RECENT DEVELOPMENTS IN THE MEASUREMENT OF LABOR MARKET ACTIVITY

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1. WORKLIFE EXPECTANCY AND RECENT ADVANCES BEYOND WORKLIFE EXPECTANCY

1.1. Brief History of Worklife Expectancy Tables in the United States

In the most recent survey of members of the National Association of Forensic Economics (NAFE) (Brookshire, Luthy, & Slesnick, 2003), the authors write that "it is clear that issues related to worklife are at the top of the list" of the members' preferences for forensic economics research. Worklife-disabled, worklife-self-employed, and worklife-general were ranked #1, #2 and #5 among 20 categories. This chapter addresses two out of these three topics. Worklife of the self-employed is not addressed, and the authors are not aware of any quantitative papers on this point.

The U.S. Bureau of Labor Statistics (BLS, 1950, 1957, 1982, 1986) has calculated worklife expectancies spanning the entire twentieth century. For example, Garfinkle (1955) estimated a worklife expectancy (WLE) of 39.4

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years for 20-year-old men (whose remaining life expectancy was only 42.2 years) for 1900; further, he predicted a WLE of 45.1 years for 20-year-old men for 2000, with a life expectancy of 53.8 years based on a Social Security Administration study. BLS Bulletin 1001 (1950) contained worklife tables for men by race and urban-rural residence for 1940 and 1947. Bulletin 1204 (1957) dealt with worklife expectancies for women by marital status for 1940 and 1950. Wolfbein (1949) published worklife estimates independently from the BLS for men for 1940, using methods similar to an earlier study that produced worklife estimates based on labor market activity for 1890–1900. Fullerton and Byrne (1976) reported worklife expectancies for men and women (by marital status and birth of the last child) using 1970 data. All of this work was based on what the BLS calls the *conventional model*: "Men enter and leave the labor force only once, and (that) women enter and leave only as the result of specific changes in marital and parental status" (BLS, Bulletin 2135, 1982). The BLS made a dramatic break from its conventional model in Bulletin 2135 when it introduced the Markov, or increment–decrement, model which viewed people as "entering and leaving the labor market repeatedly during their lifetimes, with nearly all participating for some period during their lives." The BLS used the Markov model to produce worklife estimates for men and women by labor force status (i.e., initially active and inactive) and without regard to the labor market status for 1977 (Bulletin 2135) and for men and women by labor force status and with and without regard to status by education or race for 1979–1980 (Bulletin 2254, 1986).

Regardless of whether the conventional model or the Markov model was used, the main objective of all the foregoing work was to produce a single number WLE, given the age, gender, and other characteristics (that varied from one study to another) such as education, marital status, and parental status. WLE is the expected value, or mean, of years of labor market activity; but until recently, no one was able to answer basic questions including: What are the values of other measures of central tendency like the median and mode? What is the shape of the distribution of years of activity (*YA*)? What is the probability that *YA* will fall within an interval of a given length, and what is the length of a *YA* interval given a certain probability level? In short, what is the entire probability distribution of *YA*? Although these questions can be successfully answered within the context of both the conventional model and the Markov model, the theoretical and empirical work we report below is based on the Markov model, which is superior to the conventional model.

1.2. Recent Theoretical Developments in Analyzing Time in the Labor Force and Time to Final Separation from the Labor Force

The Markov model employs probabilistic concepts (transition probabilities, (i.e., the probability of changing labor force status or remaining in the same status from one age to the next age) with embedded mortality probabilities) that permit one to determine various mathematical expectations. Before our recent work with the Markov model, no one had thoroughly exploited the model's probabilistic implications. There had been no discussion of sample paths, i.e., the statistical distribution of functions of statuses several years into the future, conditional on current status. Once a model is analyzed and/or augmented so as to permit the specification of such general distribution functions, one has broken through the barrier that had restricted previous study only to expectations. Our theoretical framework permits the study of natural random variables, such as *YA* and years to final labor force separation (*YFS*), among several others. Any statistic involving these random variables, such as the mean, median, or mode, may now be studied in the population and in a sample. We may thus compare an estimator claimed to be estimating some "median" with proper estimators of the median, within the context of any particular model.[1] We now have estimates of the entire probability distributions of *YA* and *YFS*, and we have estimated many of its parameters (and can compute any others that may be of interest). For example, we have constructed probability intervals that are consistent with the ideas of economic and statistical certainty such as "more probable than not" and "to within a reasonable degree of economic certainty."

In this section of the chapter, we summarize our recent work in analysis of *YA* and *YFS*. *YA* only counts time spent in the labor force, but *YFS* includes all time (whether in or out of the labor force) until the last exit from the labor force. We treat both *YA* and *YFS* as random variables that possess probability mass functions (pmfs). The goal is to find the pmf or statistical distribution for *YA* and *YFS*, and thereby to be able to compute for *YA* and *YFS* any characteristic of interest. (A pmf assigns a specific probability value (i.e., mass value) to every possible outcome of a random variable. For example, consider the years-of-activity random variable *YA* for people currently active in the labor force that takes on half-integer values of 0.5, 1.5, 2.5, ...years due to the mid-point transition assumption. The pmf gives the probability that $YA = 0.5$ years, $YA = 1.5$ years, $YA = 2.5$ years, etc. Of course, the sum of these probabilities must be 1.0.) Our tables show three measures of central tendency (mean, median, and mode), the standard deviation as a measure of dispersion, two measures of shape (skewness (lack of symmetry) and kurtosis (thickness of the tails and height of the peak of the pmf)), and three probability intervals (the smallest interval that contains 50% of all probability mass, the inter-quartile range (the interval, which excludes 25% of the probability mass in each tail), and an interval, which excludes 10% of the probability from each of the tails of the pmf). The minimal 50% interval and the inter-quartile range may be of special interest because they capture the idea of *YA* and *YFS* being accurate to a reasonable degree of economic and statistical certainty, or what is more probably true than not true. The theoretical and empirical work we present here can be found in Skoog (2002b) and in Skoog and Ciecka (2001a, b, 2002, 2003).

The defining features of the Markov model of labor market activity are that labor force transitions occur between the current state (*a* (for active), or *i* (for inactive)) and the next period's state (*a*, *i*, or *d*), transition probabilities depend only on the current state, and only the death state (*d*) is absorbing. Transitions can occur at the beginning, end, or mid-point of a period, which is taken to be one year. A pmf is defined by a set of global conditions (which hold whether transitions occur at the beginning, end, or mid-point), boundary conditions describing the mass functions near zero additional years (which generally depend on when transitions occur), and main recursions, which define probability mass values beyond those specified in the boundary conditions. See Skoog and Ciecka (2001a) for a heuristic discussion of pmfs.

Let $YA_{x,m}$ denote the years-of-activity random variable with $p_{YA}(x,m,y)$ being the probability that a person who is in state m at exact age x will accumulate $YA_{x,m} = y$ years of labor force activity in the future. Similarly, let $YFS_{x,m}$ denote the years-to-final-separation random variable with $p_{YFS}(x,m,y)$ being the probability that a person who is in state m at exact age x makes a final separation from the labor force in $YFS_{x,m} = y$ years. The probability that a person who is in state m at age x will be in state n at age $x+1$ is denoted by ${}^{m}p_x^{n}$ where $m \in \{a,i\}$, $n \in \{a,i,d\}$ and, ${}^{a}p_x^{a} + {}^{a}p_x^{i} + p_x^{d} = 1$, ${}^{i}p_x^{a} + {}^{i}p_x^{i} + p_x^{d} = 1$, where, as is customary, we assume ${}^{a}p_x^{d} = {}^{i}p_x^{d} \equiv p_x^{d}$. We assume that transitions between state m at age x and state n at age $x+1$ occur at age $x+0.5$ (i.e., mid-period transitions). We define *BA* (beginning age) to be the earliest exact age at which labor force activity becomes possible. Define *TA* (truncation age) to be the youngest exact age at which everyone is dead. On the assumption that labor force activity is always possible if a person is alive at age BA or beyond, TA is the youngest exact age at which no labor force activity can occur. Everyone alive at age $TA-1$ dies at age $TA-0.5$, so ${}^{a}p^{d}_{TA-1} = {}^{i}p^{d}_{TA-1} = 1$ since the only transition at age $TA-1$ is to the death state. That is, ${}^{a}p^{a}_{x} = {}^{a}p^{i}_{x} = {}^{i}p^{a}_{x} = {}^{i}p^{i}_{x} = 0$ for $x \geq TA-1$.

The YA and YFS pmfs with mid-period transitions for initial actives and inactives are specified in the boxes below. The global conditions in the first box are identical for YA and YFS. Neither negative YA or YFS can occur, nor can YA or YFS exceed the number of years until death must occur. At the truncation age TA (taken to be age 111), it is certain that there is no activity or inactivity because everyone has died, that is, all transitions at age $TA-1$ are to the death state.

In the first YA boundary condition, we observe that an active person at age x must accumulate some positive amount of activity because transitions occur at the mid-point of the age interval $(x, x+1)$. The second YA boundary condition accounts for the probability of a person active at age x accumulating exactly one-half year of future activity by dying in mid-year or turning inactive in mid-year and staying inactive thereafter. The last boundary condition expresses the observation that there are only two ways a person inactive at age x can experience no additional YA: die or remain inactive a year and repeat the process. The remaining probability mass values for YA are defined by the main recursions. The right-hand side of the first main recursion is the sum of two terms that contribute to the probability that an active person age x will accumulate y years of activity: $p(x+1, a, y-1)$ and $p(x+1, i, y-0.5)$ are the probabilities of experiencing $y-1$ and $y-0.5$ active years when being active and inactive at age $x+1$, respectively. If one remains active, part of the probability of y years of activity results when the former probability, which aggregates sample paths resulting from the remaining active $y-1$ years from age $x+1$, is multiplied by ${}^{a}p^{a}_{x}$. The same treatment of the sample paths resulting from an active to inactive transition, multiplied by this probability, ${}^{a}p^{i}_{x}$, completes the recursion. By multiplying $p(x+1, a, y-1)$ by ${}^{a}p^{a}_{x}$, accumulated YA change from $y-1$ to y; similarly, $y-0.5$ years increase to y years when $p(x+1, i, y-0.5)$ is multiplied by ${}^{a}p^{i}_{x}$. The second main recursion works in a similar manner. Transition probabilities for people who start age x as inactive are ${}^{i}p^{a}_{x}$ and ${}^{i}p^{i}_{x}$, in order to accumulate y years of activity, these probabilities must be multiplied by probabilities $p(x+1, a, y-0.5)$ and $p(x+1, i, y)$ for people age $x+1$ who have already accumulated $y-0.5$ active years and y years, respectively since ${}^{i}p^{a}_{x}$ produced another half year of activity but ${}^{i}p^{i}_{x}$ adds no additional amount of active time.

In regard to *YFS*, if one is active, since the next transition takes place one-half year later, one must accumulate at least one-half of an additional year of time until the final separation. Further, if one ever transitions into the active state again, one or more full years until final separation are added, so that the function $p_{YFS}(x, a, y)$ is non-zero only on the half integers and zero on the integers. The first boundary condition recognizes that zero probability occurs for integer values of *YFS*. If a person is initially inactive at age x and will never return to inactivity, either that person dies at age $x + 0.5$ and so realizes $y = 0$, or that person transitions into activity and forestalls separation by 1.5, 2.5,...years. The domain of $p_{YFS}(x, i, y)$ where this function is positive includes zero and the half integers, skipping 0.5; and it is zero for $YFS = 0.5, 1, 2, 3, \ldots$ The latter statement is the second *YFS* boundary condition. The third boundary condition gives the probability of one-half year until final separation for an active person age x as the probability of dying before age $x + 1$ (thereby being credited with a half year before final labor force separation) plus the probability of zero years to final separation at age $x + 1$ weighted by the probability of a transition (between age x and $x + 1$) from active to inactive status (thus accumulating a half year before final separation). In the last boundary condition, an inactive person age x can have zero years before final separation by dying before age $x + 1$ or by having had zero years before separation at age $x + 1$ weighted by the probability of remaining inactive (thereby accumulating no time before final separation) from age x to $x + 1$.

In regard to the first main *YFS* recursion, the right-hand side is the sum of two terms that contribute to the probability that there will be y years before an active person finally separates from the labor force: $p_{YFS}(x + 1, a, y - 1)$ and $p_{YFS}(x + 1, i, y - 1)$ are the probabilities of separating $y-1$ years after age $x+1$ when active and inactive at age $x+1$, respectively; the probability of y years before final separation (from age x) results when the former probability is multiplied by ${}^{a}p_x^{a}$ and the later by ${}^{a}p_x^{i}$. The last main recursion works the same way. Since ${}^{i}p_x^{a}$ and ${}^{i}p_x^{i}$ are the probabilities for people who start age x as inactive, multiply ${}^{i}p_x^{a}$ by $p_{YFS}(x + 1, a, y - 1)$ and ${}^{i}p_x^{i}$ by $p_{YFS}(x + 1, i, y - 1)$; the sum of these products is the separation probability of y years for an inactive person age x. In both of the *YFS* main recursions, the probability $p_{YFS}(x + 1, m, y - 1)$, for $m \in \{a, i\}$, when multiplied by ${}^{a}p_x^{m}$ and ${}^{i}p_x^{m}$, changes the reference age from $x + 1$ to x and adds one year to final separation time by "pushing back" the age index one year.

Global conditions for random variables $RV \in \{YA, YFS\}$ with mid-point transitions.

$$p_{RV}(x,a,y) = p_{RV}(x,i,y) = 0 \quad \text{if } y<0 \text{ or } y>TA-x-0.5$$
$$p_{RV}(TA,a,0) = p_{RV}(TA,i,0) = 1$$
$${}^{a}p_{x}^{d} = {}^{i}p_{x}^{d} = 1 \quad for \quad x \geq TA-1$$

YA pmfs for $YA_{x,m} = y$ for $m \in \{a, i\}$ with mid-point transitions.
Boundary conditions

$$p_{YA}(x,a,0) = 0$$
$$p_{YA}(x,a,0.5) = {}^{a}p_{x}^{d} + {}^{a}p_{x}^{i}p_{YA}(x+1,i,0)$$
$$p_{YA}(x,i,0) = {}^{i}p_{x}^{d} + {}^{i}p_{x}^{i}p_{YA}(x+1,i,0)$$
$$\text{for } x = BA,\ldots,TA-1$$

Main recursions

$$p_{YA}(x,a,y) = {}^{a}p_{x}^{a}p_{YA}(x+1,a,y-1) + {}^{a}p_{x}^{i}p_{YA}(x+1,i,y-0.5),$$
$$y = 1.5, 2.5, 3.5\ldots TA-x-0.5$$
$$p_{YA}(x,i,y) = {}^{i}p_{x}^{a}p_{YA}(x+1,a,y-0.5) + {}^{i}p_{x}^{i}p_{YA}(x+1,i,y),$$
$$y = 1,2,3,\ldots,TA-x-0.5 \text{ for } x = BA,\ldots,TA-1$$

YFS pmfs for $YFS_{x,m} = y$ for $m \in \{a, i\}$ with mid-point transitions
Boundary conditions

$$p_{YFS}(x,a,y) = 0, \quad y = 0, 1, 2, 3, \ldots, TA-1$$
$$p_{YFS}(x,i,y) = 0, \quad y = 0.5, 1, 2, 3, \ldots, TA-1$$
$$p_{YFS}(x,a,0.5) = {}^{a}p_{x}^{d} + {}^{a}p_{x}^{i}p_{YFS}(x+1,i,0)$$
$$p_{YFS}(x,i,0) = {}^{i}p_{x}^{d} + {}^{i}p_{x}^{i}p_{YFS}(x+1,i,0)$$
$$\text{for } x = BA,\ldots,TA-1$$

Main recursions

$$p_{YFS}(x,a,y) = {}^{a}p_{x}^{a}p_{YFS}(x+1,a,y-1) + {}^{a}p_{x}^{i}p_{YFS}(x+1,i,y-1)$$
$$p_{YFS}(x,i,y) = {}^{i}p_{x}^{a}p_{YFS}(x+1,a,y-1) + {}^{i}p_{x}^{i}p_{YFS}(x+1,i,y-1)$$
$$\text{for } x = BA, \ldots, TA-1 \text{ and } y = 1.5, 2.5, 3.5, \ldots, TA-x-0.5$$

1.3. Some Illustrative Empirical Results Flowing from Recent Theoretical Advances

Tables 1–8 show *YA* and *YFS* characteristics for initially active and initially inactive men and women without regard to education (see Skoog & Ciecka (2001a, 2003) for additional tables by educational attainment for initially active and inactive statuses for men and women). Figures 1–4 illustrate the pmf for 30-year-old initially active and inactive men and women without regard to education. Although different in appearance, pmfs could be graphed for each age in Tables 1–8.

The characteristics of the *YA* and *YFS* random variables depend on age. For example, the mass function for an active 20-year-old male is skewed to the left: the mean or WLE (37.28 years) is less than the median (38.29), which is less than the mode (40.50) and the skewness coefficient is−1.14 (see Table 1). The standard deviation of *YA* is 9.39 years, and the minimal 50% probability interval is (35.58, 44.50). WLE is closer to the left end point of this interval than the right end point because of the negative skewness. By mid-life (say age 45), the *YA* pmf is approximately symmetrical about the mean with skewness of −0.15; and it is approximately normal with kurtosis of 2.94. The pmf for *YA* is skewed to the right at later ages. At age 65, for example, the skewness coefficient is 1.02 and the mean (4.20 years) exceeds the median (2.99), which exceeds the mode (0.50).

The *YFS* random variable possesses some similar characteristics to *YA*. *YFS* also is skewed to the left at young ages, approximately normal (as indicated by approximate zero skewness and kurtosis approximately 3.0) in mid-life, and skewed to the right at older ages. However, given the age and labor force status, *YFS* has a larger mean, median, mode, standard deviation, and wider probability intervals than *YA*. For example, the separation expectancy *YFSE* (34.18 years) of *YFS* for 30-year-old active men is 4.83 years longer than WLE (see Fig. 1 and Tables 1 and 5). The standard deviation of *YFS* is approximately two years bigger than the standard deviation of *YA*, and probability intervals are somewhat wider for *YFS*. Figure 2 shows the pmf for 30-year-old men who are initially inactive. The separation expectancy (34.17 years) of *YFS* exceeds *YA*'s mean by 6.63 years. Although active 30-year-old men have a WLE 1.81 years longer than their inactive counterparts, the means of *YFS* for active and inactive men are the same within one-tenth of a year. At older ages, the separation expectancies for actives and inactives grow apart somewhat. However, not until age 44 do the separation expectancies differ by more than one-half

Table 1. *YA* Characteristics for Initially Active Men, Regardless of Education.

Age	WLE Mean	Median	Mode	SD	SK	KU	Minimal 50% PI		Inter-Quartile PI		10–90% PI	
							Low	High	25%	75%	10%	90%
16	39.47	40.58	42.50	9.88	−1.21	5.22	37.50	46.81	34.66	45.37	26.79	49.41
17	39.01	40.10	42.50	9.77	−1.20	5.18	37.29	46.50	34.22	44.84	26.43	48.85
18	38.50	39.57	41.50	9.65	−1.18	5.13	36.50	45.62	33.74	44.26	26.02	48.24
19	37.95	38.99	41.50	9.51	−1.16	5.07	36.50	45.50	33.22	43.63	25.60	47.56
20	37.28	38.29	40.50	9.39	−1.14	4.99	35.58	44.50	32.57	42.89	25.02	46.81
21	36.63	37.61	39.50	9.26	−1.11	4.91	34.66	43.50	31.92	42.16	24.50	46.06
22	35.94	36.87	38.50	9.12	−1.08	4.82	34.50	43.26	31.25	41.38	23.90	45.26
23	35.20	36.09	38.50	8.99	−1.05	4.72	33.50	42.18	30.53	40.57	23.28	44.41
24	34.42	35.28	37.50	8.87	−1.02	4.61	32.89	41.50	29.75	39.72	22.61	43.55
25	33.62	34.44	36.50	8.75	−0.98	4.50	31.96	40.50	28.94	38.86	21.89	42.67
26	32.79	33.58	35.50	8.63	−0.95	4.40	31.02	39.50	28.12	37.97	21.17	41.77
27	31.95	32.69	34.50	8.52	−0.92	4.30	30.07	38.50	27.28	37.06	20.42	40.86
28	31.09	31.79	33.50	8.41	−0.88	4.21	29.13	37.50	26.43	36.14	19.65	39.93
29	30.22	30.88	32.50	8.31	−0.85	4.11	28.18	36.50	25.57	35.21	18.87	38.99
30	29.35	29.97	31.50	8.19	−0.81	4.02	27.23	35.50	24.69	34.27	18.10	38.05
31	28.48	29.05	30.50	8.08	−0.78	3.92	26.50	34.71	23.82	33.33	17.35	37.10
32	27.61	28.14	29.50	7.96	−0.74	3.83	25.50	33.65	22.95	32.39	16.60	36.15
33	26.75	27.23	28.50	7.84	−0.70	3.74	24.50	32.59	22.09	31.46	15.85	35.21
34	25.89	26.32	27.50	7.72	−0.66	3.65	23.50	31.52	21.24	30.52	15.12	34.26
35	25.03	25.41	26.50	7.59	−0.62	3.57	22.54	30.50	20.40	29.59	14.41	33.31
36	24.17	24.50	26.50	7.46	−0.58	3.49	21.61	29.50	19.56	28.66	13.69	32.36
37	23.32	23.59	25.50	7.34	−0.54	3.41	20.68	28.50	18.71	27.72	12.98	31.41
38	22.47	22.68	24.50	7.21	−0.49	3.34	19.75	27.50	17.87	26.79	12.29	30.46
39	21.62	21.78	23.50	7.08	−0.45	3.27	19.50	27.16	17.03	25.86	11.61	29.51
40	20.77	20.87	22.50	6.94	−0.40	3.20	18.50	26.07	16.21	24.93	10.92	28.57
41	19.94	19.98	21.50	6.80	−0.36	3.14	17.50	24.97	15.40	24.00	10.27	27.63
42	19.11	19.09	20.50	6.66	−0.31	3.08	16.50	23.87	14.60	23.08	9.63	26.70
43	18.29	18.20	19.50	6.52	−0.26	3.03	15.50	22.77	13.79	22.16	8.99	25.77
44	17.46	17.31	18.50	6.38	−0.20	2.98	14.50	21.66	12.99	21.23	8.37	24.84
45	16.64	16.43	17.50	6.24	−0.15	2.94	13.50	20.56	12.20	20.31	7.73	23.90
46	15.82	15.55	16.50	6.10	−0.10	2.90	12.55	19.50	11.42	19.39	7.10	22.97
47	15.01	14.67	15.50	5.96	−0.04	2.87	11.66	18.50	10.63	18.47	6.52	22.04
48	14.21	13.80	14.50	5.82	0.01	2.85	11.50	18.21	9.86	17.57	5.91	21.12
49	13.42	12.94	13.50	5.67	0.07	2.83	10.50	17.07	9.10	16.68	5.35	20.20
50	12.63	12.09	12.50	5.53	0.13	2.82	9.50	15.92	8.36	15.79	4.78	19.28
51	11.86	11.25	11.50	5.38	0.19	2.83	8.50	14.76	7.64	14.91	4.25	18.37
52	11.10	10.43	10.50	5.23	0.26	2.84	7.50	13.60	6.92	14.04	3.75	17.47
53	10.37	9.63	9.50	5.07	0.32	2.87	6.58	12.50	6.25	13.18	3.28	16.59
54	9.66	8.85	8.50	4.91	0.39	2.90	6.50	12.22	5.60	12.34	2.84	15.74
55	8.97	8.09	8.50	4.76	0.46	2.95	5.50	10.99	4.96	11.51	2.45	14.89
56	8.30	7.35	7.50	4.60	0.53	3.01	4.50	9.75	4.37	10.73	2.03	14.06

Table 1. (*Continued*)

Age	WLE Mean	Median	Mode	SD	SK	KU	Minimal 50% PI		Inter-Quartile PI		10–90% PI	
							Low	High	25%	75%	10%	90%
57	7.65	6.65	6.50	4.44	0.60	3.08	3.50	8.50	3.79	9.96	1.67	13.25
58	7.04	5.99	5.50	4.28	0.67	3.16	2.75	7.50	3.26	9.22	1.34	12.45
59	6.48	5.38	4.50	4.13	0.74	3.25	2.50	6.93	2.78	8.52	1.04	11.73
60	5.97	4.83	3.50	3.97	0.80	3.35	1.50	5.62	2.36	7.89	0.79	11.05
61	5.51	4.34	2.50	3.82	0.86	3.44	1.50	5.28	2.01	7.30	0.59	10.39
62	5.12	3.92	2.50	3.66	0.91	3.53	0.50	3.92	1.72	6.79	0.50	9.82
63	4.77	3.55	1.50	3.51	0.95	3.61	0.50	3.55	1.48	6.32	0.50	9.29
64	4.47	3.26	1.50	3.37	0.99	3.68	0.50	3.26	1.30	5.92	0.50	8.80
65	4.20	2.99	0.50	3.22	1.02	3.73	0.50	2.99	1.14	5.53	0.50	8.33
66	3.96	2.74	0.50	3.08	1.04	3.76	0.50	2.74	1.02	5.23	0.50	7.91
67	3.74	2.52	0.50	2.94	1.06	3.78	0.50	2.52	0.90	4.94	0.50	7.47
68	3.53	2.35	0.50	2.81	1.06	3.77	0.50	2.35	0.79	4.64	0.50	7.13
69	3.36	2.22	0.50	2.67	1.05	3.75	0.50	2.22	0.71	4.38	0.50	6.78
70	3.19	2.10	0.50	2.52	1.05	3.75	0.50	2.10	0.66	4.14	0.50	6.39
71	3.01	1.94	0.50	2.37	1.05	3.76	0.50	1.94	0.59	3.88	0.50	5.99
72	2.81	1.76	0.50	2.22	1.06	3.79	0.50	1.76	0.52	3.62	0.50	5.48
73	2.61	1.58	0.50	2.06	1.06	3.83	0.50	1.58	0.50	3.36	0.50	5.08
74	2.44	1.50	0.50	1.90	1.07	3.94	0.50	1.50	0.50	3.08	0.50	4.63
75	2.26	1.38	0.50	1.73	1.13	4.19	0.50	1.38	0.50	2.72	0.50	4.24

year. At age 50 the separation expectancy for actives exceeds that of inactives by 1.2 years and by 1.76 years at age 55.

Figures 3 and 4 show related results for women. Active (inactive) 30-year-old women have mean *YFS* approximately seven (nine) years longer than for *YA*. As with men age of 30, there is practically no difference in the separation expectancy of *YFS* with respect to labor force status. By age 43, the separation expectancy of actives is 0.54 years longer than for inactive women; the difference is 2.43 years at age 55.

The mean *YFS* gender gap between active (inactive) men and women is only 1.85 (1.87) years, but WLE differs by 4.18 (4.77) years at age 30. That is, younger men and women are more similar in regard to *YFSE* than WLE. This also tends to be the case for other characteristics for *YFS* and *YA* at younger ages. However, older men and women are less similar in regard to *YFSE* than WLE. By age 60, the *YFS* mean gender difference for actives (inactives) is 1.66 years (2.25 years), but it is only 0.89 years (0.98 years) for *YA*, respectively.

Table 2. *YA* Characteristics for Initially Inactive Men, Regardless of Education.

Age	WLE Mean	Median	Mode	SD	SK	KU	Pr(0)	Minimal 50% PI Low	Minimal 50% PI High	Inter-Quartile PI 25%	Inter-Quartile PI 75%	10–90% PI 10%	10–90% PI 90%
16	38.27	39.87	42.00	9.88	−1.20	5.19	0.00	36.78	46.00	33.95	44.67	26.08	48.72
17	37.87	39.45	41.00	9.78	−1.19	5.14	0.00	36.00	45.16	33.57	44.21	25.77	48.24
18	37.32	38.87	41.00	9.67	−1.17	5.08	0.00	35.91	45.00	33.03	43.60	25.32	47.60
19	36.63	38.15	40.00	9.54	−1.14	5.00	0.00	35.00	43.99	32.36	42.84	24.73	46.82
20	36.02	37.51	39.00	9.42	−1.12	4.92	0.00	34.08	43.00	31.75	42.16	24.21	46.12
21	35.35	36.80	38.00	9.29	−1.09	4.83	0.00	34.00	42.87	31.09	41.41	23.65	45.35
22	34.63	36.04	38.00	9.17	−1.06	4.73	0.00	33.00	41.79	30.38	40.62	23.01	44.53
23	33.87	35.25	37.00	9.05	−1.02	4.63	0.00	32.27	41.00	29.62	39.80	22.36	43.70
24	33.09	34.43	36.00	8.93	−0.99	4.51	0.00	31.32	40.00	28.83	38.96	21.67	42.85
25	32.27	33.58	35.00	8.82	−0.95	4.40	0.00	30.36	39.00	28.00	38.09	20.92	41.97
26	31.38	32.65	34.00	8.72	−0.92	4.29	0.00	29.39	38.00	27.10	37.15	20.10	41.02
27	30.46	31.69	33.00	8.63	−0.88	4.17	0.00	28.41	37.00	26.16	36.18	19.23	40.05
28	29.51	30.71	32.00	8.54	−0.84	4.06	0.00	27.43	36.00	25.19	35.20	18.34	39.07
29	28.54	29.70	31.00	8.47	−0.80	3.94	0.01	26.42	35.00	24.19	34.19	17.41	38.07
30	27.54	28.67	30.00	8.39	−0.76	3.82	0.01	25.46	34.00	23.16	33.17	16.45	37.05
31	26.53	27.61	29.00	8.32	−0.71	3.69	0.01	24.46	33.00	22.10	32.13	15.45	36.01
32	25.48	26.53	28.00	8.26	−0.67	3.57	0.01	23.46	32.00	21.00	31.06	14.41	34.95
33	24.41	25.42	27.00	8.19	−0.62	3.44	0.01	22.46	31.00	19.89	29.97	13.34	33.87
34	23.35	24.33	26.00	8.12	−0.58	3.33	0.01	21.46	30.00	18.79	28.90	12.30	32.80
35	22.32	23.26	25.00	8.06	−0.53	3.21	0.01	20.00	28.52	17.70	27.84	11.27	31.76
36	21.27	22.17	24.00	8.00	−0.48	3.10	0.02	19.00	27.50	16.60	26.77	10.23	30.70
37	20.20	21.06	23.00	7.93	−0.43	2.99	0.02	18.00	26.47	15.48	25.68	9.17	29.61
38	19.15	19.95	22.00	7.85	−0.38	2.89	0.02	17.00	25.42	14.37	24.60	8.13	28.54
39	18.12	18.87	21.00	7.77	−0.33	2.80	0.03	15.65	24.00	13.28	23.53	7.14	27.48
40	17.09	17.78	19.00	7.67	−0.27	2.71	0.03	14.76	23.00	12.20	22.46	6.16	26.42
41	16.09	16.72	18.00	7.57	−0.22	2.64	0.04	13.89	22.00	11.15	21.40	5.23	25.38
42	15.10	15.66	17.00	7.45	−0.16	2.57	0.04	13.00	20.96	10.11	20.35	4.33	24.33
43	14.12	14.60	16.00	7.31	−0.09	2.51	0.05	12.00	19.77	9.09	19.29	3.48	23.28
44	13.19	13.59	0.00	7.16	−0.03	2.47	0.06	11.00	18.54	8.12	18.27	2.68	22.25
45	12.29	12.60	0.00	7.01	0.03	2.43	0.07	10.00	17.29	7.19	17.27	1.96	21.25
46	11.42	11.63	0.00	6.84	0.10	2.41	0.08	9.02	16.00	6.29	16.28	1.30	20.26
47	10.55	10.65	0.00	6.66	0.17	2.41	0.10	8.35	15.00	5.41	15.28	0.68	19.26
48	9.71	9.69	0.00	6.46	0.25	2.43	0.11	7.73	14.00	4.55	14.29	0.00	18.26
49	8.90	8.75	0.00	6.25	0.33	2.46	0.13	7.00	12.84	3.74	13.32	0.00	17.27
50	8.13	7.83	0.00	6.02	0.42	2.52	0.15	5.64	11.00	2.98	12.36	0.00	16.30
51	7.38	6.94	0.00	5.79	0.51	2.61	0.17	5.17	10.00	2.27	11.41	0.00	15.34
52	6.67	6.07	0.00	5.54	0.61	2.73	0.19	4.00	8.25	1.62	10.47	0.00	14.37
53	5.97	5.22	0.00	5.28	0.72	2.89	0.22	3.40	7.00	1.02	9.53	0.00	13.41
54	5.31	4.39	0.00	5.00	0.83	3.10	0.25	2.11	5.00	0.00	8.60	0.00	12.43
55	4.69	3.62	0.00	4.71	0.95	3.36	0.28	1.00	3.12	0.00	7.70	0.00	11.47

Table 2. (*Continued*)

Age	WLE Mean	Median	Mode	SD	SK	KU	Pr(0)	Minimal 50% PI		Inter-Quartile PI		10–90% PI	
								Low	High	25%	75%	10%	90%
56	4.15	2.95	0.00	4.43	1.07	3.65	0.32	1.00	2.45	0.00	6.88	0.00	10.58
57	3.67	2.35	0.00	4.15	1.19	3.99	0.35	1.00	1.85	0.00	6.11	0.00	9.75
58	3.23	1.80	0.00	3.88	1.32	4.37	0.39	1.00	1.30	0.00	5.38	0.00	8.96
59	2.84	1.32	0.00	3.62	1.45	4.80	0.42	0.00	0.82	0.00	4.73	0.00	8.20
60	2.50	0.91	0.00	3.38	1.57	5.26	0.46	0.00	0.41	0.00	4.13	0.00	7.48
61	2.20	0.53	0.00	3.15	1.70	5.76	0.49	0.00	0.03	0.00	3.57	0.00	6.86
62	1.94	0.00	0.00	2.93	1.82	6.29	0.53	0.00	0.00	0.00	3.10	0.00	6.27
63	1.71	0.00	0.00	2.73	1.95	6.86	0.56	0.00	0.00	0.00	2.65	0.00	5.72
64	1.51	0.00	0.00	2.54	2.08	7.50	0.60	0.00	0.00	0.00	2.24	0.00	5.21
65	1.32	0.00	0.00	2.35	2.23	8.24	0.63	0.00	0.00	0.00	1.85	0.00	4.69
66	1.15	0.00	0.00	2.17	2.38	9.09	0.66	0.00	0.00	0.00	1.46	0.00	4.21
67	0.99	0.00	0.00	1.99	2.55	10.08	0.69	0.00	0.00	0.00	1.14	0.00	3.73
68	0.85	0.00	0.00	1.80	2.73	11.28	0.72	0.00	0.00	0.00	0.82	0.00	3.26
69	0.72	0.00	0.00	1.63	2.93	12.70	0.75	0.00	0.00	0.00	0.00	0.00	2.80
70	0.60	0.00	0.00	1.45	3.16	14.44	0.78	0.00	0.00	0.00	0.00	0.00	2.34
71	0.49	0.00	0.00	1.28	3.41	16.51	0.80	0.00	0.00	0.00	0.00	0.00	1.94
72	0.41	0.00	0.00	1.13	3.66	18.83	0.83	0.00	0.00	0.00	0.00	0.00	1.53
73	0.34	0.00	0.00	0.99	3.91	21.30	0.85	0.00	0.00	0.00	0.00	0.00	1.28
74	0.28	0.00	0.00	0.87	4.15	23.98	0.86	0.00	0.00	0.00	0.00	0.00	1.06
75	0.23	0.00	0.00	0.75	4.41	26.99	0.88	0.00	0.00	0.00	0.00	0.00	0.83

2. CRITICISMS OF THE MARKOV MODEL

2.1. Importance of Initial Labor Force Status

We have elsewhere (Skoog & Ciecka, 2004) discussed at length the comparisons of the Markov model with other models, notably the conventional model. If one does not distinguish between whether the current state is active or inactive, one is implicitly assuming that ${}^{a}p_x^a$ and ${}^{i}p_x^a$ are equal. It does not take elaborate statistical hypothesis testing to see that this is rejected by the data. Further, the conventional model assumes that, beyond an age of peak participation, any exit from activity is the final exit: in other words, that ${}^{i}p_x^a = 0$ for these ages, again inconsistent with the data. Rather than rejecting such models, critics of the Markov model, including Hunt, Pickersgill, and Rutemiller (HPR), (2001) and elsewhere, and Richards (1999, 2000) appear willing to ignore the information in the current activity status and confine the domain of worklife calculation to the *entire* population – the mixture distribution of those inactive and those active. Their

Table 3. *YA* Characteristics for Initially Active Women, Regardless of Education.

							Minimal 50% PI		Inter-Quartile PI		10–90% PI	
Age	WLE Mean	Median	Mode	SD	SK	KU	Low	High	25%	75%	10%	90%
16	34.40	34.52	36.50	8.78	−0.47	3.50	30.50	40.87	28.52	39.99	22.56	44.51
17	33.85	33.97	35.50	8.72	−0.46	3.46	30.19	40.50	27.98	39.41	22.05	43.92
18	33.27	33.38	35.50	8.66	−0.44	3.42	29.50	39.76	27.43	38.80	21.54	43.28
19	32.66	32.76	34.50	8.60	−0.43	3.37	29.30	39.50	26.83	38.15	20.97	42.60
20	32.03	32.12	33.50	8.54	−0.42	3.33	28.36	38.50	26.22	37.48	20.40	41.91
21	31.40	31.48	33.50	8.47	−0.41	3.30	27.50	37.58	25.62	36.81	19.82	41.21
22	30.75	30.83	32.50	8.41	−0.40	3.26	27.49	37.50	24.99	36.12	19.24	40.48
23	30.09	30.16	31.50	8.34	−0.39	3.22	26.57	36.50	24.36	35.41	18.65	39.75
24	29.41	29.47	31.50	8.27	−0.37	3.19	25.63	35.50	23.71	34.70	18.04	39.00
25	28.73	28.78	30.50	8.19	−0.36	3.16	25.50	35.28	23.06	33.97	17.45	38.23
26	28.04	28.08	29.50	8.11	−0.35	3.13	24.81	34.50	22.41	33.22	16.83	37.44
27	27.33	27.36	28.50	8.03	−0.34	3.10	23.90	33.50	21.73	32.45	16.22	36.65
28	26.62	26.63	28.50	7.94	−0.33	3.07	23.50	33.01	21.05	31.68	15.61	35.85
29	25.90	25.90	27.50	7.85	−0.31	3.04	22.50	31.91	20.38	30.91	14.97	35.04
30	25.17	25.16	26.50	7.76	−0.30	3.02	22.19	31.50	19.69	30.12	14.36	34.21
31	24.45	24.42	25.50	7.67	−0.28	2.99	21.30	30.50	19.00	29.33	13.74	33.38
32	23.72	23.67	25.50	7.58	−0.27	2.96	20.42	29.50	18.32	28.52	13.12	32.54
33	22.98	22.91	24.50	7.48	−0.25	2.93	19.52	28.50	17.63	27.72	12.51	31.71
34	22.24	22.16	23.50	7.38	−0.23	2.91	18.62	27.50	16.92	26.91	11.88	30.88
35	21.50	21.40	23.50	7.28	−0.21	2.88	18.50	27.26	16.23	26.10	11.26	30.03
36	20.76	20.63	22.50	7.18	−0.19	2.85	17.50	26.15	15.54	25.28	10.65	29.18
37	20.02	19.86	21.50	7.07	−0.17	2.83	16.97	25.50	14.83	24.45	10.03	28.32
38	19.27	19.09	20.50	6.96	−0.15	2.80	16.09	24.50	14.13	23.63	9.44	27.46
39	18.53	18.32	19.50	6.85	−0.12	2.78	15.21	23.50	13.44	22.80	8.82	26.60
40	17.78	17.55	19.50	6.73	−0.10	2.76	14.50	22.66	12.74	21.97	8.22	25.75
41	17.04	16.77	18.50	6.61	−0.07	2.74	13.50	21.54	12.03	21.14	7.64	24.89
42	16.30	16.00	17.50	6.49	−0.04	2.72	12.59	20.50	11.35	20.30	7.06	24.03
43	15.56	15.22	16.50	6.36	0.00	2.71	12.50	20.27	10.66	19.46	6.52	23.16
44	14.83	14.45	15.50	6.23	0.03	2.70	11.50	19.12	9.97	18.62	5.95	22.29
45	14.10	13.68	15.50	6.09	0.07	2.69	10.50	17.98	9.30	17.79	5.43	21.41
46	13.37	12.91	14.50	5.95	0.11	2.69	10.19	17.50	8.63	16.96	4.90	20.54
47	12.65	12.14	13.50	5.81	0.15	2.69	9.37	16.50	7.97	16.12	4.42	19.69
48	11.96	11.40	12.50	5.65	0.20	2.71	8.56	15.50	7.34	15.30	3.95	18.84
49	11.27	10.66	11.50	5.49	0.25	2.73	7.76	14.50	6.73	14.48	3.54	17.99
50	10.60	9.93	10.50	5.33	0.30	2.76	6.97	13.50	6.14	13.68	3.10	17.14
51	9.94	9.22	10.50	5.17	0.35	2.79	6.21	12.50	5.58	12.89	2.71	16.30
52	9.30	8.52	9.50	5.00	0.41	2.84	5.50	11.54	5.03	12.10	2.33	15.46
53	8.68	7.84	8.50	4.83	0.46	2.90	4.72	10.50	4.52	11.33	1.97	14.65
54	8.08	7.19	7.50	4.65	0.52	2.98	4.50	9.99	4.03	10.58	1.68	13.88
55	7.53	6.57	6.50	4.47	0.59	3.07	3.50	8.67	3.60	9.88	1.44	13.11
56	6.99	5.98	5.50	4.29	0.66	3.17	3.50	8.34	3.18	9.19	1.21	12.35

Table 3. (*Continued*)

Age	WLE Mean	Median	Mode	SD	SK	KU	Minimal 50% PI Low	Minimal 50% PI High	Inter-Quartile PI 25%	Inter-Quartile PI 75%	10–90% PI 10%	10–90% PI 90%
57	6.47	5.40	4.50	4.12	0.73	3.28	2.50	6.99	2.78	8.50	0.99	11.62
58	5.97	4.86	3.50	3.94	0.80	3.40	2.35	6.50	2.40	7.88	0.79	10.94
59	5.50	4.36	2.50	3.78	0.87	3.53	1.50	5.26	2.05	7.27	0.61	10.27
60	5.08	3.90	2.50	3.62	0.93	3.65	1.11	4.50	1.73	6.70	0.50	9.63
61	4.69	3.48	1.50	3.47	0.99	3.77	0.50	3.48	1.46	6.19	0.50	9.09
62	4.37	3.16	1.50	3.31	1.04	3.87	0.50	3.16	1.25	5.73	0.50	8.55
63	4.08	2.87	0.50	3.17	1.08	3.96	0.50	2.87	1.08	5.32	0.50	8.12
64	3.82	2.60	0.50	3.03	1.12	4.02	0.50	2.60	0.94	4.98	0.50	7.69
65	3.60	2.38	0.50	2.90	1.14	4.04	0.50	2.38	0.84	4.66	0.50	7.31
66	3.39	2.17	0.50	2.77	1.15	4.03	0.50	2.17	0.71	4.39	0.50	6.94
67	3.21	2.01	0.50	2.64	1.14	3.98	0.50	2.01	0.60	4.19	0.50	6.55
68	3.07	1.91	0.50	2.52	1.12	3.90	0.50	1.91	0.54	4.00	0.50	6.24
69	2.93	1.84	0.50	2.38	1.09	3.85	0.50	1.84	0.50	3.80	0.50	5.92
70	2.79	1.75	0.50	2.22	1.08	3.85	0.50	1.75	0.50	3.54	0.50	5.54
71	2.61	1.59	0.50	2.07	1.09	3.91	0.50	1.59	0.50	3.29	0.50	5.15
72	2.41	1.42	0.50	1.91	1.12	4.02	0.50	1.42	0.50	3.03	0.50	4.68
73	2.20	1.26	0.50	1.75	1.15	4.18	0.50	1.26	0.50	2.75	0.50	4.22
74	2.01	1.15	0.50	1.59	1.20	4.45	0.50	1.15	0.50	2.42	0.50	3.75
75	1.83	1.01	0.50	1.43	1.31	4.95	0.50	1.01	0.50	2.12	0.50	3.33

chief criticism is that the matching process "can be biased due to attenuation of the sample over the one year period" (HPR, 2001, p. 204). Richards (2000, p. 26) writes that in his 1996–1998 study and with his matching algorithm (about which no details are supplied) "matching resulted in lower second period labor force participation rates than occurred in the total population, transition probabilities from active to active and inactive to active were underestimated, and transition probabilities from inactive to inactive and active to inactive were overestimated." ("Matching" refers to an empirical requirement encountered when estimating transition probabilities. A specific person's labor force status must be observed at a certain point in time and again one year later. This is not a trivial exercise because survey data are not coded to be individual specific and people simply drop out of sample over a yearly time period.)

Our first observation is that, even if true, the cure – ignoring initial status – is worse than the disease. If we observe a 50–year-old male, from Table 1 the WLE is 12.63 years if active and, if inactive, 8.13 years. Whichever status is observed, the bias will be less in choosing between the relevant worklife than to announce the 85% – 15% weighted average (if the participation rate

Table 4. *YA* Characteristics for Initially Inactive Women, Regardless of Education.

	WLE							Minimal 50% PI		Inter-Quartile PI		10 90% PI	
Age	Mean	Median	Mode	SD	SK	KU	Pr(0)	Low	High	25%	75%	10%	90%
16	33.21	33.83	35.00	8.79	−0.46	3.49	0.00	29.66	40.00	27.82	39.30	21.86	43.86
17	32.76	33.37	35.00	8.73	−0.45	3.45	0.00	29.00	39.29	27.38	38.82	21.46	43.34
18	32.22	32.83	34.00	8.68	−0.44	3.41	0.00	28.75	39.00	26.86	38.26	20.95	42.76
19	31.54	32.13	33.00	8.63	−0.42	3.36	0.00	27.80	38.00	26.19	37.54	20.32	42.03
20	30.79	31.38	33.00	8.57	−0.41	3.31	0.00	27.00	37.15	25.47	36.77	19.62	41.23
21	30.10	30.68	32.00	8.51	−0.40	3.27	0.00	26.89	37.00	24.78	36.04	18.97	40.47
22	29.36	29.93	31.00	8.46	−0.38	3.23	0.00	25.95	36.00	24.06	35.27	18.28	39.69
23	28.60	29.15	30.00	8.41	−0.37	3.19	0.00	25.01	35.00	23.31	34.47	17.57	38.87
24	27.81	28.35	29.00	8.35	−0.36	3.15	0.00	24.01	34.00	22.54	33.65	16.82	38.03
25	26.99	27.52	29.00	8.30	−0.34	3.12	0.00	23.10	33.00	21.73	32.80	16.05	37.16
26	26.14	26.66	28.00	8.24	−0.33	3.08	0.00	23.00	32.85	20.89	31.92	15.26	36.26
27	25.28	25.79	27.00	8.18	−0.31	3.04	0.00	22.00	31.78	20.05	31.02	14.47	35.34
28	24.43	24.92	26.00	8.12	−0.29	3.00	0.00	21.00	30.70	19.22	30.12	13.67	34.42
29	23.59	24.07	25.00	8.05	−0.28	2.97	0.00	20.00	29.62	18.41	29.24	12.90	33.52
30	22.77	23.22	24.00	7.98	−0.26	2.93	0.01	19.46	29.00	17.61	28.37	12.15	32.63
31	21.94	22.38	23.00	7.90	−0.24	2.90	0.01	18.55	28.00	16.80	27.49	11.41	31.74
32	21.11	21.53	23.00	7.82	−0.22	2.86	0.01	17.65	27.00	15.99	26.60	10.65	30.83
33	20.28	20.69	22.00	7.74	−0.21	2.83	0.01	16.77	26.00	15.19	25.72	9.91	29.93
34	19.50	19.89	21.00	7.66	−0.19	2.80	0.01	16.00	25.11	14.44	24.89	9.21	29.06
35	18.72	19.09	20.00	7.58	−0.17	2.77	0.01	15.00	24.00	13.69	24.06	8.52	28.20
36	17.94	18.29	19.00	7.50	−0.15	2.73	0.01	15.00	23.89	12.92	23.22	7.80	27.34
37	17.14	17.47	18.00	7.42	−0.12	2.70	0.02	14.00	22.75	12.14	22.37	7.07	26.46
38	16.31	16.61	18.00	7.34	−0.09	2.66	0.02	13.00	21.60	11.32	21.48	6.30	25.55
39	15.47	15.74	17.00	7.25	−0.06	2.62	0.03	12.56	21.00	10.49	20.59	5.53	24.65
40	14.63	14.88	16.00	7.17	−0.03	2.58	0.03	11.75	20.00	9.64	19.70	4.74	23.75
41	13.79	14.00	15.00	7.07	0.01	2.54	0.04	10.96	19.00	8.79	18.81	3.94	22.84
42	12.94	13.10	14.00	6.98	0.05	2.50	0.05	10.00	17.81	7.91	17.90	3.14	21.93
43	12.05	12.15	0.00	6.87	0.10	2.47	0.06	9.00	16.53	6.98	16.94	2.30	20.96
44	11.14	11.16	0.00	6.74	0.17	2.44	0.08	8.00	15.19	6.02	15.95	1.48	19.97
45	10.24	10.17	0.00	6.59	0.24	2.43	0.09	7.22	14.00	5.07	14.95	0.70	18.97
46	9.37	9.19	0.00	6.42	0.31	2.45	0.11	6.68	13.00	4.14	13.96	0.00	17.98
47	8.53	8.22	0.00	6.23	0.40	2.48	0.14	6.00	11.80	3.26	12.98	0.00	17.00
48	7.71	7.24	0.00	6.02	0.49	2.55	0.17	5.00	10.19	2.40	11.98	0.00	16.00
49	6.90	6.25	0.00	5.78	0.60	2.67	0.20	4.00	8.50	1.58	10.96	0.00	14.97
50	6.13	5.29	0.00	5.51	0.71	2.83	0.23	3.00	6.73	0.84	9.93	0.00	13.94
51	5.42	4.38	0.00	5.22	0.83	3.04	0.27	1.00	3.88	0.00	8.94	0.00	12.92
52	4.79	3.56	0.00	4.93	0.96	3.30	0.30	1.00	3.06	0.00	8.01	0.00	11.95
53	4.21	2.81	0.00	4.63	1.09	3.62	0.34	1.00	2.30	0.00	7.11	0.00	11.01
54	3.68	2.11	0.00	4.33	1.22	4.01	0.38	1.00	1.61	0.00	6.25	0.00	10.08
55	3.20	1.49	0.00	4.03	1.37	4.47	0.42	0.00	0.99	0.00	5.43	0.00	9.20
56	2.77	0.95	0.00	3.73	1.52	5.01	0.46	0.00	0.44	0.00	4.67	0.00	8.33

Table 4. (*Continued*)

Age	WLE Mean	Median	Mode	SD	SK	KU	Pr(0)	Minimal 50% PI Low	Minimal 50% PI High	Inter-Quartile PI 25%	Inter-Quartile PI 75%	10–90% PI 10%	10–90% PI 90%
57	2.40	0.00	0.00	3.45	1.68	5.64	0.50	0.00	0.00	0.00	3.97	0.00	7.51
58	2.06	0.00	0.00	3.18	1.84	6.36	0.54	0.00	0.00	0.00	3.31	0.00	6.77
59	1.78	0.00	0.00	2.92	2.01	7.17	0.58	0.00	0.00	0.00	2.72	0.00	6.07
60	1.52	0.00	0.00	2.68	2.19	8.10	0.62	0.00	0.00	0.00	2.19	0.00	5.38
61	1.30	0.00	0.00	2.45	2.38	9.16	0.66	0.00	0.00	0.00	1.69	0.00	4.77
62	1.11	0.00	0.00	2.24	2.57	10.31	0.69	0.00	0.00	0.00	1.26	0.00	4.20
63	0.95	0.00	0.00	2.04	2.76	11.58	0.72	0.00	0.00	0.00	0.89	0.00	3.66
64	0.81	0.00	0.00	1.86	2.97	13.01	0.75	0.00	0.00	0.00	0.50	0.00	3.18
65	0.69	0.00	0.00	1.68	3.18	14.59	0.78	0.00	0.00	0.00	0.00	0.00	2.70
66	0.59	0.00	0.00	1.53	3.39	16.25	0.80	0.00	0.00	0.00	0.00	0.00	2.30
67	0.50	0.00	0.00	1.39	3.60	18.06	0.82	0.00	0.00	0.00	0.00	0.00	1.95
68	0.43	0.00	0.00	1.25	3.84	20.20	0.84	0.00	0.00	0.00	0.00	0.00	1.56
69	0.36	0.00	0.00	1.12	4.11	22.83	0.86	0.00	0.00	0.00	0.00	0.00	1.26
70	0.30	0.00	0.00	0.99	4.42	26.16	0.88	0.00	0.00	0.00	0.00	0.00	0.96
71	0.24	0.00	0.00	0.86	4.80	30.58	0.89	0.00	0.00	0.00	0.00	0.00	0.61
72	0.19	0.00	0.00	0.74	5.23	36.23	0.91	0.00	0.00	0.00	0.00	0.00	0.00
73	0.15	0.00	0.00	0.63	5.72	43.28	0.93	0.00	0.00	0.00	0.00	0.00	0.00
74	0.11	0.00	0.00	0.53	6.29	52.39	0.94	0.00	0.00	0.00	0.00	0.00	0.00
75	0.09	0.00	0.00	0.44	6.92	63.55	0.95	0.00	0.00	0.00	0.00	0.00	0.00

is 85%) for the population as a whole. It is better to have an approximate answer to the relevant question than to have a precise answer to an irrelevant question. We do not however accept the premise that significant "bias" in the Markov worklives has been established, and turn to that issue.

2.2. *Predicting the Future*

First, the critics above view the exercise being undertaken differently from us. The Markov model implements the same synthetic cohort assumption employed in current or period U.S. life tables: assuming no change from the most recent data (two or one years, respectively), the question asked is "What are the long-term implications?" No one criticizes the National Vital Statistics System for not undertaking the project of extrapolating mortality trends throughout the remainder of the current century. In fact, such life tables are available to forensic economists from the Social Security Administration and are not used. We do not see ourselves as responsible for undertaking the much more ambitious economic and actuarial projections

Table 5. *YFS* Characteristics for Initially Active Men, Regardless of Education.

							Minimal 50% PI		Inter-Quartile PI		10–90% PI	
Age	*YFSE* Mean	Median	Mode	SD	SK	KU	Low	High	25%	75%	10%	90%
16	47.29	48.40	47.50	11.70	−1.08	5.31	43.00	54.81	42.58	54.42	33.56	60.25
17	46.34	47.41	46.50	11.60	−1.05	5.20	42.00	53.80	41.60	53.43	32.68	59.26
18	45.40	46.43	45.50	11.49	−1.01	5.09	41.00	52.78	40.63	52.44	31.82	58.27
19	44.46	45.44	44.50	11.37	−0.97	4.97	40.00	51.76	39.67	51.45	30.98	57.27
20	43.53	44.46	43.50	11.25	−0.93	4.85	39.00	50.74	38.70	50.46	30.12	56.28
21	42.59	43.47	42.50	11.13	−0.89	4.74	38.00	49.71	37.74	49.47	29.27	55.29
22	41.66	42.49	41.50	11.01	−0.84	4.62	37.00	48.69	36.78	48.48	28.42	54.30
23	40.73	41.50	40.50	10.89	−0.80	4.51	36.00	47.66	35.82	47.49	27.58	53.31
24	39.80	40.52	39.50	10.77	−0.76	4.40	35.00	46.64	34.86	46.51	26.75	52.32
25	38.86	39.54	38.50	10.66	−0.72	4.30	34.00	45.61	33.90	45.52	25.91	51.32
26	37.93	38.56	37.50	10.55	−0.68	4.21	33.00	44.59	32.94	44.53	25.06	50.33
27	36.99	37.57	36.50	10.44	−0.64	4.12	32.00	43.57	31.98	43.54	24.20	49.34
28	36.05	36.59	35.50	10.34	−0.60	4.03	31.00	42.54	31.01	42.55	23.34	48.35
29	35.12	35.61	34.50	10.24	−0.56	3.95	30.00	41.51	30.05	41.57	22.49	47.36
30	34.18	34.63	33.50	10.14	−0.52	3.87	29.00	40.48	29.09	40.58	21.65	46.37
31	33.25	33.65	32.50	10.03	−0.48	3.79	28.00	39.45	28.13	39.60	20.82	45.38
32	32.33	32.67	31.50	9.92	−0.44	3.71	27.00	38.42	27.18	38.61	20.01	44.39
33	31.40	31.70	30.50	9.81	−0.40	3.64	26.00	37.39	26.23	37.63	19.18	43.41
34	30.48	30.72	29.50	9.69	−0.35	3.56	25.00	36.35	25.28	36.65	18.35	42.42
35	29.56	29.75	28.50	9.58	−0.31	3.49	24.00	35.31	24.33	35.67	17.54	41.43
36	28.64	28.77	27.50	9.47	−0.27	3.43	23.00	34.27	23.39	34.69	16.74	40.45
37	27.72	27.80	26.50	9.36	−0.22	3.36	22.00	33.23	22.45	33.71	15.94	39.46
38	26.81	26.83	25.50	9.25	−0.18	3.30	21.00	32.19	21.51	32.73	15.13	38.48
39	25.89	25.86	24.50	9.13	−0.13	3.25	20.00	31.14	20.57	31.75	14.33	37.49
40	24.98	24.90	23.50	9.02	−0.08	3.20	19.00	30.09	19.64	30.78	13.54	36.51
41	24.07	23.93	22.50	8.91	−0.04	3.15	18.00	29.04	18.71	29.80	12.76	35.53
42	23.17	22.97	21.50	8.79	0.01	3.10	17.02	28.00	17.79	28.83	11.99	34.55
43	22.26	22.01	20.50	8.68	0.06	3.07	16.08	27.00	16.87	27.85	11.22	33.56
44	21.36	21.05	19.50	8.56	0.11	3.03	15.14	26.00	15.96	26.88	10.45	32.59
45	20.47	20.10	18.50	8.45	0.16	3.01	14.20	25.00	15.04	25.91	9.70	31.61
46	19.57	19.14	17.50	8.33	0.20	2.98	13.27	24.00	14.13	24.94	8.97	30.63
47	18.68	18.19	16.50	8.22	0.25	2.97	12.35	23.00	13.22	23.98	8.23	29.65
48	17.80	17.25	15.50	8.10	0.30	2.96	11.44	22.00	12.32	23.02	7.51	28.68
49	16.92	16.31	14.50	7.98	0.35	2.96	10.53	21.00	11.43	22.06	6.83	27.70
50	16.05	15.37	13.50	7.86	0.40	2.96	9.64	20.00	10.56	21.10	6.16	26.73
51	15.19	14.44	12.50	7.73	0.45	2.98	8.77	19.00	9.69	20.15	5.51	25.76
52	14.34	13.52	11.50	7.60	0.50	3.00	7.00	17.08	8.85	19.21	4.91	24.80
53	13.50	12.61	10.50	7.46	0.56	3.04	6.11	16.00	8.03	18.26	4.32	23.83
54	12.68	11.71	9.50	7.32	0.61	3.08	5.33	15.00	7.23	17.33	3.78	22.87
55	11.88	10.83	8.50	7.16	0.67	3.14	4.60	14.00	6.45	16.40	3.26	21.92
56	11.09	9.96	7.50	7.01	0.73	3.21	3.91	13.00	5.71	15.48	2.78	20.96

Table 5. (*Continued*)

Age	*YFSE* Mean	Median	Mode	SD	SK	KU	Minimal 50% PI Low	Minimal 50% PI High	Inter-Quartile PI 25%	Inter-Quartile PI 75%	10–90% PI 10%	10–90% PI 90%
57	10.33	9.12	6.50	6.84	0.79	3.29	2.31	11.00	5.01	14.57	2.34	20.01
58	9.59	8.30	5.50	6.66	0.85	3.39	1.00	9.18	4.35	13.67	1.96	19.08
59	8.88	7.53	3.50	6.47	0.92	3.52	0.00	7.53	3.76	12.78	1.61	18.15
60	8.22	6.80	2.50	6.26	0.99	3.67	0.00	6.80	3.24	11.92	1.33	17.22
61	7.60	6.13	0.50	6.04	1.06	3.84	0.00	6.13	2.80	11.09	1.11	16.31
62	7.04	5.54	0.50	5.80	1.13	4.05	0.00	5.54	2.44	10.29	0.94	15.41
63	6.52	4.99	0.50	5.55	1.20	4.29	0.00	4.99	2.15	9.54	0.81	14.53
64	6.05	4.54	0.50	5.29	1.28	4.56	0.00	4.54	1.92	8.82	0.72	13.65
65	5.61	4.11	0.50	5.03	1.36	4.85	0.00	4.11	1.73	8.15	0.65	12.79
66	5.22	3.76	0.50	4.77	1.43	5.17	0.00	3.76	1.58	7.53	0.59	11.95
67	4.85	3.47	0.50	4.51	1.50	5.52	0.00	3.47	1.45	6.94	0.55	11.17
68	4.52	3.20	0.50	4.26	1.57	5.90	0.00	3.20	1.32	6.43	0.50	10.42
69	4.22	2.99	0.50	4.00	1.65	6.32	0.00	2.99	1.24	5.94	0.47	9.69
70	3.94	2.82	0.50	3.75	1.72	6.80	0.00	2.82	1.17	5.56	0.45	8.96
71	3.67	2.62	0.50	3.50	1.81	7.36	0.00	2.62	1.10	5.16	0.43	8.31
72	3.40	2.41	0.50	3.27	1.90	8.00	0.00	2.41	1.02	4.77	0.41	7.66
73	3.13	2.22	0.50	3.04	2.00	8.74	0.00	2.22	0.92	4.36	0.37	6.98
74	2.90	2.11	0.50	2.81	2.13	9.72	0.00	2.11	0.87	3.92	0.35	6.40
75	2.66	1.94	0.50	2.58	2.31	11.06	0.00	1.94	0.87	3.57	0.35	5.78

involved in projecting labor force participation and mortality. The determinants of labor force participation at and beyond middle age and retirement are the subjects of intense research interest by economists: how will baby boomers respond to policy changes in Social Security and Medicare, for example? In addition, how will those facing retirement react to the receipt of inherited wealth, their alleged "undersaving" for retirement, and the switch from most pension plans being defined benefits to defined contributions, and their increased longevity? If these are open questions, the projection of future political and social policy responses is even less clear. In addition to these long-run considerations, transition probabilities a few years into the future may vary with the business cycle, a topic typically and properly ignored in the long-term calculations of forensic economics. We could, of course, take our crack at projecting how all of these forces will change the evolution of transition probabilities, but our work would require users to accept our projections. For these reasons, we see no interest in looking back to the 1970s or to 1992–1993 and comparing the participations implicit in conventional or Markov models over the last 30 years or the last 5 years with what actually had happened. Those modelers performing those

Table 6. *YFS* Characteristics for Initially Inactive Men, Regardless of Education.

Age	*YFSE* Mean	Median	Mode	SD	SK	KU	Pr(0)	Minimal 50% PI		Inter-Quartile PI		10–90% PI	
								Low	High	25%	75%	10%	90%
16	47.28	48.40	47.50	11.72	−1.09	5.37	0.00	43.00	54.70	42.58	54.42	33.56	60.25
17	46.34	47.41	46.50	11.62	−1.06	5.25	0.00	42.00	53.69	41.60	53.43	32.68	59.26
18	45.40	46.43	45.50	11.51	−1.02	5.14	0.00	41.00	52.67	40.63	52.44	31.82	58.27
19	44.46	45.44	44.50	11.39	−0.98	5.03	0.00	40.00	51.65	39.67	51.45	30.98	57.27
20	43.52	44.46	43.50	11.27	−0.94	4.91	0.00	39.00	50.62	38.70	50.46	30.12	56.28
21	42.59	43.47	42.50	11.15	−0.90	4.79	0.00	38.00	49.60	37.74	49.47	29.27	55.29
22	41.66	42.49	41.50	11.03	−0.86	4.68	0.00	37.00	48.58	36.78	48.48	28.42	54.30
23	40.72	41.50	40.50	10.90	−0.81	4.56	0.00	36.00	47.56	35.82	47.49	27.58	53.31
24	39.79	40.52	39.50	10.79	−0.77	4.45	0.00	35.00	46.53	34.86	46.51	26.74	52.32
25	38.86	39.54	38.50	10.67	−0.73	4.35	0.00	34.00	45.51	33.90	45.52	25.91	51.32
26	37.92	38.56	37.50	10.57	−0.69	4.26	0.00	33.00	44.48	32.94	44.53	25.06	50.33
27	36.98	37.57	36.50	10.47	−0.66	4.18	0.00	32.00	43.45	31.98	43.54	24.20	49.34
28	36.04	36.59	35.50	10.37	−0.62	4.11	0.00	31.00	42.41	31.01	42.55	23.34	48.35
29	35.10	35.61	34.50	10.28	−0.59	4.04	0.01	30.00	41.36	30.05	41.57	22.48	47.36
30	34.17	34.63	33.50	10.19	−0.56	3.97	0.01	29.00	40.31	29.09	40.58	21.64	46.37
31	33.23	33.65	32.50	10.09	−0.52	3.91	0.01	28.00	39.25	28.13	39.60	20.81	45.38
32	32.29	32.67	31.50	10.00	−0.49	3.86	0.01	27.00	38.19	27.18	38.61	19.98	44.39
33	31.36	31.69	30.50	9.92	−0.46	3.80	0.01	26.00	37.11	26.22	37.63	19.13	43.41
34	30.42	30.72	29.50	9.84	−0.43	3.75	0.01	25.00	36.03	25.27	36.65	18.28	42.42
35	29.48	29.74	28.50	9.76	−0.41	3.70	0.01	24.05	35.00	24.31	35.67	17.43	41.43
36	28.53	28.77	27.50	9.70	−0.38	3.66	0.02	23.14	34.00	23.36	34.69	16.57	40.45
37	27.58	27.79	26.50	9.64	−0.36	3.61	0.02	22.25	33.00	22.40	33.71	15.69	39.46
38	26.63	26.82	25.50	9.60	−0.34	3.56	0.02	21.37	32.00	21.45	32.73	14.80	38.48
39	25.67	25.84	24.50	9.56	−0.32	3.51	0.03	20.51	31.00	20.49	31.75	13.88	37.49
40	24.70	24.87	23.50	9.52	−0.30	3.45	0.03	19.66	30.00	19.52	30.77	12.94	36.51
41	23.73	23.89	22.50	9.49	−0.28	3.38	0.04	18.82	29.00	18.55	29.79	11.95	35.52
42	22.76	22.92	21.50	9.47	−0.26	3.30	0.04	18.00	27.99	17.58	28.82	10.90	34.54
43	21.78	21.94	0.00	9.45	−0.23	3.22	0.05	17.00	26.79	16.59	27.84	9.78	33.56
44	20.79	20.97	0.00	9.43	−0.20	3.13	0.06	16.00	25.58	15.60	26.86	8.56	32.58
45	19.81	19.99	0.00	9.40	−0.17	3.03	0.07	15.00	24.36	14.59	25.89	7.21	31.60
46	18.82	19.00	0.00	9.38	−0.13	2.94	0.08	14.00	23.11	13.56	24.91	5.55	30.62
47	17.82	18.02	0.00	9.35	−0.09	2.84	0.10	13.17	22.00	12.51	23.94	3.05	29.64
48	16.83	17.03	0.00	9.31	−0.04	2.74	0.11	12.48	21.00	11.42	22.97	0.00	28.67
49	15.84	16.03	0.00	9.26	0.01	2.66	0.13	12.00	20.18	10.30	21.99	0.00	27.69
50	14.85	15.04	0.00	9.20	0.07	2.58	0.15	11.00	18.81	9.13	21.02	0.00	26.72
51	13.88	14.03	0.00	9.11	0.14	2.51	0.17	10.59	18.00	7.86	20.05	0.00	25.75
52	12.91	13.01	0.00	9.02	0.21	2.46	0.19	10.00	16.95	6.42	19.09	0.00	24.78
53	11.96	11.98	0.00	8.90	0.28	2.43	0.22	9.00	15.44	4.63	18.12	0.00	23.81
54	11.03	10.93	0.00	8.76	0.37	2.43	0.25	9.00	14.85	0.00	17.15	0.00	22.84
55	10.12	9.86	0.00	8.59	0.45	2.45	0.28	8.78	14.00	0.00	16.18	0.00	21.88
56	9.26	8.77	0.00	8.39	0.55	2.50	0.32	8.47	13.00	0.00	15.22	0.00	20.91

Table 6. (*Continued*)

Age	YFSE Mean	Median	Mode	SD	SK	KU	Pr(0)	Minimal 50% PI Low	Minimal 50% PI High	Inter-Quartile PI 25%	Inter-Quartile PI 75%	10–90% PI 10%	10–90% PI 90%
57	8.45	7.64	0.00	8.16	0.64	2.59	0.35	8.22	12.00	0.00	14.26	0.00	19.96
58	7.67	6.46	0.00	7.91	0.75	2.71	0.39	8.06	11.00	0.00	13.29	0.00	19.00
59	6.94	5.19	0.00	7.63	0.85	2.87	0.42	7.96	10.00	0.00	12.33	0.00	18.06
60	6.27	3.71	0.00	7.33	0.96	3.08	0.46	8.00	9.07	0.00	11.37	0.00	17.12
61	5.64	1.38	0.00	7.02	1.08	3.32	0.50	7.00	7.08	0.00	10.42	0.00	16.18
62	5.06	0.00	0.00	6.70	1.19	3.62	0.53	0.00	0.00	0.00	9.46	0.00	15.25
63	4.53	0.00	0.00	6.36	1.32	3.97	0.56	0.00	0.00	0.00	8.50	0.00	14.33
64	4.04	0.00	0.00	6.02	1.45	4.39	0.60	0.00	0.00	0.00	7.52	0.00	13.40
65	3.57	0.00	0.00	5.68	1.59	4.88	0.63	0.00	0.00	0.00	6.51	0.00	12.48
66	3.15	0.00	0.00	5.34	1.74	5.46	0.66	0.00	0.00	0.00	5.46	0.00	11.57
67	2.77	0.00	0.00	5.00	1.90	6.14	0.69	0.00	0.00	0.00	4.33	0.00	10.65
68	2.41	0.00	0.00	4.66	2.08	6.96	0.72	0.00	0.00	0.00	3.03	0.00	9.74
69	2.09	0.00	0.00	4.34	2.27	7.92	0.75	0.00	0.00	0.00	0.00	0.00	8.82
70	1.80	0.00	0.00	4.02	2.47	9.05	0.78	0.00	0.00	0.00	0.00	0.00	7.91
71	1.55	0.00	0.00	3.71	2.69	10.36	0.80	0.00	0.00	0.00	0.00	0.00	6.99
72	1.33	0.00	0.00	3.42	2.92	11.86	0.83	0.00	0.00	0.00	0.00	0.00	6.10
73	1.14	0.00	0.00	3.14	3.15	13.57	0.85	0.00	0.00	0.00	0.00	0.00	5.20
74	0.98	0.00	0.00	2.88	3.40	15.52	0.86	0.00	0.00	0.00	0.00	0.00	4.29
75	0.84	0.00	0.00	2.63	3.67	17.78	0.88	0.00	0.00	0.00	0.00	0.00	3.31

benchmark calculations were simply not attempting to answer those questions at the time.

2.3. *The Markov Model's Alleged Underestimation of Participation Rates Implicit in the Model*

Another criticism of the Markov model is that for the population as a whole, its participation-weighted average WLE is lower than the conventional model's WLE. Finch (1983) asserted that the Markov and the conventional models, applied to the same data, would produce the same overall WLE, and Shirley Smith (1983) agreed. This equivalence has been reasserted by the more recent critics above, but has never been proved. In fact, it is wrong, and when participation rates fall with age, we have proven a theoretical inequality, which for all males results in the conventional worklife exceeding the Markov worklife by 0.16–0.33 of a year or so.

Let ${}_tPP_x$ denote the labor force participation rate in period t for a population age x, and let ${}_t^M p_x^N \equiv {}_t^m p_x^n/(1 - {}_t p_x^d)$ denote the conditional-on-survival transition probability from state M in period t to state N in period

Table 7. *YFS* Characteristics for Initially Active Women, Regardless of Education.

Age	YFSE Mean	Median	Mode	SD	SK	KU	Minimal 50% PI		Inter-Quartile PI		10–90% PI	
							Low	High	25%	75%	10%	90%
16	46.01	46.53	46.50	9.77	−0.69	5.02	41.00	52.12	40.86	51.98	34.47	57.72
17	45.03	45.53	45.50	9.72	−0.65	4.89	40.00	51.11	39.87	50.98	33.50	56.72
18	44.05	44.54	44.50	9.67	−0.62	4.76	39.00	50.10	38.88	49.99	32.53	55.72
19	43.08	43.54	43.50	9.62	−0.59	4.64	38.00	49.10	37.89	48.99	31.56	54.72
20	42.10	42.55	42.50	9.57	−0.56	4.53	37.00	48.09	36.90	47.99	30.59	53.73
21	41.12	41.55	41.50	9.53	−0.53	4.42	36.00	47.08	35.91	47.00	29.63	52.73
22	40.14	40.56	40.50	9.48	−0.50	4.32	35.00	46.07	34.92	46.00	28.66	51.73
23	39.16	39.56	39.50	9.44	−0.47	4.23	34.00	45.06	33.94	45.00	27.69	50.73
24	38.18	38.57	38.50	9.40	−0.44	4.14	33.00	44.06	32.95	44.01	26.72	49.74
25	37.21	37.57	37.50	9.35	−0.42	4.05	32.00	43.05	31.96	43.01	25.76	48.74
26	36.23	36.58	36.50	9.31	−0.39	3.97	31.00	42.04	30.97	42.02	24.79	47.74
27	35.25	35.58	35.50	9.27	−0.36	3.89	30.00	41.03	29.99	41.02	23.83	46.75
28	34.28	34.59	34.50	9.22	−0.33	3.82	29.00	40.02	29.00	40.03	22.87	45.75
29	33.30	33.60	33.50	9.18	−0.31	3.75	28.00	39.01	28.02	39.03	21.92	44.75
30	32.33	32.60	32.50	9.13	−0.28	3.68	27.00	38.00	27.03	38.04	20.96	43.76
31	31.36	31.61	31.50	9.08	−0.25	3.61	26.01	37.00	26.05	37.04	20.01	42.76
32	30.39	30.62	30.50	9.03	−0.22	3.54	25.02	36.00	25.07	36.05	19.06	41.76
33	29.42	29.63	29.50	8.98	−0.19	3.48	24.04	35.00	24.09	35.06	18.11	40.77
34	28.45	28.64	28.50	8.92	−0.16	3.42	23.05	34.00	23.11	34.06	17.17	39.77
35	27.49	27.65	27.50	8.87	−0.13	3.37	22.07	33.00	22.13	33.07	16.23	38.78
36	26.53	26.66	26.50	8.81	−0.10	3.32	21.08	32.00	21.16	32.08	15.30	37.78
37	25.57	25.67	25.50	8.75	−0.07	3.27	20.10	31.00	20.19	31.09	14.38	36.79
38	24.61	24.68	24.50	8.68	−0.04	3.22	19.13	30.00	19.22	30.10	13.47	35.80
39	23.66	23.70	23.50	8.62	−0.01	3.18	18.15	29.00	18.25	29.11	12.56	34.80
40	22.71	22.72	22.50	8.54	0.03	3.14	17.18	28.00	17.29	28.12	11.68	33.81
41	21.77	21.73	21.50	8.47	0.07	3.10	16.21	27.00	16.34	27.13	10.81	32.82
42	20.83	20.75	20.50	8.38	0.10	3.08	15.25	26.00	15.39	26.14	9.96	31.83
43	19.90	19.78	19.50	8.29	0.15	3.05	14.30	25.00	14.45	25.16	9.12	30.83
44	18.98	18.80	18.50	8.20	0.19	3.03	13.35	24.00	13.52	24.18	8.30	29.84
45	18.07	17.83	17.50	8.09	0.23	3.02	12.42	23.00	12.60	23.19	7.52	28.86
46	17.16	16.87	16.50	7.98	0.28	3.02	11.49	22.00	11.69	22.21	6.78	27.87
47	16.27	15.91	15.50	7.86	0.33	3.03	10.59	21.00	10.81	21.24	6.08	26.88
48	15.39	14.96	14.50	7.73	0.38	3.05	9.70	20.00	9.95	20.26	5.40	25.89
49	14.53	14.01	13.50	7.59	0.44	3.08	8.85	19.00	9.10	19.29	4.79	24.91
50	13.69	13.08	11.50	7.44	0.50	3.12	8.00	17.98	8.28	18.33	4.21	23.93
51	12.86	12.17	10.50	7.27	0.56	3.18	7.00	16.78	7.50	17.37	3.67	22.95
52	12.05	11.27	9.50	7.10	0.62	3.26	5.49	15.00	6.75	16.42	3.18	21.97
53	11.26	10.38	8.50	6.92	0.69	3.35	4.81	14.00	6.05	15.47	2.74	21.00
54	10.50	9.53	7.50	6.73	0.76	3.47	3.19	12.00	5.38	14.54	2.37	20.03
55	9.77	8.70	6.50	6.52	0.84	3.62	2.68	11.00	4.78	13.62	2.07	19.07
56	9.07	7.91	5.50	6.30	0.92	3.80	1.24	9.00	4.22	12.72	1.81	18.11

Table 7. (*Continued*)

Age	*YFSE* Mean	Median	Mode	SD	SK	KU	Minimal 50% PI		Inter-Quartile PI		10–90% PI	
							Low	High	25%	75%	10%	90%
57	8.40	7.15	4.50	6.08	1.00	3.99	0.88	8.00	3.70	11.83	1.55	17.16
58	7.75	6.44	3.50	5.86	1.09	4.22	0.00	6.44	3.21	10.96	1.32	16.22
59	7.13	5.77	2.50	5.63	1.17	4.48	0.00	5.77	2.77	10.14	1.13	15.29
60	6.56	5.16	1.50	5.39	1.26	4.77	0.00	5.16	2.39	9.36	0.95	14.38
61	6.03	4.64	0.50	5.15	1.34	5.10	0.00	4.64	2.07	8.62	0.80	13.48
62	5.57	4.18	0.50	4.89	1.43	5.47	0.00	4.18	1.84	7.93	0.70	12.61
63	5.14	3.79	0.50	4.64	1.51	5.89	0.00	3.79	1.64	7.33	0.63	11.76
64	4.76	3.45	0.50	4.38	1.59	6.35	0.00	3.45	1.48	6.78	0.56	10.93
65	4.42	3.14	0.50	4.13	1.68	6.85	0.00	3.14	1.37	6.30	0.52	10.17
66	4.10	2.88	0.50	3.89	1.75	7.38	0.00	2.88	1.23	5.86	0.47	9.47
67	3.82	2.69	0.50	3.65	1.82	7.95	0.00	2.69	1.11	5.48	0.43	8.79
68	3.58	2.57	0.50	3.41	1.89	8.59	0.00	2.57	1.04	5.12	0.41	8.15
69	3.37	2.47	0.50	3.18	1.97	9.37	0.00	2.47	0.99	4.79	0.40	7.54
70	3.15	2.35	0.50	2.95	2.08	10.37	0.00	2.35	0.98	4.45	0.39	6.91
71	2.91	2.17	0.50	2.73	2.22	11.61	0.00	2.17	0.93	4.06	0.37	6.32
72	2.67	1.96	0.50	2.52	2.38	13.12	0.00	1.96	0.86	3.77	0.35	5.72
73	2.43	1.80	0.50	2.32	2.57	14.97	0.00	1.80	0.79	3.43	0.32	5.10
74	2.20	1.68	0.50	2.12	2.79	17.32	0.00	1.68	0.72	3.03	0.29	4.63
75	1.99	1.53	0.50	1.93	3.11	20.56	0.00	1.53	0.70	2.70	0.28	4.09

$t+1$, $M, N \in \{A, I\}$, where A denotes active and I denotes inactive. By conditioning transition probabilities on survival, we have ${}^{A}_{t}p^{A}_{x} + {}^{A}_{t}p^{I}_{x} = 1$ and ${}^{I}_{t}p^{A}_{x} + {}^{I}_{t}p^{I}_{x} = 1$. In addition, as the x-year-old population in period t ages one year, its participation rate at age $x+1$ in period $t+1$ would be given by

$$_{t+1}PP_{x+1} = {}^{A}_{t}p^{A}_{x}\,{}_{t}PP_{x} + {}^{I}_{t}p^{A}_{x}(1 - {}_{t}PP_{x}) \equiv {}_{t+1}PP^{\text{Markov}}_{x+1}. \tag{1}$$

If applied to the matched sample, (1) would be an identity. We expect the left- and right-hand side of (1) to be approximately equal empirically, especially absent in- or out migration or under the assumption that migrants exhibit the same labor force behavior as non-migrants, provided that the matched sample was similar to the unmatched sample. The reader may compare (1) with Finch's (1983) Eq. (5), after adjusting for mortality. Some authors (e.g., Richards and HPR) criticize the Markov model on the grounds that estimated transition probabilities are or may be biased – the source of the bias being attributed to unmatched people being excluded from calculated transition probabilities and the assumption that the unmatched undergo significantly different transitions than the matched. This

Table 8. *YFS* Characteristics for Initially Inactive Women, Regardless of Education.

Age	YFSE Mean	Median	Mode	SD	SK	KU	Pr(0)	Minimal 50% PI Low	Minimal 50% PI High	Inter-Quartile PI 25%	Inter-Quartile PI 75%	10–90% PI 10%	10–90% PI 90%
16	46.01	46.53	46.50	9.77	−0.69	5.06	0.00	41.00	52.08	40.86	51.98	34.47	57.72
17	45.03	45.53	45.50	9.73	−0.66	4.93	0.00	40.00	51.07	39.87	50.98	33.50	56.72
18	44.05	44.54	44.50	9.68	−0.63	4.80	0.00	39.00	50.07	38.88	49.99	32.53	55.72
19	43.08	43.54	43.50	9.63	−0.60	4.68	0.00	38.00	49.06	37.89	48.99	31.56	54.72
20	42.10	42.55	42.50	9.58	−0.57	4.57	0.00	37.00	48.05	36.90	47.99	30.59	53.73
21	41.12	41.55	41.50	9.54	−0.54	4.47	0.00	36.00	47.04	35.91	47.00	29.62	52.73
22	40.14	40.56	40.50	9.49	−0.51	4.38	0.00	35.00	46.03	34.92	46.00	28.66	51.73
23	39.16	39.56	39.50	9.45	−0.48	4.29	0.00	34.00	45.01	33.94	45.00	27.69	50.73
24	38.18	38.57	38.50	9.41	−0.46	4.21	0.00	33.00	44.00	32.95	44.01	26.72	49.74
25	37.20	37.57	37.50	9.38	−0.44	4.14	0.00	32.02	43.00	31.96	43.01	25.76	48.74
26	36.22	36.58	36.50	9.34	−0.41	4.07	0.00	31.04	42.00	30.97	42.02	24.79	47.74
27	35.24	35.58	35.50	9.30	−0.39	4.01	0.00	30.06	41.00	29.99	41.02	23.83	46.75
28	34.26	34.59	34.50	9.27	−0.37	3.95	0.00	29.08	40.00	29.00	40.03	22.87	45.75
29	33.28	33.59	33.50	9.23	−0.35	3.90	0.00	28.11	39.00	28.02	39.03	21.91	44.75
30	32.30	32.60	32.50	9.20	−0.33	3.84	0.01	27.14	38.00	27.03	38.04	20.95	43.76
31	31.33	31.61	31.50	9.16	−0.31	3.79	0.01	26.17	37.00	26.05	37.04	19.99	42.76
32	30.35	30.62	30.50	9.13	−0.30	3.74	0.01	25.21	36.00	25.06	36.05	19.03	41.76
33	29.37	29.62	29.50	9.10	−0.28	3.70	0.01	24.26	35.00	24.08	35.05	18.07	40.77
34	28.39	28.63	28.50	9.07	−0.26	3.65	0.01	23.31	34.00	23.09	34.06	17.11	39.77
35	27.41	27.64	27.50	9.05	−0.25	3.60	0.01	22.37	33.00	22.11	33.07	16.14	38.78
36	26.42	26.65	26.50	9.03	−0.23	3.55	0.01	21.44	32.00	21.13	32.08	15.17	37.78
37	25.43	25.66	25.50	9.01	−0.22	3.50	0.02	20.53	31.00	20.14	31.08	14.18	36.79
38	24.44	24.67	24.50	9.00	−0.21	3.45	0.02	19.64	30.00	19.15	30.09	13.18	35.79
39	23.44	23.67	23.50	9.00	−0.20	3.40	0.03	18.77	29.00	18.15	29.10	12.15	34.80
40	22.44	22.68	22.50	9.01	−0.18	3.33	0.03	17.93	28.00	17.15	28.11	11.08	33.81
41	21.42	21.68	21.50	9.02	−0.17	3.26	0.04	17.00	26.89	16.13	27.11	9.95	32.81
42	20.40	20.68	20.50	9.04	−0.15	3.18	0.05	16.00	25.68	15.10	26.12	8.71	31.82
43	19.36	19.67	0.00	9.07	−0.13	3.08	0.06	15.59	25.00	14.04	25.13	7.31	30.83
44	18.30	18.66	0.00	9.11	−0.11	2.97	0.08	14.91	24.00	12.94	24.13	5.58	29.83
45	17.24	17.63	0.00	9.13	−0.07	2.86	0.09	14.00	22.71	11.79	23.13	2.94	28.84
46	16.17	16.60	0.00	9.14	−0.03	2.74	0.11	13.00	21.29	10.58	22.13	0.00	27.85
47	15.11	15.55	0.00	9.13	0.03	2.64	0.14	12.18	20.00	9.29	21.13	0.00	26.86
48	14.05	14.49	0.00	9.10	0.10	2.55	0.17	11.71	19.00	7.86	20.12	0.00	25.86
49	12.99	13.40	0.00	9.05	0.17	2.48	0.20	11.00	17.69	6.16	19.11	0.00	24.87
50	11.94	12.28	0.00	8.96	0.26	2.44	0.23	10.96	17.00	3.80	18.09	0.00	23.88
51	10.93	11.13	0.00	8.83	0.35	2.43	0.27	10.00	15.32	0.00	17.07	0.00	22.89
52	9.97	9.95	0.00	8.65	0.46	2.47	0.30	9.40	14.00	0.00	16.04	0.00	21.89
53	9.04	8.71	0.00	8.44	0.57	2.55	0.34	9.00	12.81	0.00	15.01	0.00	20.90
54	8.16	7.38	0.00	8.19	0.68	2.67	0.38	9.00	11.96	0.00	13.97	0.00	19.91
55	7.34	5.93	0.00	7.92	0.81	2.85	0.42	8.00	10.03	0.00	12.93	0.00	18.92
56	6.56	4.13	0.00	7.61	0.93	3.08	0.46	8.00	9.00	0.00	11.87	0.00	17.93

Table 8. (*Continued*)

Age	*YFSE* Mean	Median	Mode	SD	SK	KU	Pr(0)	Minimal 50% PI Low	Minimal 50% PI High	Inter-Quartile PI 25%	Inter-Quartile PI 75%	10-90% PI 10%	10-90% PI 90%
57	5.84	0.00	0.00	7.28	1.07	3.37	0.50	0.00	0.00	0.00	10.80	0.00	16.94
58	5.18	0.00	0.00	6.94	1.21	3.73	0.54	0.00	0.00	0.00	9.72	0.00	15.95
59	4.57	0.00	0.00	6.58	1.36	4.16	0.58	0.00	0.00	0.00	8.61	0.00	14.96
60	4.02	0.00	0.00	6.22	1.52	4.68	0.62	0.00	0.00	0.00	7.47	0.00	13.97
61	3.52	0.00	0.00	5.85	1.68	5.30	0.66	0.00	0.00	0.00	6.27	0.00	12.98
62	3.08	0.00	0.00	5.48	1.85	6.03	0.69	0.00	0.00	0.00	4.99	0.00	11.99
63	2.68	0.00	0.00	5.11	2.04	6.90	0.72	0.00	0.00	0.00	3.49	0.00	11.00
64	2.32	0.00	0.00	4.75	2.23	7.94	0.75	0.00	0.00	0.00	1.04	0.00	10.00
65	2.00	0.00	0.00	4.39	2.45	9.19	0.78	0.00	0.00	0.00	0.00	0.00	9.00
66	1.72	0.00	0.00	4.05	2.68	10.69	0.80	0.00	0.00	0.00	0.00	0.00	7.99
67	1.48	0.00	0.00	3.72	2.93	12.52	0.82	0.00	0.00	0.00	0.00	0.00	6.96
68	1.26	0.00	0.00	3.40	3.22	14.79	0.84	0.00	0.00	0.00	0.00	0.00	5.90
69	1.06	0.00	0.00	3.10	3.56	17.65	0.86	0.00	0.00	0.00	0.00	0.00	4.78
70	0.89	0.00	0.00	2.81	3.94	21.27	0.88	0.00	0.00	0.00	0.00	0.00	3.53
71	0.73	0.00	0.00	2.54	4.39	25.86	0.89	0.00	0.00	0.00	0.00	0.00	1.90
72	0.60	0.00	0.00	2.29	4.90	31.54	0.91	0.00	0.00	0.00	0.00	0.00	0.00
73	0.49	0.00	0.00	2.06	5.45	38.44	0.93	0.00	0.00	0.00	0.00	0.00	0.00
74	0.40	0.00	0.00	1.86	6.06	46.69	0.94	0.00	0.00	0.00	0.00	0.00	0.00
75	0.32	0.00	0.00	1.67	6.70	56.21	0.95	0.00	0.00	0.00	0.00	0.00	0.00

alleged problem is thought to be so damning that critics eschew the Markov model in favor of the conventional model in spite of all of the unrealistic assumptions of that model.

Finch claimed that, when Markov transition probabilities of the time were used to compute ${}_{t+1}PP_{x+1}^{\text{Markov}}$, this implied participation was too low. He adjusted the Markov transition probabilities upward, to match the larger ${}_{t+1}PP_{x+1}$. His adjustments were less important than the underlying reasoning. The source of this bias is caused by the participation in the (second period) matches which, as a result of the matching process, is too low (assuming no net immigration of workers who participate more than those here in the last period) relative to the unmatched or the population as a whole. If matches give too low a value for the left-hand side in (1), then there is too little to allocate to the transitions into the active state on the right-hand side and WLE, which varies directly with these, will be biased downward.

We do take the issue of potential bias seriously. First, as Peracchi and Welch (1995 p. 173) say: "We conclude that, although selecting the matched individuals does bias measures of participation, especially for men, no

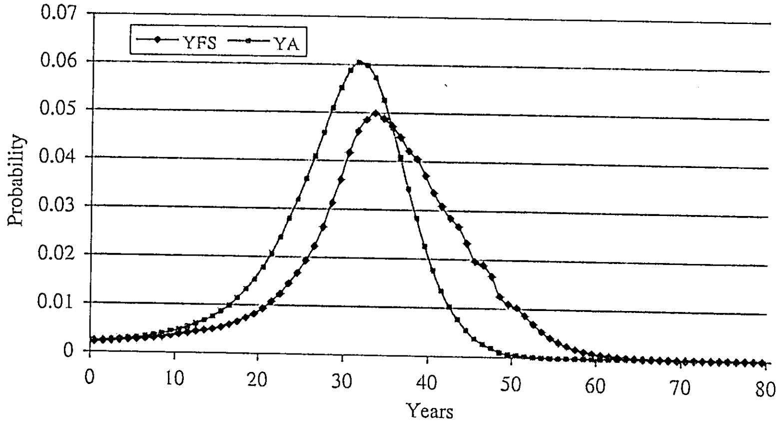

Fig. 1. Probability Mass Functions for Years of Activity and Years to Final Separation for Initially Active Men of Age 30.

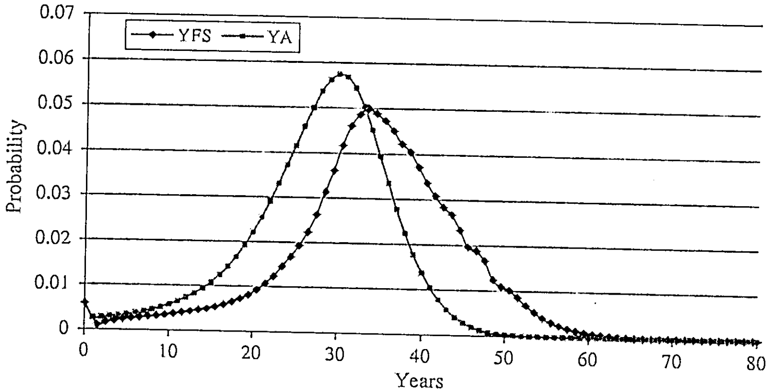

Fig. 2. Probability Mass Functions for Years of Activity and Years to Final Separation for Initially Inactive Men of Age 30.

systematic bias appears in the estimates of transitions after controlling for sex, age, and labor force status at the time of the first survey." A few points should be made. We emphasize their bottom line conclusion – no bias in the transition probabilities. Finis Welch is not just any author when it comes to data issues; he has a reputation among labor economists for extremely careful treatment of data. In fact, he founded (and is currently the President of) Unicom Research in Santa Monica in 1979, a company, which "has

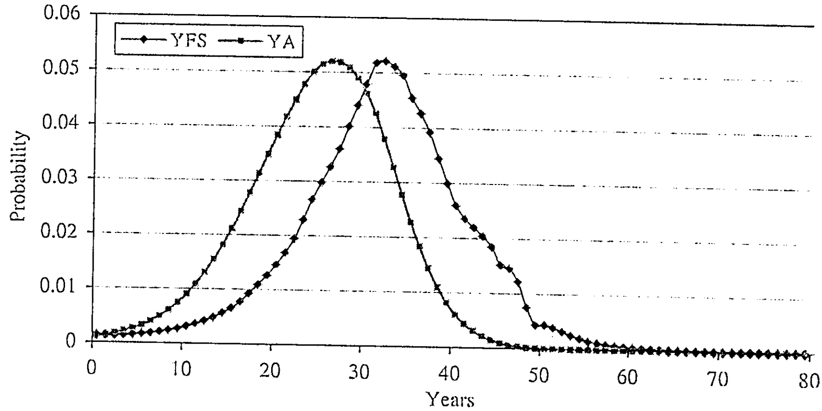

Fig. 3. Probability Mass Functions for Years of Activity and Years to Final Separation for Initially Active Women of Age 30.

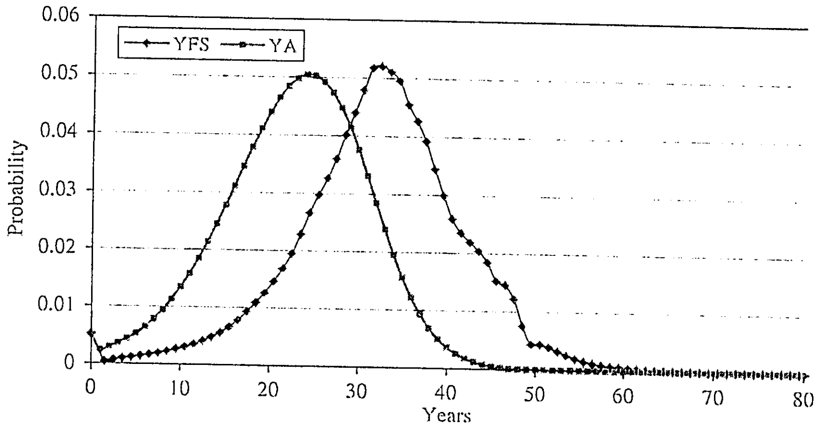

Fig. 4. Probability Mass Functions for Years of Activity and for Years to Final Separation for Initially Inactive Women of Age 30.

produced the CPS Utilities, a set of data, documentation and extraction software, since the early 1990s. The CPS Utilities provides easy access to over 40 years of data from the Current Population Survey along with comprehensive documentation and original survey questionnaires." Few possess knowledge of the Current Population Survey (CPS) as thorough as Welch, who has personally discussed this issue with one of the authors. Second, without further sampling adjustments, which may be made to eliminate the matching-participation discrepancy altogether as discussed below, the direction of the bias in the critics' argument has now reversed itself – the matched probabilities from the Markov model were higher, a decade later. Yet the critics' argument did not change, rather they continue to assert Markov's underestimation. Below, we propose taking another look at the alleged bias in the estimated transition probabilities by using (1).

First, we compute the left-hand side of (1). This is not done with data from only a matched sample but with the same participation rates that the BLS would have calculated from the entire CPS sample if it had calculated age-specific participation rates rather than the age-group rates it typically reports. Next, transition probabilities are calculated from a matched sample from the CPS. This, along with the previously estimated participation rates, enables us to evaluate the right-hand side of (1). Now we compare. Significant sample selection problems that lead to severely biased estimated transition probabilities would cause large discrepancies between the separately estimated left- and right-hand sides of (1). Close agreement between the estimates of the left- and right-hand sides of (1) would be further evidence of little bias.

Kurt Krueger (2004) has compiled a set of transition tables for 1998–2003, extending the work of his PhD dissertation (Krueger, 2003). His transition tables contain weighted and sample counts of the entire U.S. civilian population, its active and inactive subpopulations, and transitions (between adjacent years) from inactive to inactive, inactive to active, active to inactive, and active to active states at each exact age 16–90 from the CPS. Months in sample (MIS) 4 and 8 are used exclusively; but by using the outgoing rotation weights and adjusting the weights of the matched MIS 4,8 records, the MIS 4,8 data "forces the combined MIS4 and MIS8 sub-sample of the CPS to sum to the composite estimates of employment, unemployment and not in the labor force for each month by age, race and sex" (Krueger, 2003, p. 134). Krueger calculated transition tables for men and women with less than high school, high school, some college, college, and without regard to education. We utilize the Krueger data for all men and women, without regard to education, below, and thank Kurt Krueger for making his data available to us.

Figure 5 shows participation rates for males for 1998–1999, which HPR cite in their most current paper on what they refer to as "median years to retirement" (2001) and which they indicate were produced by the BLS from CPS microdata files. The figure also shows average participation rates for 1998–1999 that we computed from Krueger's transition tables for all males.

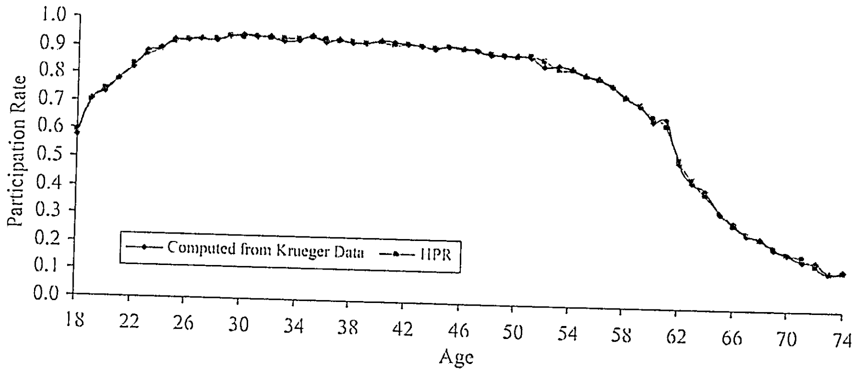

Fig. 5. Male Participation Rates (1998–1999) Computed from Krueger Data and Rates Cited by HPR.

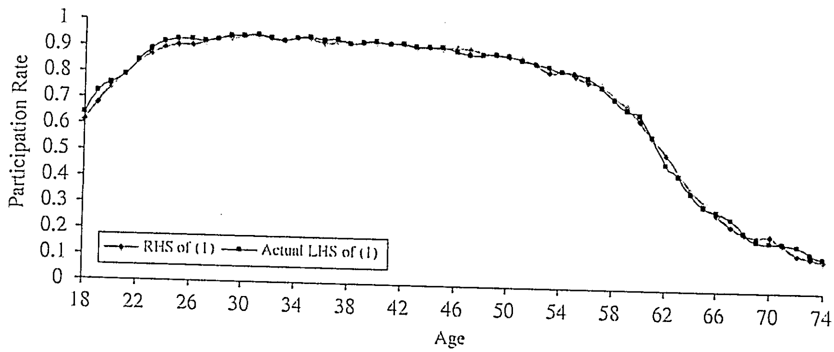

Fig. 6. Actual Participation Rates for Men in 1999 and Rates Computed from (1).

To the eye, there appears to be only one series plotted in Fig. 5 because both series are practically identical. Figure 6 shows the left- and right-hand sides of (1), keeping in mind that the right-hand side of (1) depends on transition probabilities. One is struck by the close agreement of these two series. To be sure, they are not identical, but the average difference (actual ${}_{t+1}PP_{x+1}$ less calculated value of the right-hand side of (1)) is only 0.004. Figures 7 and 8 are for all women, regardless of education. Figure 7 shows HPR participation rates that are once again practically identical to those computed from Krueger's data. The left- and right-hand sides of (1) are displayed in Fig. 8.

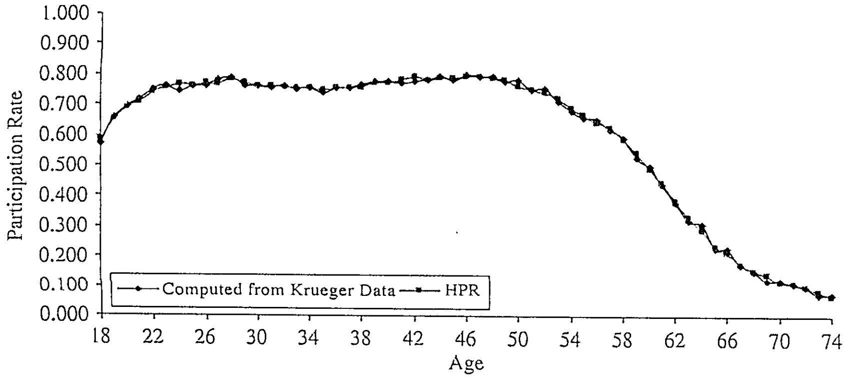

Fig. 7. Female Participation Rates (1998–1999) Computed from Krueger Data and Rates Cited by HPR.

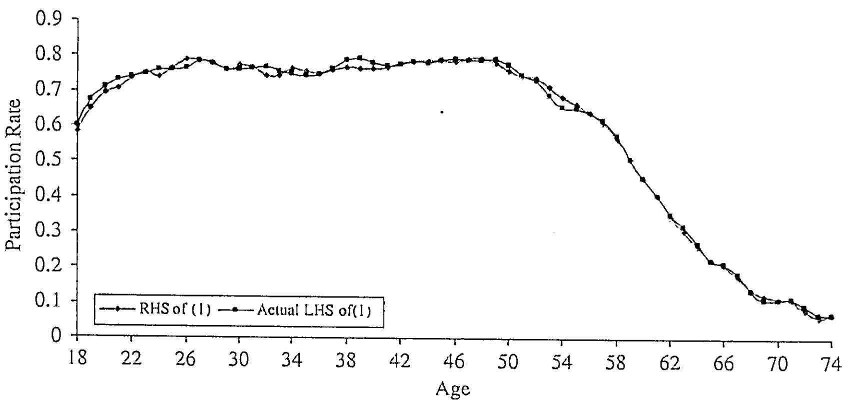

Fig. 8. Actual Participation Rates for Women in 1999 and Rates Computed from (1).

These curves also are in close agreement; the average difference (actual ${}_{t+1}PP_{x+1}$ less calculated value of the right-hand side of (1)) is 0.002. Thus, the underestimation bias thought to cause bias in transition probability estimation found by Richards in earlier data and with a different algorithm, and warned against by HPR, is not present in the first years of the Krueger data, which cover the years 1998–2003.

2.4. *Participation Rates Computed by BLS and from Matched Samples*

Krueger's 2003 dissertation used data from 1998 through 2002. He studied sources of potential bias in the CPS for these purposes in over 100 pages – more thoroughly than anyone else. He considered the probabilities each of the four possible one year apart matches would provide, considered rotation group, and looked at how characteristics such as employment were affected by the months in the sample at which they were observed. He noted that not only the final weights used by others, but also the BLS's composite weights, outgoing rotation weights as well as the use of no weights, represented choices available to the researcher. He read the BLS weight construction literature and determined that he could select the MIS4 and MIS8 sample, minimize biases for matching, employ these outgoing weights, and perform a final "raking" of the sample to eliminate almost entirely any participation discrepancy in the matched sample. At page 145, he plotted graphs of labor force participation by age, for males and females separately. In each graph, the overall participation rate and the participation rates in the matched samples, for MIS1–4, are plotted. While the graphs are very similar, one sees that, if anything, the participation rates in the matched samples are a little higher – opposite to the Finch result but consistent with that of Peracchi-Welch. On the other hand, Krueger noted in Table 4.14 that male activity participation percentages were lower in the MIS1–4 matches than in the overall (matched and unmatched) MIS1–4 averages, which in turn differ from the MIS1–8 (official) averages when the composite weightings are used.

Using his extended data set, and employing his preferred MIS4–8 matches with raked outgoing rotation weights, Krueger compared the official BLS participation rates with those from his composite weighted matches used to calculate Markov transition probabilities. Additionally, he took a weighted average of the overall participation probability weighted by the number of years in the interval, WLP, which appears at the bottom (see Table 9).

The conclusion is that, with the exception of the younger ages where transitions of students are notoriously hard to track, by careful statistical techniques transition probabilities will not be affected by discrepancies in the matched participation probabilities because they are minimal and because they vanish on average.

The CPS data used in our recent work come from 1997–1998, a different time period from Krueger's. Further, we did not restrict attention to the MIS4 and MIS8 samples, so we used the ordinary rather than the rotation weights. Our matching algorithm was also slightly different. Despite these

Table 9. Average of BLS Participation Rates and Participation Rates Computed from MIS4 and MIS8 Matched Sample with Composite Weights for All Males and All Females.

(a) MIS4 Matched Sample (1998–2002)

All Males (1998–2002)	Average of BLS Published Data	MIS4 Matched Weighted with Composite Weight	All Females (1998–2002)	Average of BLS Published Data	MIS4 Matched Weighted with Composite Weight
18–19	63.4	63.2	18–19	60.5	60.5
20–24	81.8	81.6	20–24	72.8	73.1
25–29	92.2	92.2	25–29	76.5	76.6
30–34	93.7	93.8	30–34	75.3	75.4
35–39	93.0	93.0	35–39	75.8	75.8
40–44	92.1	92.2	40–44	78.2	78.2
45–49	90.3	90.3	45–49	78.6	78.8
50–54	86.8	86.9	50–54	73.9	74.0
55–59	77.8	77.8	55–59	62.0	61.9
60–61	66.9	67.4	60–61	49.2	49.2
62–64	47.9	47.2	62–64	35.1	35.0
65–69	29.8	29.7	65–69	19.3	19.1
70–74	17.5	17.5	70–74	10.2	10.1
75 and over	7.9	7.8	75 and over	3.3	3.2
WLP	42.2	42.2	WLP	34.5	34.6

(b) From MIS8 matched sample (1999–2003).

All Males (1999–2003)	Average of BLS Published Data	MIS8 Matched Weighted with Composite Weight	All Females (1999–2003)	Average of BLS Published Data	MIS8 Matched Weighted with Composite Weight
18–19	62.2	58.7	18–19	59.2	57.5
20–24	81.4	78.2	20–24	72.4	70.9
25–29	91.8	91.6	25–29	75.9	76.4
30–34	93.6	93.9	30–34	75.0	75.6
35–39	93.0	93.6	35–39	75.5	76.2
40–44	91.9	92.8	40–44	78.0	78.8
45–49	90.0	90.9	45–49	78.6	79.6
50–54	86.6	87.3	50–54	74.2	75.2
55–59	77.7	78.5	55–59	62.8	63.5
60–61	66.9	68.0	60–61	50.5	51.4

Table 9. (*Continued*)

(b) From MIS8 matched sample (1999–2003).

All Males (1999–2003)	Average of BLS Published Data	MIS8 Matched Weighted with Composite Weight	All Females (1999–2003)	Average of BLS Published Data	MIS8 Matched Weighted with Composite Weight
62–64	48.4	49.0	62–64	36.1	36.4
65–69	30.8	31.2	65–69	20.3	20.6
70–74	18.0	17.7	70–74	10.6	10.4
75 and over	8.1	7.9	75 and over	3.6	3.4
WLP	42.2	42.2	WLP	34.6	34.8

Source: Tables produced by Kurt Krueger and provided to the authors by e-mail correspondence on September 29, 2004.

differences, when we ran Krueger's data through our software, the WLEs differ only slightly. Since Krueger's data do not possess the sources for the alleged biases, and our data operationally produce results very close to his, issues involving our data have been removed from the table, and comparisons between the Markov and conventional model may revert to the merits of these models.

Our conclusion is that, while we would tolerate a small amount of bias to have a model capable of answering most of the interesting questions that could be put to it, we do not need to do so; the work of Peracchi-Welch and of Krueger do not suggest the presence of the biases warned against.

3. TABLES PURPORTEDLY MEASURING DISABLED WORKLIFE EXPECTANCY

3.1. The VEI and Disability Worklife Expectancy – Background and Methods

Vocational Econometrics Inc. (VEI) and Anthony M. Gamboa, Jr., also co-owner of Vocational Economics, Inc. (VE) produce tables which claim to measure the WLEs for persons with and without disabilities. The latest version of the tables referenced in this paper were published in 2002

(Gamboa, 2002), hereinafter "the Gamboa Tables" or simply the "Tables." These Tables are typically used only in litigation by plaintiffs to support an opinion about the duration of the remaining length of working life of individuals who have suffered an injury. Frequently, their use is in cases where the plaintiff has returned to some work, or is capable of employment, perhaps in another line of work, which gives rise to an earnings differential. The effect of the Tables is to shorten the postinjury worklife in the new, lower paying job chosen in mitigation and to overstate the preaccident WLE. Unfortunately, severe methodological and data problems and a variety of biases render these tables invalid for their intended use. The remainder of this section highlights these data problems and biases; more details are provided in the references.

The VE/VEI concept of worklife differs from all generally accepted definitions of WLE *ever* used by the BLS as well as from those currently used in the forensic economics literature. The BLS has itself never published "disabled worklife expectancy tables." Rather, the model of worklife employed in these Tables derives from the living, participation, and employment (LPE) model, a model never used by the BLS and which, when applied to sex and education groups within the entire population, is used by only a small and shrinking minority of forensic economists – 7.6% as per the latest 2003 survey of NAFE members, down from 17.3% in 1997 (Brookshire et al., 2003). The LPE model, like the conventional model, does not consider the subject's initial state – whether active or inactive – and we have seen that the worklives of an active and of an otherwise identical inactive individual (in the tables in Section 1) may show significant differences. Bringing unemployment into the definition of worklife creates a further departure from the BLS's conventional model. Skoog (2002a) and Skoog & Ciecka (2004) discussed the difficulties, even assuming unbiased disability data, of analyzing disability within the currently accepted paradigm of the Markov model: one would need to validly and reliably estimate transitions into and out of a multitude of disabled states. Necessary and sufficient conditions to be able to aggregate many disability states into fewer states were derived. The vast heterogeneity of disability, in light of the aggregation conditions, renders this practically impossible for current or contemplated data sets.

For readers who have not run across them, in the Tables, individuals in CPS are grouped into one of the three categories: not disabled, severely disabled, or not severely disabled, on the basis of answers to *screener* questions, which are designed to ascertain those individuals receiving some form of disability income. These questions therefore do not attempt to define *any* notion of disability (Hale, 2001) and consequently have not undergone validity and reliability testing (Hale, 2001 and the Census web site (see U.S. census URL in references) disclaimer). It has long been understood by properly trained statisticians working with survey data that one should *not* run cross tabulations and report results about characteristics of a population on the basis of such screener questions, and economists at the BLS have cautioned against doing this (Rones, 1981; Hamel, 1994). These observations alone should have been enough to deter VEI from running cross tabulations and reporting the results.

When one is truly severely disabled, the inability to participate in the labor force is evident, and there is no need of tables to state the obvious. It is the classification of "non-severe disability" which has lead to widespread abuse, and which is therefore the focus of this section. The definition of non-severely disabled involves answering "yes" to one or more of the following three questions: (a) "Do you have a health problem or disability which prevents working or which limits the kind or amount of work?" (b) "Have you ever retired or left a job for health reasons?" (c) "Do you receive Veterans' payments for disability?" while answering "no" to four other questions determines the presence of a "severe disability". Probabilities of employment are then calculated. Not surprisingly, the probability of employment is lower for those self-reporting a "non-severe work disability" and is lower still for those self-reporting a "severe work disability." The partial circularity of the very definition is apparent – people claiming to trouble working will not be observed working as much!

The Tables go on to multiply the joint probability of employment and participation with survival probabilities taken from the U.S. Life Tables, sum the product over future years to age 90, and report the result as a "worklife expectancy."

An inspection of the questions suggests additional problems. The presence of the word *ever* in (b) and the presence of Veterans' payments in (c), as well as the use of the Tables by VE's employees and affiliates, makes being "non-severely disabled" a permanent condition. This is obviously absurd – people have been known to recover from disabilities! Equally absurd, when the Tables calculate "worklife expectancy" for those who are not now disabled, they implicitly assume that the individual will never become disabled in the future. Evidently, the ensuing higher worklife from someone magically insured against becoming disabled in the future can logically have no role as a comparator in personal injury and wrongful death litigation. This does not stop VE employees and affiliates from using this upwardly biased worklife as a base, from which they subtract a downwardly biased disabled worklife to produce a difference which is doubly biased, overstating economic damages.

To be useful, the characteristics embedded in a worklife table must be permanent. Thus, current tables embed sex and education. The use of proper tables, of course, may involve judgment; application of our tables to a very young person who might change his or her educational attainment would be ill advised without proper qualification. The BLS abandoned its calculation of worklife for females by marital status almost 30 years ago, undoubtedly influenced by the lack of permanence of marital status. The lack of permanence of impairments ("disability" in the present context) is still another reason militating against the use of the Tables.

A reading of the questions defining non-severe "work disability" also reveals their compound nature and ambiguity. Health problems are mixed with disabilities; any connection of the resulting population with those possessing similar impairments to those in the subject lawsuit would be a remarkable coincidence. Further, what does it mean to be "limited" – does this refer to any past job or to one's immediate past job, or to one's current job? It is hard to conjecture what CPS respondents believe they should be answering. Any link between leaving a previous job for health reasons and one's ability to participate in a different present job or a contemplated future job is tenuous.

3.2. *Main Econometric Criticisms of VEI Tables*

Another major flaw in the Tables is *sample selection bias* – if a sample is not random, statistical inference which does not correct the lack of randomness is flawed. Here, a subset of the underlying entire ("CPS") sample, those who self-report one of the "non-severe disability" criteria, does not represent a random sample of those with any kind of impairment or condition, since by construction the sample includes those whose impairment presents a work-related problem; systematically missing are those with the same impairment that is *not* work-limiting. Consequently, the measurement of the probability of a work-related outcome, specifically whether or not one is participating in the labor market and is also employed, or averages of the salaries for such individuals, will be biased. The reason is that those with a similar impairment or condition for whom there is no such "work limitation" will be underrepresented in this non-random sample. In less careful words, the very definition of "work disability" is partially *statistically circular*.

A second econometric difficulty plagues the construction of the Tables – the failure of econometric *exogeneity*. Quite simply, this technical term refers to the lack of clear-cut causation from the presence of the impairment to the purported effect, the inability to participate in the labor market or to be employed. In addition to the desired explanation for the association of impairment and lowered employment, the presence of a feedback relation or reverse causation is also present: people may first decide that they do not wish to work, and then seek a socially acceptable and remunerative explanation in declaring themselves disabled.

The typical use of these Tables is illustrated by a simple example. Suppose, that a carpenter injures his back and can no longer perform carpentry. Subsequently, he becomes a housing inspector. Now the fact that he left his carpentry job because of a back injury need not have any measurable effect on his capacity to work as an inspector, a job chosen so as to accommodate his back injury. By mixing the plaintiff into a population with many others with more serious injuries *do* impact the ability to participate in the labor force, however, a spurious statistical loss of a few years of "worklife expectancy" will be erroneously created by these Tables. Skoog and Toppino (2002) and Ciecka, Rodgers and Skoog (2002) refer to the cause of this phenomenon as *heterogeneity*, a third econometric problem; its presence permits the Tables to indicate specious economic loss where no loss exists.

The Tables have been critically discussed in the forensic economics literature, first in the book review by Corcione (1995) and later in full-scale peer-reviewed articles (Skoog & Toppino, 1999, 2002; Ciecka & Skoog, 2001; Rodgers, 2001; Ciecka et al., 2002). In addition, they have been discussed in professional conferences and on internet listserves. There has been no serious intellectual defense of these Tables and no defense that has attracted any following of informed PhD economists. This research has shown that the Gamboa disability tables are unreliable, invalid, misleading, biased, and inappropriate.

4. CONCLUSION

The Markov or increment–decrement model remains the centerpiece of WLE. Its vitality and scope have been expanded with recent theoretical developments. Also, like other good models, it has implications, extensions, and the richness to undertake questions which have only recently been asked and answered, such as the probability distributions of *YA* and *YFS*, and questions which have not heretofore been asked of it, such as the statistical distribution of time to and in retirement. We have summarized the research documenting several problems which render the VEI Tables, based on CPS data, unreliable and invalid. Severe problems, notably heterogeneity and lack of exogeneity, will persist even if 2000 Census data were used instead of CPS data.

NOTES

1. For example, the Hunt, Pickersgill and Rutemiller (1997, 1999, & 2001) estimator is claimed to estimate the "median" of the years to final separation random variable, *YFS*, within the Markov model, but it is an inappropriate estimator for this model since it is not statistically consistent. It is shown (Skoog & Ciecka, 2004) to be consistent instead for only the BLS's conventional model for certain ages, and in the presence of regularity conditions not present in the Hunt, Pickersgill, and Rutemiller data.

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