Volume Title: Issues in the Economics of Aging

Volume Author/Editor: David A. Wise, editor

Volume Publisher: University of Chicago Press, 1990

Volume ISBN: 0-226-90297-8

Volume URL: http://www.nber.org/books/wise90-1

Conference Date: May 19-21, 1988

Publication Date: January 1990

Chapter Title: Adjusting to an Aging Labor Force

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Chapter URL: http://www.nber.org/chapters/c7121

Chapter pages in book: (p. 287 - 316)

10 Adjusting to an Aging Labor Force

Edward P. Lazear

The next few decades will witness some major changes in the composition of the labor force. Some trends that have already become apparent are the increased labor force participation of women and the declining ages of retirement among elderly men.[1] A number of observers view earlier retirement with alarm. As the baby boom generation ages, a larger proportion of the work force will be in its 60s and a relatively smaller proportion in its 30s and 40s. The implications of this change for the Social Security system have already been discussed in detail. But there are effects on private firms as well. Since older workers earn more than young, firms will become top-heavy and will be paying a higher average wage. Of course, to the extent that age-earnings profiles mirror age-productivity profiles, an older work force is also a more productive one, so the rising wage may be of no consequence. Still, life-cycle theories of wages, either human capital (as in Becker 1962) or incentive based (as in Lazear 1979), imply that the relation of earnings to productivity is a loose one. Promotion possibilities and the hierarchical structure of the firm may change as the age distribution of workers changes. Firms may react by altering age-earnings profiles, pension plans, explicit buyouts, and the shape of the promotion pyramid. The purpose of this paper is to consider those reactions. Before that can be done, however, it is necessary to have a clearer view of what the future holds. In particular, it is important first to describe the next century's labor force.

Like most economists, I am reluctant to predict the future since I am certain to be proven wrong. Unfortunately, the task is unavoidable if one is to discuss

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This work was supported in part by the National Science Foundation. The author thanks Finis Welch for helpful comments.

the way that institutions are likely to evolve. Thus, I defend what follows with the disclaimer that prediction is a dirty job, but someone has to do it.

10.1 Labor Force, Wages, and Productivity in the Decades Ahead

The first step is to project the labor force into succeeding decades. There are two basic ingredients. First, population by age and sex must be estimated for each year in the future. Second, labor force participation rates must be determined.

The Bureau of Census not only provides data on population by age for past years but also estimates age-specific population rates for the United States up through 2083. Those numbers are summarized in table 10.1. If the census predictions are to be believed, two trends can be noted. First, the proportion of the population between 60 and 70 will be 4 percentage points higher for both males and females in 2020 than it is today. Second, the proportion between 30 and 40 will be 3 percentage points lower in 2020 than it is today.

To get a sense of how large an effect changing population might have on the labor force, assume that age- and sex-specific labor force participation rates remain what they are currently (in 1987).[2] Using the various population weights predicted in table 10.1, an estimate of the age-specific labor force participation rate for each year can be estimated. This is done in table 10.2.

No standard errors are presented in table 10.2 primarily because standard errors for population estimates on which these numbers are based are unavailable. There are two main findings. First, the proportion of the male labor force between 55 and 69 years old will rise from 12 percent in 1990 to 18 percent in 2020. The proportion of the female labor force between 55 and 69 years old will rise even more dramatically, from 9 percent in 1990 to 17 percent in 2020. Second, the proportion of the male labor force between 25 and 44 years old will shrink from 55 to 45 percent over the same period. Again, the same basic effect applies to women. Additionally, the total male labor force will grow at an average rate of about ½ percent per year until 2020 and then will decline. For women, ½ percent annual growth occurs until 2010, and then labor force levels decline.

Of course, some key assumptions go into estimating the numbers in table 10.2. Population predictions are crucial, but so is the assumption that labor force participation rates will remain the same over time. The latter cannot be true, especially for women, and one might hope to do better. Since data on age-specific labor force participation rates are available over time, one can estimate age and year effects (cohort effects are redundant) and predict age-specific labor force participation rates for the future. This was done by estimating labor force participation rate trend equations (linear, quadratic, and logistic) for each age group. Labor force participation rates can be predicted as the out-of-period extrapolation of the estimates. Unfortunately, as one might expect, such extrapolations are likely to be almost uninformative. In fact,

Table 10.1 Population Projections, U.S. Bureau of Census, 1983

	Age									
Year	0–9	10–19	20–29	30–39	40–49	50–59	60–69	70–79	80–100	Total
Males:										
1983	17.3	19.0	21.6	17.6	11.9	10.8	9.1	5.1	1.8	114.4
1990	19.3	17.3	20.3	20.9	15.6	10.5	9.4	5.8	2.3	121.5
2000	18.6	19.7	17.5	20.5	20.7	14.8	9.0	6.5	3.1	130.5
2010	18.2	19.0	19.9	17.8	20.3	19.7	13.0	6.5	3.8	138.0
2020	18.9	18.5	19.2	20.1	17.6	19.3	17.2	9.5	4.0	144.5
2030	18.3	19.2	18.8	19.5	20.0	16.8	16.9	12.6	5.8	147.9
2040	18.3	18.7	19.5	19.1	19.3	19.1	14.8	12.4	8.0	149.1
Male proportion of total population accounted for by cell:										
1983	.15	.17	.19	.15	.10	.09	.08	.04	.02	1.00
1990	.16	.14	.17	.17	.13	.09	.08	.05	.02	1.00
2000	.14	.15	.13	.16	.16	.11	.07	.05	.02	1.00
2010	.13	.14	.14	.13	.15	.14	.09	.05	.03	1.00
2020	.13	.13	.13	.14	.12	.13	.12	.07	.03	1.00
2030	.12	.13	.13	.13	.13	.11	.11	.09	.04	1.00
2040	.12	.13	.13	.13	.13	.13	.10	.08	.05	1.00
Females:										
1983	16.5	18.2	21.4	17.9	12.5	11.9	10.8	7.4	3.9	120.4
1990	18.5	16.5	19.8	21.1	16.2	11.4	11.2	8.5	5.1	128.1
2000	17.8	18.8	17.0	20.3	21.1	15.8	10.6	9.3	6.8	137.5
2010	17.4	18.1	19.3	17.5	20.3	20.6	14.8	8.9	8.3	145.2
2020	18.0	17.7	18.6	19.8	17.6	19.8	19.2	12.6	8.7	152.1
2030	17.5	18.4	18.2	19.1	19.9	17.3	18.5	16.4	11.6	156.9
2040	17.5	17.8	18.9	18.7	19.2	19.5	16.2	15.8	15.8	159.4
Female proportion of total population accounted for by cell:										
1983	.14	.15	.18	.15	.10	.10	.09	.06	.03	1.00
1990	.14	.13	.15	.16	.13	.09	.09	.07	.04	1.00
2000	.13	.14	.12	.15	.15	.12	.08	.07	.05	1.00
2010	.12	.12	.13	.12	.14	.14	.10	.06	.06	1.00
2020	.12	.12	.12	.13	.12	.13	.13	.08	.06	1.00
2030	.11	.12	.12	.12	.13	.11	.12	.10	.07	1.00
2040	.11	.11	.12	.12	.12	.12	.10	.10	.10	1.00

Source: U.S. Bureau of the Census (1986).

eyeballing the estimates strains even the author's imagination for a large number of the age groups. An alternative is proposed. The estimation reveals that, for all male age groups, the trend has been toward lower labor force participation rates over time, although the change has become somewhat less dramatic recently. For females, labor force participation rates have risen for all age groups with the exception of women over 65. Thus, for the purposes of comparison with table 10.2, let us conjecture that males' labor force participation rates will decline linearly between 1990 and 2040 to seven-eighths their current levels. Let us also conjecture that female labor force participation rates will rise to five-fourths their current level over the same

Table 10.2 Labor Force Projections

	16–19	20–24	25–34	35–44	45–54	55–59	60–64	65–69	70+	Total
Labor force males, by age group in thousands:										
1990	4,009	8,026	20,689	17,708	11,210	3,845	2,695	1,149	542	69,872
2000	4,340	7,397	17,377	20,663	16,499	4,960	2,716	1,057	584	75,593
2010	4,460	8,596	17,658	17,435	19,265	7,099	4,219	1,392	596	80,719
2020	4,144	7,930	19,044	17,737	16,276	7,800	5,232	2,000	925	81,088
2030	4,377	8,072	17,760	19,089	16,616	6,380	4,573	2,187	1,169	80,223
2040	4,285	8,244	18,396	17,831	17,847	7,129	4,307	1,798	1,041	80,878
Males as proportion of total work force:										
1990	.06	.11	.30	.25	.16	.06	.04	.02	.01	1.00
2000	.06	.10	.23	.27	.22	.07	.04	.01	.01	1.00
2010	.06	.11	.22	.22	.24	.09	.05	.02	.01	1.00
2020	.05	.10	.23	.22	.20	.10	.06	.02	.01	1.00
2030	.05	.10	.22	.24	.21	.08	.06	.03	.01	1.00
2040	.05	.10	.23	.22	.22	.09	.05	.02	.01	1.00
Labor force females, by age group in thousands:										
1990	3,629	6,651	15,685	14,236	8,794	2,782	1,881	779	327	54,765
2000	3,935	6,121	13,068	16,300	12,723	3,534	1,859	699	345	58,586
2010	4,038	7,095	13,262	13,652	14,512	4,947	2,813	898	343	61,560
2020	3,753	6,544	14,268	13,837	12,158	5,296	3,418	1,258	517	61,051
2030	3,964	6,662	13,314	14,876	12,407	4,319	2,950	1,340	635	60,467
2040	3,880	6,802	13,786	13,902	13,271	4,816	2,766	1,096	554	60,875
Females as proportion of total work force:										
1990	.07	.12	.29	.26	.16	.05	.03	.01	.01	1.00
2000	.07	.10	.22	.28	.22	.06	.03	.01	.01	1.00
2010	.07	.12	.22	.22	.24	.08	.05	.01	.01	1.00
2020	.06	.11	.23	.23	.20	.09	.06	.02	.01	1.00
2030	.07	.11	.22	.25	.21	.07	.05	.02	.01	1.00
2040	.06	.11	.23	.23	.22	.08	.05	.02	.01	1.00

Source: U.S. Bureau of Census (1986) and unpublished data from U.S. Bureau of Labor Statistics.

period but impose the additional constraint that female rates cannot exceed male rates in any given cohort. While obviously arbitrary, these assumptions serve to illustrate the sensitivity of the results in table 10.2 to assumptions about labor force participation rates. As before, the census population estimates are multiplied by estimated labor force participation rates to obtain estimated labor force sizes. Results are contained in table 10.3.

Table 10.3 looks like table 10.2 in almost all respects. The graying of the labor force that showed up in table 10.2 is found in table 10.3 as well. The aggregate labor force growth patterns are similar to those in table 10.2, although growth is lower for males and higher for females as a result of the assumptions built into table 10.3. The estimates in table 10.3 can be contrasted with those in table 10.2 by subtracting table 10.3 results from those of table 10.2. The proportion differences are contained in table 10.4. Proportion difference is defined as follows:

Table 10.3 Labor Force Predictions: Altered Assumptions

	16–19	20–24	25–34	35–44	45–54	55–59	60–64	65–69	70+	Total
Labor force males, by age group in thousands:										
1990	4,009	8,026	20,689	17,708	11,210	3,845	2,695	1,149	542	69,872
2000	4,340	7,397	17,377	20,663	16,499	4,960	2,716	1,057	584	75,593
2010	4,460	8,596	17,658	17,435	19,265	7,099	4,219	1,392	596	80,719
2020	4,144	7,930	19,044	17,737	16,276	7,800	5,232	2,000	925	81,088
2030	4,377	8,072	17,760	19,089	16,616	6,380	4,573	2,187	1,169	80,223
2040	4,285	8,244	18,396	17,831	17,847	7,129	4,307	1,798	1,041	80,878
Males as proportion of total work force:										
1990	.06	.11	.30	.25	.16	.06	.04	.02	.01	1.00
2000	.06	.10	.23	.27	.22	.07	.04	.01	.01	1.00
2010	.06	.11	.22	.22	.24	.09	.05	.02	.01	1.00
2020	.05	.10	.23	.22	.20	.10	.06	.02	.01	1.00
2030	.05	.10	.22	.24	.21	.08	.06	.03	.01	1.00
2040	.05	.10	.23	.22	.22	.09	.05	.02	.01	1.00
Labor force females, by age group in thousands:										
1990	3,629	6,651	15,685	14,236	8,794	2,782	1,881	779	327	54,765
2000	4,016	6,427	13,721	17,115	13,360	3,711	1,952	734	362	61,399
2010	4,053	7,760	14,588	15,017	15,963	5,442	3,094	987	377	67,282
2020	3,667	7,070	16,409	15,913	13,982	6,091	3,931	1,446	595	69,103
2030	3,768	7,000	15,621	16,980	14,742	5,183	3,540	1,608	762	69,203
2040	3,586	6,950	15,723	15,429	15,690	6,020	3,458	1,370	693	68,919
Females as proportion of total work force:										
1990	.07	.12	.29	.26	.16	.05	.03	.01	.01	1.00
2000	.07	.10	.22	.28	.22	.06	.03	.01	.01	1.00
2010	.06	.12	.22	.22	.24	.08	.05	.01	.01	1.00
2020	.05	.10	.24	.23	.20	.09	.06	.02	.01	1.00
2030	.05	.10	.23	.25	.21	.07	.05	.02	.01	1.00
2040	.05	.10	.23	.22	.23	.09	.05	.02	.01	1.00

(labor force in cell in table 10.3 − labor force in cell in table 10.2)/
(labor force in cell in table 10.2)

The differences reported in table 10.4 reflect the effects of changes in behavior on labor force participation as distinguished from pure population effects.[3] For example, allowing the female labor force participation rates to rise implies that the female labor force between 45 and 54 years old will be 15 percent higher in 2020 than it would be if rates were not permitted to increase. To the extent that assumptions are important, obviously they are more likely to affect estimates further out in time. Additionally, at least for women, estimates for the older groups are more sensitive to the particular assumptions made.

A major form of behavioral change is ignored in this analysis. In particular, age-specific wage changes brought about by changes in labor supply and complementarities in the production function are not analyzed here.[4]

Table 10.4 **Proportion Difference between Tables 10.3 and 10.4**

	16–19	20–24	25–34	35–44	45–54	55–59	60–64	65–69	70+	Total
Males:										
1990	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
2000	−.02	−.02	−.03	−.03	−.03	−.02	−.02	−.03	−.02	−.03
2010	−.05	−.05	−.05	−.05	−.05	−.05	−.05	−.05	−.05	−.05
2020	−.08	−.07	−.07	−.07	−.08	−.07	−.08	−.08	−.07	−.07
2030	−.10	−.10	−.10	−.10	−.10	−.10	−.10	−.10	−.10	−.10
2040	−.12	−.12	−.12	−.12	−.12	−.13	−.12	−.13	−.13	−.13
Females:										
1990	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
2000	.02	.05	.05	.05	.05	.05	.05	.05	.05	.05
2010	.00	.09	.10	.10	.10	.10	.10	.10	.10	.09
2020	−.02	.08	.15	.15	.15	.15	.15	.15	.15	.13
2030	−.05	.05	.17	.14	.19	.20	.20	.20	.20	.14
2040	−.08	.02	.14	.11	.18	.25	.25	.25	.25	.13

Both tables 10.3 and 10.4 reveal that, at least for males, the shift toward an older labor force is not as pronounced as the shift toward an older population as shown in table 10.1. The reason is that earlier retirement reduces the effect of an aging population on labor force composition. Thus, the worker behavior moderates the effect of pure demographics. Before turning away from the crystal ball, it is useful to document some changes in pension formulas that have occurred over the years. Table 10.5 summarizes some important changes.

There are two obvious changes. First, pension coverage has grown tremendously between 1975 and 1984. There has been an increase of about 72 percent in the number of workers covered, which is much greater than the increase in the size of the labor force over the same period (about 13 percent). Second, the proportion of plans that are of the defined benefit type has declined dramatically. Firms are switching to defined contribution plans, or firms that previously did not offer pension plans are disproportionately adopting defined contribution plans. For reasons discussed below, it is far from obvious that this trend will continue in the future.

Table 10.5 **Pensions Trends**

	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
Number of participants (in millions):										
Defined benefit	33	33.2	35	36.1	36.8	37.9	28.9	38.6	40.1	40.9
Defined contribution	11.5	13.4	15.2	16.2	18.2	19.9	21.7	24.6	30	32
Total	44.5	46.6	50.2	52.3	55	57.8	50.6	63.2	70.1	72.9
Defined Benefit (%)	74	71	70	69	67	66	57	61	57	56

Source: Ippolito and Kolodrubetz (1986).

To summarize this section, the major changes that firms can expect over the next few decades is an aging of the labor force. There will be a larger proportion of workers between ages 55 and 70 and a decline in the proportion between 25 and 44. Additionally, there will be growth in the absolute size of the labor force until around 2015 and then a decline. What are the effects of these demographic shifts?

10.2 Financial Viability of the Firm

A number of observers have already cautioned that the Social Security system, a pay-as-you-go operation, may become insolvent.[5] These pressures are equally important for firms. As long as firms do not pay each worker his marginal product at every point in time, unanticipated changes in the age/tenure distribution of the firm can have significant effects. There are a number of models of life-cycle wage determination that suggest that workers are not paid their marginal products in a spot market sense. The theory of specific human capital implies that young workers are overpaid and old workers are underpaid relative to their marginal products (the classic reference is Becker 1962). Incentive theories of wage determination imply the reverse (see Lazear 1979). Insurance theories imply that all young workers are paid less than their marginal products and that highly able old workers are paid marginal product, whereas less able ones are paid above their marginal products (see Harris and Holmstrom 1982). As I have argued elsewhere, only incentive theories are consistent with pervasive mandatory retirement among old workers. Specific human capital implies the reverse, while insurance stories are implausible across ability types because of moral hazard.[6] Thus, in this section, I will assume that firms underpay young workers relative to marginal products and overpay older ones.

Surprisingly, underpayment of young workers and overpayment of old ones implies that competitive firms have wage bills that exceed the value of current output. (Firms make zero profit because they enjoy the return on past investment.) An unanticipated aging of the labor force increases that wedge and, in a pay-as-you-go operation where high current dividends have been paid in the past, may create current cash-flow problems. This doomsday tale is made more likely by unfulfilled expectations, which may be induced by a demographic shift. To understand the problem, let us be somewhat more formal.

Consider an age-earnings profile, $w(a)$, where a is age and w is the (annual) amount paid to a given worker. Let the worker's age-productivity profile, measured in dollars, be $q(a)$. Normalize so that the youngest workers are age 0 and the oldest are age 1. Further, let the distribution of worker ages within the firm at time t be given by $f_t(a)$, and let the size of the work force be N. The wage bill of the firm at time t is then given by

$$W_t = N \int_0^1 w(a) f_t(a) da, \tag{1}$$

and total output at time t is given by

$$Q_t = N \int_0^1 q(a) f_t(a) da. \tag{2}$$

The difference between wage bill and output is then

$$D_t = N \int_0^1 [W(a) - q(a)] f_t(a) da \tag{3}$$

or

$$D_t/N = \int_0^1 [w(a) - q(a)] f_t(a) da.$$

When a worker is hired into the firm, competitive markets ensure that lifetime wages paid to the worker equal lifetime output. This means that

$$\int_0^1 w(a) e^{-ra} da = \int_0^1 q(a) e^{-ra} da$$

or

$$\int_0^1 [w(a) - q(a)] e^{-ra} da = 0. \tag{4}$$

If equation (4) holds, then it cannot be true generally that the wage bill equals output at each point in time. Only if $f_t(a) = e^{-ra}$ would the wage bill equal current period output.

Suppose, for example, that all workers join the firm at age 0 and do not leave until age 1. Suppose further that the firm hires the same number of individuals each period. Then $f_t(t) = 1$ for all t, and wages exceed output for any positive interest rate. How can this be? The firm pays back in each period what it gained during the first few periods of its operation. This is not unlike pay-as-you-go Social Security. There, the first generation receives more than it puts in. Here, the firm pays interest on the "advance" that it received in early periods, and the interest just covers the value of the advance. Workers are essentially holding their firm's bonds. By accepting less than they are worth when young, they buy bonds that are paid back as wages that exceed marginal product when they are old. The difference between current wages and current output reflects the average return on bonds held by the workers. This is true even though the average age of individuals in the firm is constant in steady state and even though the distribution of worker ages within the firm is uniform.

As interesting as this may be, it is far from obvious that the firm must have negative net revenues or cash flow. If anything, the presumption goes the other way. The reason is that current cash flow depends on what the firm did with the capital that it received in earlier periods when workers were receiving less than average output on net. If the firm took the surplus received each period on every worker and put it, say, in a bond paying r rate of interest or invested it in the firm where the rate of return is at least r, then in a deterministic world it would always have exactly enough to cover the difference between wages and output. If, on the other hand, the firm paid the surplus as dividends to current stockholders, then it would face the problem of not being able to meet payroll in steady state.[7] There are two ways that problems can arise. First, some myopia may be present. Required is an inability to smooth receipts and payments over time appropriately. In this respect, the current problem has much in common with the labor market insurance literature (see Rosen 1985). This line is pursued first, not because we hold that the world is deterministic, but because this proves useful for comparison with the stochastic environment.

A changing demographic structure may be a catalyst for myopia in the deterministic context. Suppose that the supply of young labor rises and there is a concomitant increase in demand for the average firm's product. Nothing has caused the firm to change the shape of the age-earnings profile, and the age-productivity profile is similarly unaltered. If the typical firm anticipates that the inflow of workers has changed permanently, then the pay-as-you-go mentality means that the firm is expecting next generation's workers to support (at least in part) this generation by accepting wages less than marginal product. A reversion to the previous levels of population growth will cause a current deficit for this firm, which has mistakenly assumed that the increase in young person labor supply is permanent. Again, what makes this go is that firms have already spent the windfall that they received when the size of the young work force increased above the expected levels. (Recall that young workers receive less than they produce so the firm accumulates a surplus.) Let us be somewhat more formal.

First, it is shown that an aging labor force implies an increase in the current deficit (ignoring return on other accumulated assets). An elderly baby-boom generation can be parameterized as

$$f_t(a) = k_0 \quad \text{for} \quad a < a^* \tag{5}$$
$$= k_1 \quad \text{for} \quad a \geq a^*,$$

where $k_0 < 1 < k_1$ and

$$a^*k_0 + (1 - a^*)k_1 = 1. \tag{6}$$

To show that an aging baby boom generation increases the difference between wage bill and current output, it is sufficient to show that

$$N \int_0^1 [w(a) - q(a)]da < Nk_0 \int_0^{a^*} [w(a) - q(0a)]da + Nk_1 \int_{a^*}^1 [w(a) - q(a)]da \tag{7}$$

(still assuming, for simplicity, that all workers enter the firm at age 0 and leave at age 1). The left-hand side is the deficit in the firm with a uniform age distribution. The right-hand side is the deficit in a firm with a disproportionately older labor force.

Define

$$R \equiv \int_0^{a^*} [w(a) - q(a)]da$$

and

$$S = \int_{a^*}^1 [w(a) - q(a)]da.$$

Since $w(a) - q(a)$ is increasing in a,

$$\frac{R}{a^*} < \frac{S}{(1 - a^*)}. \tag{8}$$

Note further that (6) can be rewritten as

$$\frac{a^*}{1 - a^*} = \frac{k_1 - 1}{1 - k_0}. \tag{9}$$

To prove the result, assume the opposite of (7). Then

$$\int_0^1 [w(a) - q(a)]da > k_0 R + k_1 S,$$

or

$$R + S > k_0 R + k_1 S.$$

So

$$\frac{R}{S} > \frac{k_1 - 1}{1 - k_0}.$$

But, from (8),

$$\frac{R}{S} < \frac{a^*}{1 - a^*}.$$

Substitute into (9) to obtain

$$\frac{a^*}{1 - a^*} > \frac{k_1 - 1}{1 - k_0}.$$

But

$$\frac{a^*}{1 - a^*} = \frac{k_1 - 1}{1 - k_0},$$

by (6), which is a contradiction.

This proof means that an aging labor force increases the firm's current deficit when the boom generation reaches old age when population size is fixed at N.[8] Again, two ingredients are necessary to make this a concern in a deterministic environment. First, the firm must operate on a pay-as-you-go basis. Second, the firm must dissipate the excess that it receives as a result of having a larger than equilibrium young work force.[9]

At the heart of this problem is what firms are able to forecast and how they save for the future. Whether poor planning by firms will create difficulties in a pay-as-you-go world is an empirical question. The business community's concern over cash-flow and dividend policies has puzzled economists ever since Modigliani and Miller (1958) put forth their famous theorem. In this context, only the most naive and myopic firms should find the current deficit an important variable. A more plausible alternative is that the world is not deterministic.

The firm can only assure that receipts equal payments in a deterministic world. But returns on investments are stochastic so that receipts are unlikely to match payments ever. Even a dedicated bond portfolio will not do the job. The reason is that the liability to the worker is real, whereas the dedicated bond portfolio guarantees only a nominal payment. Indeed, the frequently suggested dedicated portfolio strategy is likely to cause a larger standard deviation between receipts and payments than other investment strategies, in particular, the strategy of investing in short-term securities, like six-month Treasury bills. The reason is that short-term nominal interest rates are more closely correlated with nominal wage growth than are long-term rates.

Although there may be no investment strategy that guarantees that nominal liability equals nominal receipts, this does not imply that a pay-as-you-go structure increases risk of bankruptcy. Pay-as-you-go would have the excess of receipts over payments paid out as dividends or reinvested. Shortfalls are made up by selling off capital (physical or securities).

Define the pay as you go strategy as taking the current generation's loan, that is, the difference between output and wage payment to young workers, and investing it in the firm. Then the firm uses its resulting output to pay off the generation of old workers. If the firm is trying to minimize the probability of

bankruptcy or simply trying to minimize the variance of the deficit, then it may well be better to invest all money in the firm and use the pay-as-you-go strategy. Let us formalize this as follows.

Consider two periods. The firm collects X from the worker in period 1 and promises to pay real wage W in period 2. The real wage is set so that the worker earns the appropriate real return on his investment and so that the worker bears no real risk. (All risk is borne by the risk-neutral firm in this contract.) If W were nonstochastic, then a dedicated portfolio of X of bonds yielding nominal rate r would exactly cover the current deficit. So if Q is output in period 2,

$$W - Q = X(1 + r)$$

when W and Q equal their expectations. Put alternatively, the amount that the worker lends the firm is, in equilibrium,

$$X = \frac{\bar{W} - \bar{Q}}{1 + r},$$

where $\bar{W}$ and $\bar{Q}$ are expected values.

An alternative strategy is to take the proceeds collected from the worker in period 1 and to reinvest in the firm. This is equivalent to raising the scale of the firm to $\bar{W}/\bar{Q}$ so long as output from the new capital moves in proportion to the old capital. Then, when $W = \bar{W}$ and $Q = \bar{Q}$, the amount invested should increase Q proportionately, that is, by

$$\frac{\bar{W} - \bar{Q}}{\bar{Q}}.$$

The deficit, if the expectation is realized, is then

$$\bar{W} - \bar{Q}\left(1 + \frac{\bar{W} - \bar{Q}}{\bar{Q}}\right) = 0.$$

In general, however, W is not identically equal to $\bar{W}$, and Q is not equal to $\bar{Q}$. The seemingly low-variance dedicated portfolio strategy is likely to be worse than the "high-risk" strategy of reinvesting in output and paying as you go.

The deficit in period 2 is

$$\begin{aligned} D &= W - Q + X(1 + r) \\ &= W - Q - \bar{W} + \bar{Q} \end{aligned}$$

with the dedicated portfolio and

$$D^* = W - \frac{\bar{W}}{\bar{Q}} Q$$

with the strategy that invests in the firm itself. Now, W and Q are random variables such that

$$W = \bar{W}P$$

and

$$Q = \bar{Q}R,$$

where

$$E(P) = E(R) = 1.$$

This implies that

$$D = \bar{W}P - \bar{Q}R - \bar{W} + \bar{Q}$$

and

$$\begin{aligned} D^* &= \bar{W}P - \frac{\bar{W}}{\bar{Q}}\bar{Q}R \\ &= \bar{W}(P - R). \end{aligned}$$

Thus,

$$s_D^2 = \bar{W}^2 s_P^2 + \bar{W}^2 s_R^2 - 2\,\mathrm{cov}(\bar{W}P, \bar{Q}R),$$

and

$$s_{D^*}^2 = \bar{W}^2[s_P^2 + s_R^2 - 2\,\mathrm{cov}(P, R)].$$

If P and R are uncorrelated so that $\mathrm{cov}(P, R) = 0$, then the dedicated portfolio is the lower-risk strategy since $\bar{Q}^2 < \bar{W}^2$. But, in general, P and R are positively correlated. At the other extreme, let $P = R$. Then D^* is equal to zero always. But if $P = R$,

$$\begin{aligned} D &= P(\bar{W} - \bar{Q}) - \bar{W} + \bar{Q} \\ &= (\bar{W} - \bar{Q})(P - 1), \end{aligned}$$

so

$$s_D^2 = (\bar{W} - \bar{Q})^2 s_P^2 > 0.$$

The dedicated portfolio has higher variance, and the pay-as-you-go strategy is better. The best hedge is an instrument that is highly correlated with $W - Q$,

for example, short-term bonds or, perhaps better, the firm's stock, since it picks up firm idiosyncratic risk. Pension funds often hold a large proportion of their firms' stock, despite the adverse consequences on diversification.[10] The reason may be that reinvesting pension funds in the firm reduces the risk of bankruptcy, which affects the expected wage payment.

The policy that seems to work as a way to guarantee that the firm does not run a deficit in period 2 does not guarantee zero deficit at all. Indeed, it may be worse than a pay-as-you-go strategy that puts everything into and takes everything out of the firm. The reason is that the commitment to the worker is a real liability, whereas the dedicated portfolio is a guaranteed nominal asset.

This discussion has direct bearing on pension liabilities. Even "funded" pensions have a portfolio that is attempting to cover a liability, the value of which is a random variable. If W is redefined to be pension liability and Q is defined as the realization of the pension portfolio set aside to cover that liability, then the analysis is identical. This implies that the dedicated portfolio strategy, where assets are purchased to match the payout structure or average duration of the estimated liability, may actually be the worst way to hedge. Because the value of the fund does not vary with the liability, the deficit increases when the net nominal liability increases to keep real value constant. This is surprising since some influential pension investment advisers recommend long bonds as a hedging strategy. Short-term Treasury bills, the value of which moves more with the rate of price and wage inflation, are likely to be a better hedge. Since the pension liability is a real one (almost all defined benefit plans are tied directly or indirectly to final salary), a certain nominal return is a poor hedge for that liability.[11]

The main point is that even forward-looking firms may find themselves in dire straits as a result of output that is too low to cover its wage bill. The pay-as-you-go strategy may be the best that one can do, but it still is not good enough to prevent bankruptcy when liabilities are random variables. Virtually all defined benefit pension plans and implicit wage commitments are, at least to some extent, real liabilities that are affected by unpredictable events.

Is this an important issue? Put alternatively, how large are the potential deficits relative to the wage bill? In order to know, it is necessary to have some idea about the difference between output and wages over the life cycle. The following example makes the point that small initial deviations of output and wage can result in large steady-state deficits.

Suppose that the work life is 45 years and that the worker's output in each of those years is \$30,000. Suppose that a linear wage profile is used with wage at time zero equal to five-sixths of marginal product. It is easily verified that, if the discount rate is 2 percent real, the following wage function ensures that the worker receives the present value of lifetime marginal product (\$820,660) over his career:

$$W(t) = 25{,}000 + 280t,$$

where t is year of employment and runs from 1 to 45. To convert to nominal dollars, let the inflation rate be 5 percent so that, by the end of the first year, nominal q is \$31,500 and nominal salary is \$26,544. The final nominal salary is \$254,848. Salary overtakes marginal product in the eighteenth year of work, or with 60 percent of the career remaining. If the distribution of work ages is uniform as before, then the average deficit per worker is \$7783 per year, which is slightly less than 8 percent of the worker's average (undiscounted) wage. That is, the firm's steady-state deficit equals about 8 percent of its wage bill. As compared with pension liability figures, the number is significant (see Ippolito 1986).

Incidentally, there is an irony in that the most productive firms may also run the largest deficit. If the difference between slope of the wage profile and slope of the productivity profile is positively related to output, as it might be for incentive reasons, then high-output firms will have the largest deficit. The current deficit reflects larger bond purchases by workers, which raise worker productivity over the life cycle.

Now suppose that a firm finds itself in a situation where it cannot meet its payroll. What can the firm do?

First, it can breach its contracts. The breach can take a number of forms. As already mentioned (Shleifer and Summers 1988), bankruptcy and reopening under new management may allow for an inexpensive way to breach a contract.[12] To the extent that bankruptcy or reorganization through mergers and acquisitions involve some social cost as a result of inefficient rent seeking, this alternative is not desirable. Whether transfers in ownership increase with the (unanticipated) aging of the firm's work force has not yet been documented.

Why not lower the wages of the generation of young that follows the baby boomers to cover the deficit? That strategy is not feasible in a competitive labor market. It implies that the current young workers are willing to subsidize older workers. Competing firms can offer each new worker his lifetime marginal product, as defined by (4). Bygones are bygones, and firms cannot make up for mistakes of the past by attempting to extract additional concessions from workers of the future. Promising even higher wages in the future to the new generation of young workers is not credible because that would imply further attacks on the next generation's young workers.

As Welch (1979) argued and MaCurdy and Mroz (1988) and Berger (1988) most recently corroborated, wage profiles depend on cohort size. In particular, age-earnings profiles for the peak baby boom cohort are flatter than those of other groups. Their age–real earnings profiles are actually negatively sloped during the 1970s, even though baby boomers were going through the part of life cycle when real wages are expected to grow most rapidly. Berger offers evidence of flatter profiles for baby boomers. The firm may be adjusting to the pay-as-you-go formula. The present value of lifetime earnings need not fall much since there are more baby boomers than current older workers so that the

deficit is covered by withholding a smaller amount per worker for a larger number of workers. The converse holds when the baby boomers are older. But lifetime productivity would be expected to fall if the earlier profile provided incentives that are now reduced as a result of flatter profiles.

Perhaps the most likely solution to current deficits (and the one that comes closest to the topic at hand) involves changing the retirement behavior of the baby boomers. If older workers are paid more than they are worth, then lowering the average retirement age improves the firm's current cash-flow situation. There are a number of ways that this can be accomplished.

First are explicit buyouts. Let us assume that the firm wants to reduce the size of its older work force, either for the reasons discussed above or for any other reason. For example, older workers may possess obsolete human capital that has little value to the firm. If this reduces their marginal products below the alternative use of their time, a separation is efficient. The separation can be brought about by severance pay that takes the form of an explicit buyout.

Using the notation above, suppose a worker of age a_0 has $w(a_0) > q(a_0)$. Suppose further that the firm would "prefer" that he leave, either for reasons of cash flow or for efficient separation. How can this be accomplished while saving the firm money?

Let the worker's alternative use of time be given by $\tilde{w}(a)$. To buy out a worker of age a_0 it is necessary to offer a buyout B such that

$$B > \int_{a_0}^{1} [w(a) - \tilde{w}(a)]e^{-ra}da. \tag{10}$$

In order for the firm to make money on the buyout, it is necessary that

$$B < \int_{a_0}^{1} [w(a) - q(a)]e^{-ra}da. \tag{11}$$

Equations (10) and (11) imply that

$$\int_{a_0}^{1} [\tilde{w}(a) - q(a)]e^{-ra}da > 0. \tag{12}$$

Condition (12) is the efficiency condition for separation over the remainder of the worker's life. It says that a profitable buyout offer can be made only when a separation would be efficient, that is, only when the worker's alternative use of time exceeds his value to the firm. This is significant.

Suppose that the reason that the firm would like to rid itself of the worker is that his human capital has become obsolete. This implies that the $q(a)$ profile has shifted downward or has tilted to become less positively or more negatively sloped. If internal productivity falls more than external productivity, which is likely, especially when the alternative use of time reflects the value of leisure,

then condition (12) is more likely to be met. Thus, profitable explicit buyouts are a feasible strategy in some cases where worker skills have become obsolete.

Now suppose that the $q(a)$ profile has not fallen over time but that the firm would like to become less "top-heavy" for cash-flow reasons. Buyouts offer no relief here. In order to buy the worker out, it must be true that (12) holds. But the retirement date a^* (in this case $a^* = 1$) must have been chosen in any ex ante efficient contract to solve

$$\tilde{w}(a^*) = q(a^*). \tag{13}$$

For all $a < a^*$, $q(a) > \tilde{w}(a)$ so that condition (12) must be violated unless something else has changed. A changing demographic structure does not necessarily imply that $q(a)$ falls relative to $\tilde{w}(a)$ for high values of a. The change in the shape of the productivity profile depends on imperfect substitution across age categories and the nature of their interaction in the production function (see Murphy and Welch 1988). As a result, it is unlikely that a current deficit caused by a demographic shift can be alleviated by an explicit buyout of older workers.

10.2.1 Pensions and Implicit Buyouts

As I have argued earlier (see Lazear 1983), worker turnover can be affected by using a defined benefit pension plan. These plans have the feature that expected present value of the pension stream declines, once workers remain with the firm beyond some date. Thus, the pension acts as severance pay since remaining for an additional year costs the worker benefits. Specifically, what the worker receives at time a_0 is

$$\text{compensation } (a_0) = w(a_0) + \Delta \text{ pension } (a_0). \tag{14}$$

By selecting the appropriate defined benefit pension formula, any desired buyout structure can be achieved. For example, suppose that the interest rate is zero and a given individual is going to live to age 80. He began working for the firm at age 30. Suppose further that the firm would like to offer him a buyout of $11,000 at age 60. Let the firm offer the following (standard) pension formula:

> The worker receives ($1,000)(years of service at retirement) per year during every year that he lives after retirement.

If the worker retires at age 60, he has thirty years of service and receives $30,000 per year times twenty years, or $600,000 in pension. If he retires at 61, he has thirty-one years of service and receives $31,000 per year times nineteen years, or $589,000 in pension. The difference in pension is $11,000, so it costs the worker $11,000 to stay on one more year. The pension formula has produced the desired buyout at age 60.

While both common types of defined benefit pension formulas (pattern and conventional) can achieve any desired buyout structure, a defined contribution pension plan offers no potential for a buyout. Since defined contribution plans become the assets of the workers, and since contributions to the fund cannot be negative,[13] there is no possibility of structuring a contribution schedule such that the expected present value of the pension assets decline with years of work.[14]

The advantage of explicit buyouts over implicit ones is that the amount can be tailored to each case. But there are two problems with explicit buyouts. Explicit buyouts may create a moral hazard problem as workers try to make themselves undesirable so that the firm will increase the buyout offer. Additionally, they may be illegal. Explicit buyout programs are offered to workers in some age window, say, 55–59 years old. The firm may not want to offer as large a buyout to workers who are, say, 65 because the older workers have a higher probability of voluntary retirement in a given year (see *Karlen v. City College of Chicago*, U.S. 7th Circuit, R. Posner). But at least one court has ruled that this discriminates on the basis of age. Since 65-year-olds are not entitled to a benefit that 56-year-olds receive, they are adversely affected in a way that is related to age and not necessarily productivity. While the move makes good economic sense and may be efficient, courts have not always viewed economic efficiency as the relevant criterion.

Explicit buyouts create moral hazard. A worker who can depress his output, $q(a)$, by reducing effort can make it ex post profitable for a firm to buy him out. The worker who knows that behaves opportunistically, which can be prevented only by making buyout offers unanticipated. Each offer must be a once-and-for-all offer, and workers must not infer from it that similar offers will be available to them in the future. This is a difficult lie to tell continuously, especially since the worker knows that, ex post, it pays for the firm to buckle under and buy the worker out.

Implicit buyouts that operate through defined benefit pension plans may be equally "illegal," but they are more subtle. As such, firms are likely to be able to use them with relative impunity. (There are obvious exceptions. Courts have already ruled that explicit service credit may not cease when a worker reaches some age, say, 65.) Thus, a switch from a defined contribution to defined benefit plan may be the right approach in occupations where retirement can occur on the job.

Table 10.5 now becomes particularly relevant. The trend reflects a shift from defined benefit plans toward defined contribution plans over time. There are a number of advantages of using defined contribution plans. They are easy to administer and cheap to subcontract out to third parties. More important, they usually offer workers more choice over the instruments used as investment vehicles in the pension fund. The major disadvantage is that they cannot be used as effectively to influence the retirement decision. Of course, if wages can be reduced, there is no need to use subtle pension buyout schemes to bring

about retirement. But not only might wage reductions be viewed as breaches of implicit contracts; they are almost certainly a violation of ADEA. The same statute makes obsolete the use of mandatory retirement as a tool for adjusting the labor force, which means that implicit buyouts through defined benefit pension plans are even more important. Yet firms seem to be switching voluntarily to defined contribution plans, or at least new plans are disproportionately of this type. How can this be reconciled with the previous argument?

First, it is well known that the average age of retirement has fallen over time, at least for men. Table 10.6 presents some labor force participation rates.

For men, the decline in labor force participation rates among the older work force is quite pronounced. No similar pattern exists for females because two trends operate in opposite directions. Career women may be retiring earlier than in the past, but younger cohorts have higher average participation rates, which drives up the average, even for the 55–64 age group.

There is some evidence (for a review, see Morrison 1988) that the elimination of mandatory retirement will have a small effect on reducing that trend, but this may be a short-run phenomenon that pertains only to those workers whose wage offers were altered significantly by the unanticipated elimination of mandatory retirement. There are some occupations where elimination of mandatory retirement is likely to present significant problems. The most obvious of these is academics. Here, the working conditions are not well defined, so a worker may remain with the firm, doing relatively little, and still draw his normal salary. Because the pension is defined contribution and is owned by the worker (he may even borrow against it), there is no way that the pension can be used to induce him to retire. Universities have become quite concerned that this will create a major problem, and evidence has already accumulated that suggests reason for concern. At the University of Chicago, for example, since the retirement age was raised from 65 to 70, only one individual (an economist) opted to retire before 70.[15] Is this an issue, and how can firms in this situation deal with it?

Explicit and implicit buyout strategies are available. But the social and even private cost associated with a failure to induce individuals to retire may not be that great. When a tenure decision is made at 30, the firm must consider that the worker has an expected retirement age of, say, 73 rather than 65. The present value of the extra salary cannot be that large at the time the tenure

Table 10.6 **Labor Force Participation Rates over Time**

	Men		Women	
	55–64	65+	55–64	65+
1970	76	22	41	8
1980	72	19	41	8
1985	68	16	42	7

decision is made, even more so if the shape of the age-earnings profile can be altered to recapture some of the additional lifetime earnings. The true social cost is that retirement does not occur at the right age because workers are paid more than they are worth and the wage may exceed the reservation wage. But the difference between the value of true leisure and academic productivity plus leisure taken in one's final years as an academic may not be that large.

10.3 Too Much or Too Little Early Retirement?

Observers have been somewhat schizophrenic about retirement patterns. Some worry that there will be too many older workers and that there will be a need to induce them to leave the labor market. Others fear that early retirement patterns will continue and that aggregate output, ignoring leisure, will be too low. I believe that the issue will be one of having a top-heavy labor market for the following reasons.

First, the size of the labor force will be increasing steadily between 1990 and 2020, for both males and females. Despite a trend toward declining participation rates among elderly males, which is in a rough way built into the male panel of table 10.3, the male labor force 60 and older will increase from 4.4 million in 1990 to 7.5 million in 2020. This is an increase of 72 percent over a thirty-year period.

Second, even the labor force participation rate for the group as a whole is estimated to rise between 1990 and 2020. To the extent that workers across age categories are imperfect substitutes for one another, it is unlikely that such large increases in the elderly labor force will not depress older worker productivity so that earlier retirement becomes efficient. If old and middle-aged workers were good substitutes for one another, then a stronger case could be made that the firms will want to retain, rather than discard, older workers. Welch's (1979) and subsequent authors' evidence suggests that imperfect substitution is important since an increase in the size of a cohort does not have age-neutral effects on wages. This is significant because the male aggregate labor force participation rate is projected to decline from about 77 percent to about 70 percent by 2020. The decline occurs as the age distribution of males shifts toward older and lower participation rate cells. It is perhaps this decline in labor force participation rates that has caused some to view with alarm the labor market of the future.

Third, the trend for women goes the other way, with the participation rate rising by the same amount as the male decline, to about 63 percent by 2020. Female rates rise because the effect of younger cohorts having higher labor force participation rates outstrips the adverse consequence of a shifting age distribution.[16] Additionally, the imperfect substitutability implies that inducing older males to work may not be much help even if there is a real "shortage" of labor.

Working in the opposite direction, however, are projected changes in the Social Security system. Most obvious are changes in age of entitlement, earnings test, and pension payments associated with the Social Security system. Those effects cannot be captured by past data because many of the changes are not scheduled for years to come. Reduced benefits and increased age of entitlement work toward increasing labor force participation among the elderly, so table 10.3 probably understates the aging of the labor force by ignoring these changes.

Exogenous shifts in the Social Security system, say, by changing age of entitlement, imply that the privately optimal retirement date must rise.[17] It is privately inefficient to attempt to offset the effects of this change by encouraging older workers to retire. Thus, exogenous shifts in the Social Security system offer an example of a situation where firms will not use changes in pension formulas or age-earnings profiles to induce early retirement. This is the opposite case of the one considered in the previous section. There, it was assumed that older workers had obsolete human capital, which meant a fall in productivity relative to alternative use of time and therefore an earlier optimal retirement date. Here, the alternative use of time falls between 65 and 68 as a result of a higher age of entitlement. This raises productivity relative to alternative use of time and therefore implies a later retirement date.

10.4 Other Institutional Factors

10.4.1 Pensions

A major consideration when demographics change is the effect of the change on the pension liability. Much of the gloom over the Social Security system relates to projections that the baby boom generation will imply too much in benefits to be supported by the younger generation. This is because the Social Security system has unfunded liability. Pensions plans with unfunded liability may be in serious trouble if the young generation declines relative to the old.

The earlier discussion has already debunked the notion that a dedicated portfolio of long-term bonds is a perfect or even good hedge. This means that a changing demographic structure has important implications for the solvency of pension funds, even if those funds are fully "funded." To the extent that a shift toward an aging work force and a shrinking younger population increases the variance of the difference between current output and current payments (which include pension payments), bankruptcy will become more common. To reduce the probability of bankruptcy, a strategy of holding short-term assets, the nominal value of which is highly correlated with nominal liabilities, can be followed. Whether firms will actually adopt such a strategy is a real question.[18]

10.4.2 Promotions and the Shape of the Pyramid

Tables 10.3 and 10.4 reveal an aging labor force. The typical firm will have a larger proportion of its work force in the 55–69 age category. This implies either that the probability of promotion will fall at the top of the hierarchy and rise at the lower levels or that the shape of the typical firm's pyramid will change. A pyramid with steeper sides will be necessary to keep all promotion probabilities the same. A proliferation of high-level jobs can be expected if wages must be tied to jobs, as Carmichael (1983) suggests. Otherwise, the shape of the age-earnings profile must change. Does changing the shape of the pyramid have any real consequence? Normally, economists do not worry about jobs, per se, and the question, What is a job, is too deep to be addressed here.[19] If tasks are somehow aligned with jobs and are inseparable in the production function, then a cost of having a changing work force is that the task structure of the firm will be altered somewhat. Carmichael suggests an incentive compatibility reason for having wages tied to jobs, but not for having the tasks assigned specifically to job titles. There seems little reason why the duties that are currently assigned to vice director of management information systems cannot be those that were previously under the direction of assistant vice director. The task breakdown in the firm would then be identical, except that many tasks were previously performed by younger workers with lesser job titles.

10.4.3 Teaching

The last point suggests some potential for real effects of a changing age distribution. Since tasks are not necessarily performed equally well by all age groups, it is unlikely that the new age distribution of tasks and the old one result in the same productivity. But there is no presumption that average productivity will fall. For example, older workers may be better teachers, and previous productivity may have been lower because of fewer qualified teachers. One possibility is that older workers have a larger amount of obsolete skills. Another is that they are the creators of skills in younger workers. A changing age distribution can have real effects on productivity, but changing the hierarchical structure of the firm should not necessarily have any effect on productivity.

10.4.4 Women in the Labor Market

Women are becoming more like men in their labor force participation patterns. Female participation rates not only have risen but also have smoothed out over the life cycle, no longer exhibiting the bi-humped pattern of the 1950s in the aggregate data. The smoothness in the aggregate data probably overstates the extent to which women have ceased to interrupt their careers, at least temporarily, on child bearing.[20] The growing importance of women in the market may help explain the move from defined benefit to defined contribution plan.

Women have a relatively greater demand for not merely vested pension plans but portable ones. Consider a defined benefit pension plan that vests immediately but is not portable. A split career, where a worker works at two different firms for twenty years each, results in lower pension than a unified career, where a worker works at one firm for forty years. This is because pension benefits are tied to final salary and salary at age 45 is likely to be lower than that at age 65. (Even pattern plans have ad hoc adjustments that are generally not awarded to vested, separated employees.) This is a greater concern to women than to men since women are more likely to have a split career than men. A portable pension is one that credits summed work experience and ignores movements across employers. Most professors have portable plans. TIAA/CREF is widespread, and most universities are subscribers. But that is unnecessary. Even if a professor were to move from a TIAA/CREF institution to a non-TIAA/CREF defined contribution institution, the pension would be portable in that no penalty is suffered for a job change. Contributions are made on a monthly basis, and only the value of assets determines the pension. It is independent of the identity of the employer, as is Social Security.[21] In fact, portability is a general characteristic of defined contribution plans, which suggests that women have a relative preference for them. The growth in defined contribution plans may well be a response to increased average turnover in the labor market that accompanies the larger proportion of the labor force composed of females. As already discussed above, what is sacrificed by moving to defined contribution plans is the ability to influence retirement decisions by adjusting pension formulas.

10.5 Conclusion

Some adjustments will be necessary as firms adapt to the effects of demographic changes on the composition and size of the labor force. The first task is to predict the ways in which the labor force is likely to change. The major predictions for labor force changes are as follows. First, the labor force will get older. The proportion of workers between 60 and 70 years old will increase 4 percentage points between 1990 and 2020, and there will be a corresponding decline in the proportion between ages 30 and 40. Second, the aging of the labor force will not be as pronounced for males as for females because the trend toward earlier retirement will offset demographic changes. This is true despite the elimination of mandatory retirement. Third, the size of the labor force will grow until about 2015 and then will decline. Given these trends, the following points are relevant.

1. In steady state, a firm does not cover its wage bill by current output. The deficit must be made up by returns on previous investments. The size of the firm's current deficit grows when the labor force ages.

2. Hedging the pension liability by using a dedicated portfolio of long-term bonds is trying to cover the promised real wage bill with assets that guarantee

nominal returns. The strategy is unlikely to be successful. A superior strategy, and one that may be adopted to a greater extent as labor force demographics change, is covering liabilities by investing in assets that are highly correlated with the value of the nominal liability. Short-term Treasury bills are a good candidate. Even better may be reinvestment in the firm, but changing demographics can have important effects when this strategy is used.

3. A firm that desires to reduce the size of its older work force may consider explicit buyouts. An explicit buyout is feasible only when productivity falls below the alternative use of time. The wage is irrelevant, and this implies that buyouts cannot be used to alleviate deficit problems.

4. Implicit buyouts, through strategically designed pension formulas, have the advantages over explicit ones that workers are less likely to reduce effort to increase the buyout offer and that they are less likely to be found in violation of ADEA. The disadvantage is that the buyout cannot be tailored to the individual as easily.

5. Defined benefit plans offer implicit buyout features that are absent in defined contribution plans. As a result, firms may shift back toward defined benefit plans in the future. This is particularly true for occupations where the elimination of mandatory retirement will have the largest effect. One explanation of the recent trend toward defined contribution plans is the growing importance of females in the labor force, who have a relative preference for portable plans.

6. While most evidence points toward declining age of retirement, the major exogenous factor working in the opposite direction is the change in the Social Security system. A decline in real benefits and an increase in age of entitlement work to raise the optimal retirement age.

7. There is may be a proliferation of high-level jobs, but the task distribution need not change.

8. Aging is likely to have effects on average productivity, but the direction of the change is not obvious. This depends on complementarities in the production function, among other things.

Notes

1. For a detailed examination of trends in retirement patterns, see Tuma and Sandefur (1988).

2. Labor force participation rates from Bureau of Labor Statistics data are available for ages 16–75. All other ages were assumed to have participation rates of zero.

3. Most entries for females in table 10.5 are positive since table 10.4 assumes that labor force participation rates are going to grow. There are exceptions, however, because the rates for females in table 10.4 are not permitted to exceed those for males in table 10.4. That constraint is not imposed on table 10.3.

4. Welch (1979) and more recently Murphy and Welch (1988) have analyzed these effects in detail.

5. "Insolvent" is not well defined, especially in the government context, where multiple budget items, as well as intertemporal considerations, are involved.

6. Highly able workers would shirk, passing themselves off as low-ability ones to collect the insurance premium. Additionally, empirical analyses have found that most wage variation is individual specific, which suggests that far from perfect insurance is found. See Lillard and Weiss (1979).

7. Shleifer and Summers (1988) have argued that an acquisition of one firm by another allows for less costly breach of the implicit promise made by old management to its work force. An omniscient stock market would see through this, and purchasers of the stock would take into account future liabilities of the firm that take the form of promises to workers.

8. The effect is reduced somewhat if generations that succeed the baby boom are of previous size rather than small enough to keep population constant. But the point still holds.

9. A permanent population increase from N to N^* causes an increase deficit without any need for an aging labor force. This follows directly from (3). But deficit per worker, which is independent of N, is not increased. In some sense, the normalized deficit increases only when the age distribution shifts.

10. As long as stock price is only miniminally affected by factors other than current output, holding stock reduces the risk of bankruptcy and pension default. But stock price varies in ways unrelated to current output, which works against holding pension dollars in real assets of the firm.

11. All this begs the question of why a firm wants to hedge part or all of its liability to any one group.

12. Still, it can be argued that there is no obvious reason why new owners are better able to breach than old ones. This is especially true when there is separation of ownership and control.

13. This is true not only in practice but also as a result of recent court interpretations of the Age Discrimination in Employment Act (ADEA). In fact, contributions may not even fall off as a function of age according to the court ruling.

14. Clark, Gohmann, and McDermed (1988) find that defined benefit plans are more prevalent in large and unionized firms. They interpret this finding as consistent with a pensions-as-severance-pay interpretation.

15. Sherwin Rosen's committee on mandatory retirement (1988) provided the anecdotal evidence.

16. The census population projections are extrapolated from 1983. The weights that are used to obtain aggregate and age-group labor force participation rates are derived from these population estimates. There is reason to believe that they are already off by a reasonable amount since they predict somewhat higher than actual labor force participation rates for the current year.

17. Privately optimal means that the firm and worker perform joint maximization so as to induce the worker to leave when worker output falls below his alternative use of time, which includes the Social Security payment.

18. The macroeconomic implications of an economy-wide adoption of the short-term strategy are well beyond the scope of this paper and this author.

19. A less-than-satisfactory effort was made in Lazear and Rosen (1988). There, jobs were defined to be technologically determined investment opportunities.

20. Those data confound effects of cohort-specific labor force entry ages and cohort-specific mother's age at childbirth, so smoothing can result from averaging bi-humped patterns over different groups.

21. Exceptions include moving to government jobs, which are not part of the Social Security system.

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Comment

Finis Welch

Eddie Lazear is always provocative. You can't be intellectually alive and not be stimulated by this guy's work.

We all know that the U.S. population is aging, but in this paper Lazear provides a valuable service by taking the Census Bureau's population age distribution projections and superimposing current sex by age labor force participation rates on them, to forecast future age distribution of labor force participants. His calculations are that, although the working population will age less rapidly than the total population, the working population will age significantly for the next twenty years or so. After that, Lazear's forecasts show a reasonably stable age distribution of workers.

This, of course, is preliminary. It is a given that the work force will age, and Lazear's objective is to delineate the problems that he believes will result and then to describe alternative resolutions of them.

The basic idea is that the worker/firm labor contract is one where the worker's productivity exceeds compensation in the early career and compensation exceeds productivity in the late career. The two related justifications for this view are first that the worker's implicit posting of a bond (through early career compensation deficits) creates incentives not to shirk on the job. Shirking risks detection and being fired so that the late career compensation surpluses are at risk. The second justification is that the late career excess of compensation over productivity creates incentives for mandatory retirement. This may be a simplification of Lazear's interpretation of mandatory retirement, but I believe that it captures the essence of his argument.

He then notes that, if the compensation-productivity career profile is as he suggests, a worker's undiscounted lifetime compensation exceeds his or her undiscounted productivity. This is because net (of compensation) productivity is positive in the early career and competitive pressures with positive time discounts ensure full career equality of discounted productivity and compensation profiles. A firm with a uniform age distribution of workers will therefore have a wage bill on current account that exceeds labor's current product. Moreover, the wage bill-product deficit will increase as the age distribution shifts toward older workers.

None of this creates a problem when firms save or invest productivity surpluses that they retain in the early career to cover late career liabilities unless the returns earned on the funds that are set aside are less than the return assumptions that are embedded in the worker's calculations of alternatives. When firms are myopic or unlucky in their investments, the risks of breaching worker/firm contracts increase as the work force ages.

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The remainder of Lazear's paper is concerned with strategies that firms might adopt to reduce risks of breaching worker contracts. Since I have nothing to contribute on this front, I restrict my comments to describing an alternative view of the nature of lifetime contracts and then describe some of the problems that I expect to accompany an aging work force.

In introducing the argument for current account wage bill deficits, Lazear describes the human capital and incentive views as alternatives. According to the human capital view, the firm invests in the worker in the early career so that costs exceed productivity and the investment is recouped in the late career. The incentive view is described above, and Lazear sees the existence of mandatory retirement (until it was legislatively proscribed) as evidence for the incentive view.

It seems to me that the two views are alternatives only in a two-period world where investments in one period are recouped the next and when investments are not firm specific. Since Lazear's illustrative calculations assume a forty-five-year work life, it seems safe to assume that there are more than two periods. Now consider the human capital model presented by Becker (1962).

In the early career, the firm invests in the worker, and the worker invests in the firm. The sharing of firm-specific investments provides partial insurance against subsequent attempts to preempt rents, by either the firm or the worker. The firm invests if the product it receives is less than the worker's cost (compensation plus explicit training costs), and the worker invests if the compensation received is less than would be received in a (perhaps hypothetical) alternative job. There is nothing contradictory in joint investment because the worker's product to the firm bears no necessary relation to his or her alternative wage.

Similarly, there is no contradiction in an assumption that both investments are productive. It is only necessary that, subsequent to the firm's investment, the worker's product must exceed compensation by an amount that is sufficient to recoup investment costs. From the worker's perspective, it is necessary only that, subsequent to the investment, compensation from the firm must exceed the alternative wage. The specificity of the investment breaks the link between productivity within the firm and the alternative wage, and the existence of multiple periods suggests that the timing of returns on investments need not coincide with approaching retirement.

Notice that, if firms invest in workers in the early career, then undiscounted lifetime product exceeds undiscounted lifetime compensation. With a uniform age distribution of workers, the firm realizes a current account surplus, and the surplus increases as the age distribution shifts toward older workers. This implication is the opposite of the one Lazear analyzes.

The next question is whether the existence of mandatory retirement (or, under current law, the potential existence) can provide information regarding time profiles of compensation-productivity differentials or, from the worker's perspective, of compensation-alternative wage differentials. If there is a

relation, I do not see it. Long careers simply offer too much room for flexibility in timing. For what it is worth, I think of mandatory retirement as follows.

In a world of independent worker productivities with costless recontracting, retirement or any other separation between worker and firm would occur only with mutual agreement. All that matters is the contrast between the worker's productivity to the firm and the alternative value of time (in retirement or working elsewhere). If the value of the worker's time with the firm exceeds the value elsewhere, there must be a compensation package that would keep the worker with the firm. Similarly, if the worker's perception of the value of the time spent elsewhere exceeds the firm's perception of the value of the worker's time with the firm, there should be no agreement that would keep the worker in place.

I believe we have mandatory retirement because productivities are interdependent and because recontracting is expensive. Interdependence includes the ability to work with colleagues as well as the expectations and aspirations of younger workers concerning opportunities for advancement, and it extends to personnel relations involving satisfaction when others are treated no better than I am treated or envy when others receive what I see as superior treatment. Mandatory retirement has the advantage of even-handedness, and it facilitates planning. Coupled with unvested pensions etc., mandatory retirement can be considered simply as variance reducing.

In closing, I will list but not develop problems that I see as coincident and perhaps caused by an aging work force. One is that aging is coincident with reduced population growth and, in closed economies, perhaps with reduced growth in product demand. A firm that is organized vis-à-vis promotion ladders etc. that incorporate continuing growth will have to reorganize internally. With reduced growth there may be reduced opportunities for internal advancement.

Worker careers are interdependent not only in the sense of promotion ladders but also in the sense of spot productivity enhancement. Current estimates are that the productivity of mid-aged workers, for example, is increased by increased numbers of younger workers—in part, perhaps, because the older workers are assisted by and in turn help train the younger workers. A reduced inflow of younger workers will probably reduce the productivity of mid-aged workers.

There are macro- as well as micro-effects of a changing age distribution. Consider as an example the stereotyped career of a physicist. The early phase is brash and fast; it is where the innovations are produced. Next, there is consolidation, where numbers of publications may be great but are tending toward reiteration, minor extension, and development of applications. During this phase, the emphasis shifts from doing to teaching. Then, in the late career, say age 40, there is nothing left but administration. Physicists represent an amazing proportion of graduate school deans at major universities. The micro implication of an aging work force may be only that the ratio of deans to

research associates will increase. The macro implication may be that rates of discovery will fall as the first-phase entry resides.

Fortunately for economics (the other major source of graduate school deans), the most productive are either gray or bald.

Eddie Lazear is one of the outstanding labor economists who is interested in the human resource side of human capital research, and he has been able to extend his insight in these areas into some aspects of labor relations. In the present paper, he has drawn on earlier work on mandatory retirement. He ignored his work on tournaments, that is, on the incentive aspects of promotion ladders. The omission is unfortunate. If there are important consequences of an aging working population, one of them must be the implications for opportunities for advancement within firms. Promotional ladders that coincide with rapid population growth cannot resemble those that exist with falling populations.

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