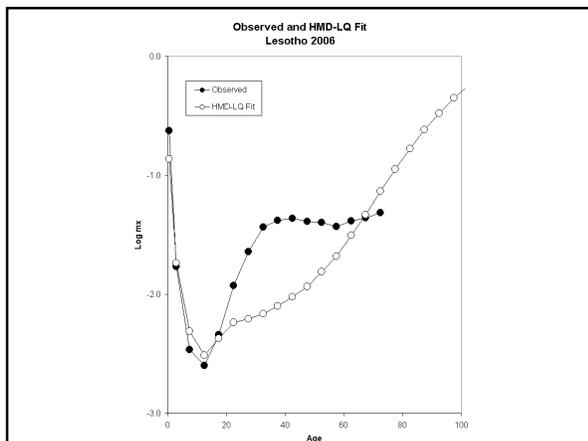
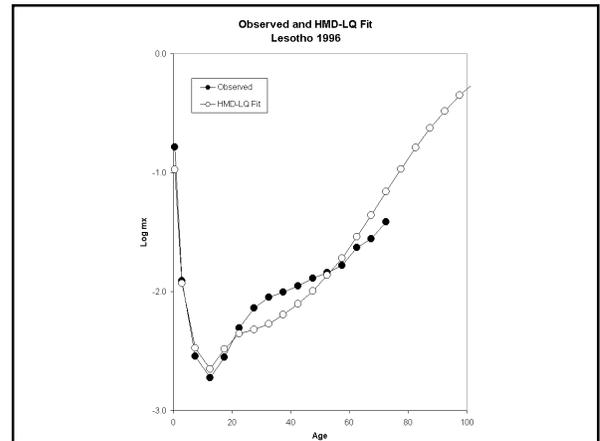
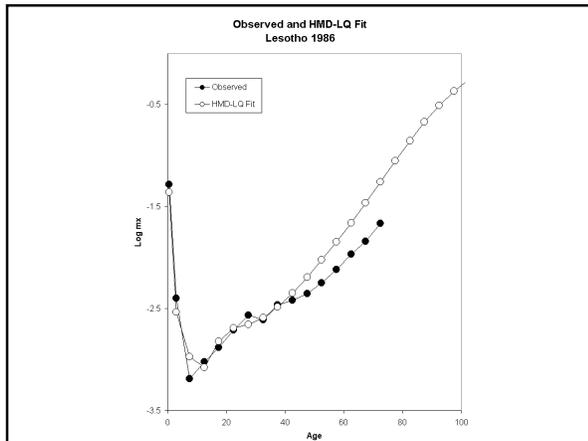
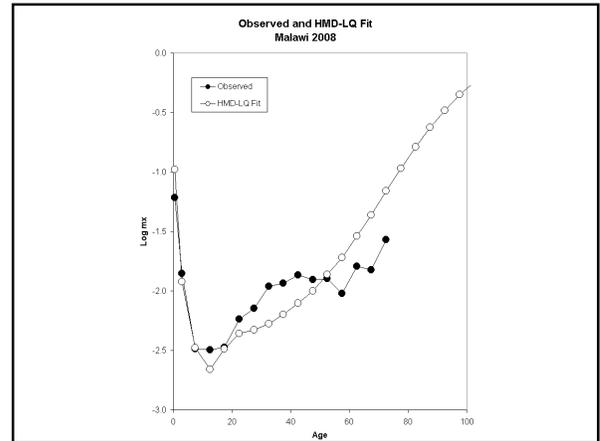
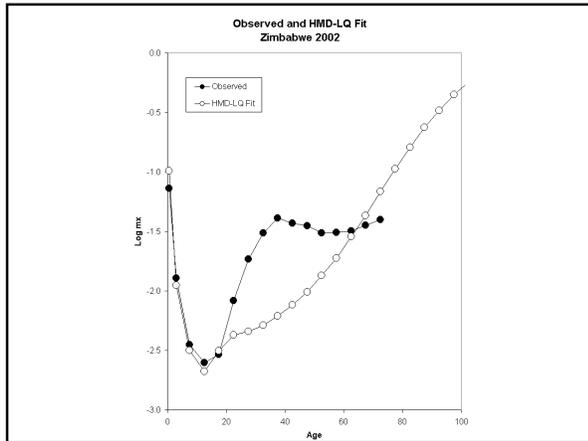




Application of the HMD-LQ Model to HH Deaths Data

- Idea: Measure the size of the “hump”
- Define measure of goodness of fit, choose parameter h to minimize this
- Excel implementation of HMD-LQ
- What measure of goodness of fit is appropriate, given that we do not *expect* the model to fit the “hump”?





Observations

- Fit to ASDRs from age 0-20 years is okay
- Fit to ASDRs over 50-60 years is not good
- What explanation? Model or data?
- The “hump” is observed in high HIV prevalence countries
- This and epidemiology of HIV-AIDS suggests it reflects AIDS-related deaths

Thoughts on Next Steps

- Estimate completeness of reporting - Hill's 1987 Generalized Growth Balance Method
- Refit HMD-LQ to rates adjusted for completeness of reporting
- Use model fit to estimate excess deaths
- Model excess deaths implied by fit, e.g., with Weibull distribution
- Model overall mortality by HMD-LQ plus Weibull “hump”

Conclusions

- Existence of “hump” established
- Hump reflects HIV/AIDS deaths – evidence is circumstantial, but powerful
- Household deaths data may prove to be a powerful tool for assessing adult mortality impact of HIV/AIDS

Thank you!

- Questions?
- Comments?
- Look for files containing these slides and related material at

gfeeney.com/presentations/2012-the-new-hmd-lq-model-life-tables