# SENSITIVITY OF GENERATION TABLL. OF WORKING LIFE FOR MEN TO DIFFERENT PROJECTIONS OF LABOR FORCE PARTICIPATION RATES AND MORTALITY RATES

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Tables of working life currently have three principal uses. First, measures developed in the tables are used to estimate the entrants to and withdrawal from the labor force. Second, as an hypothetical work force, they may be used as models whereby the effects of various social and demographic factors may be studied. Finally, they are used in court cases to aid in the determination of the potential loss of earnings incurred in cases of work-related deaths or injuries.

Generation tables of working life for men were first developed by this writer earlier this year. (3) Their potential usefulness had been suggested in a Canadian study, and our own comparison of such tables with conventional period tables has confirmed their usefulness. (2) In particular, generation tables have been found to be more realistic than period tables for measuring labor force flows and for certain kinds of through-time analyses and model construction. The superiority of the generation table was seen in each of the four measures most commonly utilized: the expectation of work-life remaining, the expected length of retirement, the rate of retirement, and the rate of accession to the labor force.

As generation tables of working life come to be used more frequently, there is a need to see how sensitive they are to changes in rates of mortality and labor force participation. Because the relations of the events affecting labor force entry and withdrawal to age and mortality have not been described in theoretical terms, it was not feasible to carry out a theoretical analysis as has been done by Keyfitz for stable populations. (4) Instead, an empirical analysis has been attempted. There are difficulties in generalizing from an empirical study. It is also difficult to know if the postulated changes in the mortality rates are of the same order of magnitude as the postulated changes in the labor force rates. However, the rates postulated are considered to be within the range of probable occurrences. Although this paper concentrates on the effects of these factors on generation tables, most of the conclusions also apply to period tables.

This study was made for two work-cohorts of men, those entering the labor force in 1960 and in 1970. For each cohort, two assumptions concerning labor force participation rates in the future were made. The first was that the set of rates observed for men in 1970 would continue unchanged. This has been termed the "constant" labor force participation rate (LFPR) assumption. A second assumption was that the age-specific labor force participation rates would continue the gradual declines which have been observed, but that the change would be less for each successive period, ending with constant rates after 2020. Three sets of mortality rates were used. The first two were the low and high projections of mortality to 2000 made by the Social Security Administration (2) and the third was an assumption that mortality would continue at the 1970 level after 1970. The Social Security Administration (SSA) low projection has the highest expectation of life, and the 1970 mortality assumption has the lowest, while the SSA high projection falls in between. The latter assumption is the one used by the Bureau of the Census in its recent projections.

Thus, for each cohort, there are six tables of working life (or sets). In tables 1 through 4, these measures are arranged in the same order, first the three sets for the constant labor force assumption, then the three sets for the declining labor force assumption. The order of the three sets within the particular labor force assumption is in order of lowest to highest mortality. For convenience in reference, we shall refer to a particular set within a cohort by its column number, i.e., 1960 (5) would be the table formed by the 1960 cohort with the declining labor force assumption and SSA high mortality, and 1960 (6) would be the table formed with the declining labor force assumption and 1970 mortality.

The first measure to be investigated for sensitivity is the expectation of work-life remaining (table 1). For each of the cohorts, and under both projections of labor force participation, the higher the mortality, the lower the expectation of work-life. Also for each mortality assumption, the declining labor force participation has a lower expectation of worklife. Three points can be explored in this connection. First, the  $ew_x$  is less sensitive than the expectation of life remaining,  $e_x$ , to changes in mortality projections. For example, for the 1970 cohort, assuming constant labor force rates, the expectations of life at age 16 for each group were (in order of increasing mortality) 56.8, 55.0, and 53.3, a range of 3.6 years. The expectations of work-life for the same age were 46.8, 46.1, and 45.2 years, a range of 1.6 years. For the other labor force assumption for the 1970 cohort, and for the 1960 cohort, the same observation applies.

Second, within the 1960 cohort, the expectation of work-life is almost the same for both columns (3) and (4) until age 55. This gives some indication of the difference between the two projections of labor force participation. The highest work-life expectancy in the declining labor force rate group is at the same level with the lowest in the constant labor force rates group. The correspondence is not so strong in the 1970 cohort, but the work-life remaining for 1970 (4) for this cohort is only slightly greater than for 1970 (3).

The effect of changes in the labor force participation rates on the expectation of worklife remaining may be obtained by comparing the

measure for a given mortality assumption under each of the labor force projections for a cohort, i.e. by comparing columns (1) and (4). Until age 65, there is a difference of about a year in  $ew_x$ . For the 1960 cohort, the difference between columns (1) and (4) is 1.1 years until age 45, and for columns (2) and (5), one year. (The 1970 mortality rates are not as smooth, but the differences are either 1.0 or 0.9 years.) After age 45, the differences are slightly lower, 0.9 or 0.8 years. At age 65, the effect of being well beyond the end of the period of projection (2000 and 2020 for mortality and labor force) override the differences between the cohort and the low expectancy of work-life and result in lower differences, either 0.6 or 0.5 years. However, this is a greater percent of the remaining work-life. At age 70, each of the cohorts and labor force groups has the same expectation of work-life for the same mortality assumption: 6.9 years for SSA low, 6.6 years for SSA high, and 6.3 years for 1970 mortality. This is because work-life for most men ends before age 70, and it also reflects the effects noted for age 65.

The impact of the two different labor force assumptions depends on the cohort. For the 1960 cohort, there is a difference of about a year between the expectation of work-life for the highest and the lowest mortality assumptions until age 45, when the work-life remaining is less than half that for age 16. For the 1970 cohort, the difference between the work-life remaining for the high and the lowest mortality assumptions is about one and a half years and it declines slowly through age 60. Because both mortality and labor force participation are the same for all groups for ages 16-25 for the 1960 cohort, the pattern for that cohort differs from the 1970 cohort for the younger ages. These observations lead to the conclusion that when it is necessary to change either the mortality or labor force participation assumptions when projecting the remainder of a cohort's work experience, the work-life expectancy will be changed by a constant for those younger ages for which the data were not projected. The changes in work-life expectancy that have been observed in this exercise are of the same order as the 1950 to 1960 changes in period tables.

The next measure to be discussed is the expectation of "retirement" (table 2). In the context of this paper, "retirement" refers to a worker's final withdrawal from the labor force, not to participation in any formal program providing annuity benefits. Looking down any column, one observes that there is little change in the figures until age 65. The range in most cases is 0.3 years. The two Social Security Administration projections give a maximum expectation of retirement at age 35, with a relative maximum at age 55. These mortality projections have a relative minimum in the rates at the ages 25-30, and this combined with the maximum labor force participation rate for the following age group, causes the peak expectancy of retirement at age 35. The 1970 mortality rates are even lower at ages 25-30, changing the pattern enough that there is only a relative maximum at age 55. The appearance of maximums at age 55 presumably results from the effects of soon-to-occur labor force withdrawals and greater increases in mortality.

Turning to the impact of the labor force participation rates upon the expectation of retirement, we note that the differences between the same mortality assumptions under the two labor force participation rates projected for each cohort are almost constant until the retirement ages, with only a drop of 0.2 years from age 16 to 60. This is different from what was observed with work-life expectancy. Further, the difference is a smaller percent at the older ages, the opposite of the behavior of the expectation of work-life.

A change in the mortality assumption has a greater effect on the expected duration of retirement than on the expected length of working life. The difference between the expectation of retirement under the highest and the lowest mortality is about two years. It is here that another dissimilarity between the two labor force rates can be observed. For both cohorts, the 1970 labor force rates provide a smaller difference than the declining labor force rates, but the 1960 cohort has slightly smaller difference between the highest and lowest mortality patterns within a particular labor force projection.

Continuing the examination of the effects of different labor force and mortality patterns on mortality, we turn to the retirement rates (table 3). With the possible exception of ages 65-70, mortality assumptions that vary as much as those in the present study do not significantly change the retirement rates. This is an interesting discovery, since retirement at ages before 55 probably reflects forced withdrawal due to illness or injury more than voluntary action. One would therefore have expected to find some sensitivity to mortality.

The retirement rates, however, are more sensitive to varying labor force projections. For ages 40-45 through 65-70, the declining labor force participation rates result in retirement rates that are 22 to 28 percent higher than the constant labor force rates for the same mortality rate in the same cohort. The difference in the assumed participation rates in this case could result in a sizeable over-(or under-) statement of the labor force, if used to estimate retirements or replacement needs.

The final measure under consideration, the accession rate, is part of the actual work experience of the 1960 cohort, and does not vary. Data for the 1970 cohort are present in table 4. As in the case of the retirement rates, the accession rates are not sensitive to mortality. Since the accession rate is discounted for mortality, this is the behavior expected. The relation between the two labor force assumptions results in the sensitivity being different for different ages. The maximum labor force participation rate under the declining labor force projection is almost the same as under the constant labor force, but the route to the maximum takes a different path. For the declining rates, there are fewer accessions at ages 16-20, and more during ages 20-25. There are fewer accessions under the declining pattern for ages 25-30. As a result, there are slightly less (2 percent) accessions for the younger ages, and more accession at ages 20-25 (7 percent). However, the rates are not of the same order for successive age groups. If the accession rates for ages 16-20 and 20-25 are combined, there is little difference, (less than one percent), although the declining labor force always has the lower rate:

Assumed mortality	Assumed 1	abor force
rates	participa	ation rate
	Constant	Declining
SSA 1	568.1	563.3
SSA h	567.5	562.7
1970	564.0	559.3

Although the expectation of work-life and of retirement are of interest as indicators of future work patterns, within the Bureau of Labor Statistics generation working life tables are primarily used as sources for estimates of accession and separation rates (including death and retirement). These measures are used to estimate gross flows into and out of the work force and are defined so that they may be applied to the entire population (accession rates) or labor force (separation rates). The retirement rate is used to estimate occupational replacement needs (5). The age distribution of persons employed in a given occupation is multiplied by the corresponding separation rates from the working life table. Until period working life tables were constructed recently from projections of the labor force and mortality, the projected separations were based on the most recent working life table, which might refer to a period almost a decade in the past. For projecting to 1985, the technique contemplated is to use one set of rates to go from the age distribution for an occupation reported in the 1970 Census directly to the separations in 1985 (with an adjustment for the changes expected in the age distribution of the labor force). For this purpose, a generation rate rather than some combination of the 1975 and 1980 period retirement rates would be more realistic.

#### Summary

The purpose of this paper has been to investigate the impact of various projections of mortality and the labor force on selected measures of labor force activity derived from generation tables of working life for men. The results are summarized in table 5.

Cohort and			1960 C	ohort					1970 (	Cohort		
mortality	Cons	tant lfp	L.	Dec	lining l	fpr	Cor	istant li	:pr	De	clining 1	fpr
Age	SSAL	SSAH	1970	SSAL	SSAH	1970	SSAL	SSAH	1970	SSAL	SSAL	1970
	(1)	(2)	(3)	(4)	(2)	(9)	(1)	(2)	(3)	(†)	(2)	(9)
	46.5	46.2	45.4	45.4	45.2	44.4	46.8	46.1	45.2	45.7	45.1	44.3
	42.8	42.3	41.6	41.7	41.3	40.7	43.1	42.4	41.5	42.0	41.4	40.6
25	38.1	37.6	37.0	37.0	36.6	36.0	38.4	37.7	37.0	36.3	36.7	36.0
30	33.5	32.9	32.3	32.4	31.9	31.4	33.7	33.0	32.3	32.6	32.0	31.4
35	28.8	28.2	27.7	27.7	27.3	26.8	28.9	28.3	27.7	27.8	27.3	26.7
0;	24.3	23.8	23.3	23.3	22.8	22.4	24.4	23.8	23.3	23.4	22.8	22.4
t5t	19.9	19.4	19.0	19.0	18.5	18.1	20.0	19.5	19.0	19.0	18.6	18.1
2005	15.7	15.3	14.9	14.8	14.4	14.1	15.8	15.3	14.9	14.8	14.4	14.1
55	11.7	11.4	11.0	10.8	10.5	10.2	11.7	11.3	11.0	10.8	10.5	10.1
09	8.2	8.0	7.6	7.3	7.2	6.8	8.2	7.9	7.6	7.3	7.0	6.8
55	5.8	5.6	5.4	5.1	5.0	4.8	5.8	5.6	5.4	5.1	4.9	4.8
0/	6.9	6.6	6.3	6.9	<b>6.</b> 6	6.3	6.9	6.6	6.3	6.9	6.6	6.3

Table 1. Expectation of work-life remaining

## Table 2. Expectation of retirement

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Cohort and	1960 Cohort						1970 Cohort						
mortality	Co	nstant 1	fpr	De	clining	lfpr	Cor	nstant 1:	fpr	De	clining	lfpr	
Age	SSAL	SSAH	1970	SSAL	SSAH	1970	SSAL	SSAH	1970	SSAL	SSAH	1970	
	(1)	(2)	(3)	(4)	(5)	(6)	(1)	(2)	(3)	(4)	(5)	(6)	
16	9.9	8.6	7.9	11.0	9.6	8.9	10.0	8.9	8.0	11.1	9.9	8.9	
20	9.9	8.8	8.0	11.0	9.8	8.9	10.0	8.9	8.0	11.1	9.9	8.9	
25	10.1	8.9	8.1	11.2	9.9	9.1	10.1	9.1	8.1	11.2	10.1	9.1	
30	10.1	9.1	8.2	11.2	10.1	9.1	10.2	9.1	8.2	11.3	10.1	9.1	
35	10.2	9.2	8.3	11.3	10.1	9.2	10.3	9.2	8.3	11.4	10.2	9.3	
40	10.1	9.0	8.2	11.1	10.0	9.1	10.2	9.1	8.2	11.2	10.1	9.1	
45	10.1	9.1	8.2	11.0	10.0	9.1	10.2	9.0	8.2	11.2	9.9	9.1	
50	10.1	9.0	8.2	11.0	9.9	9.0	10.1	9.1	8.2	11.1	10.0	9.0	
55	10.2	9.1	8.4	11.1	10.0	9.2	10.2	9.2	8.4	11.1	10.0	9.3	
60	10.0	9.0	8.4	10.9	9.8	9.2	10.0	9.1	8.4	10.9	10.0	9.2	
65	8.9	8.2	7.7	9.6	8.8	8.3	8.4	8.2	7.7	9.6	8.9	8.3	
70	4.8	4.4	4.2	4.8	4.4	4.2	4.8	4.4	4.2	4.8	4.4	4.2	

Table 3. Retirement rates 1/, per thousand

Cohort and	nd 1960 Cohort						1970 Cohort						
mortality	Con	stant lf	pr	Dec	lining 1	fpr	Cons	tant lfp	r	Dec	lining 1	fpr	
Age	SSAL	SSAH	1970	SSAL	SSAH	1970	SSAL	SSAH	1970	SSAL	SSAH	1970	
	(1)	(2)	(3)	(4)	(5)	(6)	(1)	(2)	(3)	(4)	(5)	(6)	
30-35	0.1	0.1	0.1	0.5	0.5	0.4	0.0	0.0	0.1	0.0	0.1	0.1	
35-40	1.4	1.4	1.3	1.7	1.6	1.7	1.4	1.3	1.3	1.9	1.9	1.8	
40-45	2.0	2.1	2.1	2.8	2.9	2.9	2.0	2.0	2.1	2.8	2.8	2.9	
45-50	3.6	3.3	3.4	4.4	4.2	4.3	3.6	3.6	3.4	4.4	4.4	4.3	
50-55	4.9	6.4	5.3	6.1	7.5	6.4	5.0	5.0	5.3	6.1	6.1	6.3	
55-60	17.8	18.4	17.2	21.9	22.5	21.3	17.6	17.6	17.2	21.8	21.7	21.3	
60-65	57.4	53.7	58.8	73.4	69.7	75.0	57.7	58.0	58.8	74.0	74.5	75.4	
65-70	160.5	159.9	158.9	196.2	195.1	194.5	160.5	159.6	158.8	197.0	196.0	195.2	

1/ Retirement refers to final withdrawal from the labor force.

Table 4.	Accession	rate,	per	thousand,	1970	cohort
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Labor force:		Constant lfp	r.	Declining lfpr				
Mortality: Age group	SSAL	SSAH	1970	SSAL	SSAH	1970		
16-20 20-25 25-30	(1) 486.0 82.1 14.0	(2) 485.8 81.7 13.4	(3) 484.3 79.7 11.7	(4) 474.6 88.7 12.2	(5) 474.4 88.3 11.6	(6) 473.0 86.3 9.9		

lfpr: labor force participation rate

Mortality: SSAL: Social Security Administration low projection SSAH: Social Security Administration high projection 1970: Rates remain at the 1970 level after 1970.

## Table 5. Sensitivity of various measures of labor force activity

		Measu	res from table	of working 1	ife
		ew <sub>x</sub> <u>1</u> /	er <sub>x</sub> <u>2</u> /	55° x <u>3</u> /	$5^{A}_{x} \underline{4}/$
Α.	Sensitivity to mortality rate 16-30 30-55 55 and over	M M L	 L L	 L L	L  
В.	Sensitivity to labor force participation rate 16-30 30-55	L L L	 M M	 M M	L  

L: low sensitivity

M: moderate sensitivity

- $e_{w_X}^{\bullet}$  = The expected length of working life remaining at age x.
- $\frac{1}{2}$ ,  $ew_x$  = The expected length of working life remaining at age x.  $\frac{1}{2}$ ,  $er_x$  = The expected duration of retirement of retirees at age x.
- $3/5Sr_x$  = The rate of separations from the labor force for reasons other than death at age x to x+5, per 1,000.
- $5^{A}_{x}$  = The rate of accession to the labor force at age x to x+5, per 1,000. 4/

#### References

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