The Effect of Cohort Size on Earnings: An Examination of Substitution Relationships

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*The basic idea of this paper is taken from my dissertation, Alsalam (1984). I need like to thank Finis Welch and Kevin Murphy for the many useful discussions and the encouragement to pursue the ideas in this paper. I remain fully responsible for the form the ideas have taken and the faults I have introduced.

I. Introduction

Events of the 1970's, particularly the fall in the earnings of young college graduates and the decline in college enrollment rates, the post war baby boom, and the eventual "bust", has focused the attention of economists on age or experience cohort size effects on earnings (Welch(1979), Berger(1985), Freeman(1979)). Findings in this literature not only have implications for issues in the distribution of income, growth, and inter-generational welfare, but also for the empirical literature on estimating the returns to schooling and on-the-job training, because they emphasize that rates of return are not time invariant.

The cohort size literature departs from previous literature on estimating earnings functions in that members of different schooling-experience groups are explicitly treated as imperfect substitutes in production whose relative wages depend on their relative numbers. The existing cohort size literature has modeled the earnings of a particular cohort as a function of the size of that cohort (relative to cohorts with similar schooling.) It does not treat more generally the effect of the distribution of cohort sizes on cohort earnings[1]. That is, it does not distinguish between between being a part of a large cohort at the leading edge of a baby boom and being on the trailing edge[2]. It is the aim of this paper to begin a treatment of this subject.

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[1]An exception is Murphy, Plant, and Welch (1984). These authors study the variation in earnings with the size of an experience-schooling cohort by viewing an experience cohort as being some linear combination of more primative factors and earning the same linear combination of those factor wages. Factor wages are determined by their stocks which in turn is determined by the size distribution of experience-schooling cohorts.

[2]In a related literature, Wachter and Washler (1984) have treated this issue vis a vis college enrollment rates, primarily from an empirical perspective. Alsalam (1984) has done the same, but primarily from a theoretical perspective.

The evidence for a negative effect of own cohort size on earnings is convincing. Welch's original estimates are an elasticity of annual earnings with respect to own cohort size of -.204 for experienced white male college graduates and substantially larger elasticities for new entrants. The approach of both Welch and Berger is to specify the own cohort size effect as a function of experience. Welch finds that the effect declines with experience, i.e. new entrants suffer the largest loss of earnings, but the effect erodes as the market "digests" them. Berger re-estimates Welch's regressions with a somewhat more complete specification of the interaction between cohort size and experience (and more years of data) and argues that to the contrary the effect increases with experience.

The economic foundation that Welch suggests is one of transition between career phases. When an unusually large cohort enters the market, the relative number of apprentices to journeymen increases. As they move toward journeyman status their apprentice-journeyman composition, at first, approaches that of the workforce as a whole and the effect of their unusual size erodes. However, during the later stages of their career, their numbers increase the relative number of journeymen to apprentices and depress their own wages. In summary, large cohorts should experience more concave earning profiles. Currently available data is more likely to shed light on the early career effect and Welch's specification and estimates reflect this.

On the other hand Berger suggests that larger cohorts may delay their transition to worker status due to congestion and lower quality or higher cost learning activities. This he conjectures would produce the flatter or slower growth early career profiles which he finds.

The sensitivity of the empirical results on this particular issue suggests that more attention should be devoted to modelling the nature of substitution relationships among workers in various schooling-experience groups.

The approach of this paper is similar to previous approaches in that it takes supply as exogenous and wages as determined by demand. It follows Freeman (1979) in that it models demand as determined by the derivatives of an aggregate production function. Freeman aggregates labor into a few broad classes: young men, old men, women, and capital, and attempts to estimate the substitution relationships. This paper separately estimates wage functions by schooling class (based on the assumption that relative earnings within a schooling class is independent of other schooling classes or that aggregate production is weakly separable by schooling groups). Within a schooling class wages in principal depend on the full experience distribution. If the substitution relationships were left unrestricted, the number of parameters to estimate would be excessive. The number of parameters is reduced by making use of the heuristic notion that substitution is a function of distance in experience between cohorts[3].

The outline of the paper is as follows. Section II presents an example of an aggregate production function where substitutability is a function of distance. Section III sets forth an econometric specification of an earnings function based on this production function. Section IV describes the sample and data used to estimate the earnings function. Section V presents the results and interprets them. Section VI concludes the paper.

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[3]The parameters potentially could depend directly on experience, in addition to distance. This is a natural generalization whose advantages must be weighed against the cost of increased complexity.

II. An Aggregate Production Function

Suppose the labor force participation of workers in various schooling-experience classes is exogenous and hence wages are determined by demand. Suppose demand in turn is determined by the properties of an aggregate production function. Suppose the aggregate production function is (weakly) separable by schooling class, so within each schooling class relative productivites depend only on the experience distribution of the workforce in that schooling class, i.e.

$$y = f(S_1, S_2, \ldots, S_n)$$

where

$$S_i = g_i(e_{i,1}, e_{i,2}, \cdots, e_{i,m}) \qquad i=1,\cdots, n$$

The S_i's are schooling class aggregates and $e_{i,j}$ is the numbers of workers in schooling class i with experience j. Therefore,

$$\partial y/\partial e_{i,j} = \frac{\partial f}{\partial S_j}\frac{\partial S_j}{\partial e_{i,j}}$$

and

$$\frac{\partial y/\partial e_{i,j}}{\partial y/\partial e_{k,j}} = \frac{\partial S_j/\partial e_{i,j}}{\partial S_k/\partial e_{k,j}}.$$

Within a schooling class aggregate, young workers and old workers are not perfect subtitutes in production because they perform different tasks on the job. Young workers, for instance, have a comparative advantage at tasks that require physical skills and are more likely to be assigned these tasks. Young workers are also more likely to be assigned to tasks that are complementary to learning activities. Older workers have a comparative advantage at tasks requiring familiarity with the capital in use and are more likely to to be assigned to these tasks. All types of tasks are useful in production. Changes in the relative number of old and young workers change the relative productivity of the tasks in which they specialize and hence their relative productivities[4]. As an unusually large birth cohort enters the labor market, it increases the relative number of young to old workers and reduces their relative wage.

This is not surprising on theoretical grounds, and in fact it has been verified empirically. What has not been established is whether the lower relative wage follows the unusually large cohort throughout its life-cycle, and if it does, whether it grows or erodes as the birth cohort gains experience. That is, do cohort size effects depend on experience?

The restrictions placed on the production function are based on the fact that workers of similar experience are more alike than workers of dissimilar experience. The closer workers are in years of experience in the labor market, the more similar they are in the skills they possess and use in the market. The more distant workers are, the less similar they are. Two groups of labor are mutually enhancing if more workers of one type increases the productivity of the other. They are mutually detracting if more workers of one type reduces the productivity of the other. This, of course, simply

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[4]Rosen (1978) and Welch (1969) provide two viewpoints of the source of a worker's productivity. In Rosen's view workers have skills and tasks have skill requirements. Workers sort themselves between tasks based on their comparative advantage. Generally, workers do not fully utilize their skills due to bundling restrictions. In Welch's view workers are a vector of skills, just as in Lancaster's view commodities are a vector of attributes. The wage of a worker is the product of skill rental rates and the skill quantities he possesses. Implicit, is the fact that all of a workers skills are utilized on the job. Both views yield the implication that changes in the relative numbers of workers of different types will change their relative earnings.

describes the signs of the cross partial derivatives of the production function. Distant groups of workers are more mutually enhancing than close groups. Carrying this reasoning to its limit, workers of the same type (located at the same point on the experience scale) are mutually detracting in the sense that an increase in their own numbers decreases their productivity. In the interest of brevity of expression, "complements" is used to mean "mutually enhancing", and "substitutes" is used to mean "mutually detracting."

Differences in "experience" is natural as a measure of differnces between workers. Identical workers are "located" at the same point on the experience scale. Workers at different points on the scale are "different." By virtue of moving along the scale, gaining experience, the worker changes, transforms, evolves. As a worker changes he specializes in different tasks in the production process. The more workers that are "different" from a given type of worker, the more productive are workers of that type. The more workers that are "like" the given type the less productive is that type.[5]

Parameterizing substitution relationships as a function of distance in experience does not economize on the number of parameters that must be estimated, if the function is allowed to be an arbitrary function of experience. However, limiting the function to be monotonic in distance and to not depend on experience directly is restrictive. The empirical specification imposes the latter two restrictions.

The rate at which complementarity increases with distance in experience, and the manner in which this rate itself depends on experience is what

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[5]This intuition says nothing about the scaling of distance. It may be linear, logarithmic, or a power of experience differences. This is a point on which estimation may shed some light.

determines the evolution of the relative wage of an unusually large cohort as it progresses through its work cycle.

When a new and unusually large cohort enters the labor force, its earnings fall. It may fall (1) because the cohort is larger than the average size of other cohorts in its schooling class, (2) because it is large relative to the size of experienced cohorts, or (3) because it is large relative to the number of workers in previous entering cohorts. If (1) were true, it would only be necessary to specify cohort size effects in terms of own size (relative to the aggregate) and to use a single cross section of data. If (2) were true, it would be necessary to have several cross sections of data and possibly to use only difference information (equivalent to including a full set of fixed effects) in the data. If (3) were true, it would be necessary to have more information on the experience distribution than simply own cohort size. For instance, it may be necessary to have some information on relative cohort size Whereas, most previous work is in the tradition of (1), this paper is in the tradition of (3). Unfortunately, the currently available time series may not be able to distinguish the two views. Choosing between the two approaches is more one of taste than evidence.

A. A Modified CES Production Function

Consider a modified multi-factor CES (constant elasticisity of subsitution)[6] production function:

(1) $$Q = \gamma \left[\delta_1 n_1^{-\rho} + \delta_2 n_2^{-\rho} + \cdots + \delta_k n_k^{-\rho} \right]^{-1/\rho}$$

where

(2) $$\sum_{i=1}^{k} \delta_i = 1$$

and

(3) $$\delta_i = \alpha_i \sum_{j=1}^{k} w_{i,j} \; n_j$$

For a standard CES production function the γ's are constants independent of the experience distribution of the workforce. However, in this application the γ_i's are functions of the full experience distribution of the workforce (in a particular schooling class).

The log first partial of this production function is:

(4) $$\log\left[\frac{\partial Q}{\partial n_i}\right] = (1+\rho)\log(Q) + \log \left\{ \delta_i n_i^{-(1+\rho)} - \frac{1}{\rho} \left[\sum_j \frac{\partial \delta_j}{\partial n_i} n_j^{-\rho} \right] \right\}$$

For a CES production function the second term in braces is zero.

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[6]The CES production function is choosen primarily due to its familiarity. It is not particularly suitable to this application. The elasticity of substitution is a parameter that is of more interest in applications where prices are taken as exogenous. The elasticity of complementarity, Hicks (1954), is a more interesting parameter in applications where quantity supplied is taken as exogenous.

B. The Weight Function

The weight function $w_{i,j}$ is the mechanism in the above specification that allows a variety of complementarity/substitution patterns. For example, if the δ_i's are constants independent of the experience distribution, then this production function reduces to a multi-factor CES. Other restrictions and functional dependencies may be applied that reflect economic theory and intuition.

It is plausible to consider groups "close" to each other to be better substitutes than those "far" from each other, i.e. the marginal rate of technical substitution between close groups is less affected by their relative numbers than it is for distant groups. In different words, close experience groups are less complementary than those further apart. Graduate students are more complementary to full professors than to assistant professors. Apprentices are more complementary to master (plumbers) than to journeymen (plumbers). This intuition is reflected in the restriction

$$w_{i,i+j} \le w_{i,i+j+1}$$
$$w_{i,i-j} \ge w_{i,i-j-1}$$

For fixed i, the weight function increases monotonically in $|i-j|$.

It is also plausible that increases in the number of workers with experience similar to another group's reduces the productivity of the latter group. An increase in the size of an experience cohort i decreases its own wages and those of nearby cohorts, however, it increases the wages of other cohorts further away[7]. This would be reflected by a weight function that is negative for j close to i and increases (eventually becoming positive) as j decreases or increases away from i.[8]

$$w_{i,j} > (\leq)\ 0 \text{ for } |i-j| > (\leq)\ c^*$$

In the specification of the production function, γ is the efficiency parameter, the δ_i's are input intensity parameters, and ρ is the substitution parameter. For constant returns to hold it is necessary that the δ_i's sum to a constant. Any constant will do as long as γ is free to vary, so 1 is chosen.

III. Empirical Specification

Separate earnings functions are estimated for each of four schooling classes. Within each schooling class two regressions are estimated corresponding to annual and weekly earnings for each specification of the experience distribution variables. In the first, mean log annual earnings is the dependent variable. In the second, mean log weekly earnings is the dependent variable, which is calculated as the mean of the log difference of annual earnings and annual weeks worked. All earnings variables are deflated by the

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[7] Welch makes n_i the "true" number of workers in experience group i, a weighted average of the "measured" number in experience group i and those in experience groups nearby.

[8] An identification problem exists here, which is discussed in the empirical section.

CPI in 1967 dollars. Imputed earnings are not used in the calculation of the earnings variables, but the proportion of the observations in the cell for which earnings were imputed is included as a regressor -- a crude control for the sample selection bias.

A. Definition of Variables

Using the approximation[9] that

$$(5) \qquad \sum_j \frac{\partial \delta_j}{\partial n_i} n_j^{-\rho} = 0$$

we have

$$(6) \qquad \log\left[\frac{\partial Q}{\partial n_i}\right] = (1+\rho)\log(Q) + \log(\alpha_i) - (1+\rho)\log(n_i) + \log\left[\sum_j w_{i,j} n_j\right]$$

The first term on the RHS can be interpreted as determined by aggregate demand conditions, which empirically is represented by a knotted linear trend spline and the aggregate unemployment rate for prime age males. Although there is little or no trend in CPI deflated wages before 1976, afterwards the trend is strongly negative. The second term is interpreted to be normal life-cycle wage growth, which is reflected in the quadratic and early career spline in experience. The third term is own experience cohort size, which empirically is represented by the proportion of the workforce (in a particular schooling class) that has i years of experience. The fourth term is the input intensity

[9] The approximation is exact when the function is evaluated at a uniform experience distribution. This suggests that in addition to normalizing on the size of a schooling class that we normalize on the average experience distribution as well, i.e. define the size of cohort i in year t as

$$n^*_{i,t} = \frac{n_{i,t}}{n_{i,\cdot}} \cdot \frac{1}{N_t}$$

parameter or complementarity index. It is a weighted average of the entire distribution of the workforce over experience.

I restrict consideration to the class of V-weight functions of the form:

$$(7) \qquad w_{i,j} = \begin{cases} \alpha \max(1, \frac{i-j}{\beta}) & \text{for } j \leq i \\ 0 & \text{for } j = i \\ \alpha \max(1, \frac{j-i}{\beta}) & \text{for } j \geq i \end{cases}$$

where α is the maximum complementarity between experience cohorts and β is the spline point at which this maximum is attained.

B. Identification Issues

The CPS is a fixed random sample of households (addresses). The sample size increased in the middle 1970's. Weights are supplied with each household and individual in the sample that allows making population estimates. The Census Bureau calculates these weights based on the decentenial census and subsequently adjusts them to accomodate changing population size. These weights are not used in the empirical analysis below. For this reason, experience cohort sizes are normalized on the size of the schooling class. All cohort sizes are expressed as a fraction of the schooling class. This normalization of the cohort size distribution in a given year makes it necessary to choose a corresponding normalization for the weight function. The data cannot give information about the effect of the size of the schooling class in a given year on their average wages. Restricting $w_{i,i}$ to be zero is the normalization imposed on the estimates below.

The question being asked of the data, the effect of cohort size on earnings, is inherently a dynamic one. However, the parameters could in principle be estimated from a single cross-section. Because the parameters depend on the full experience distribution in a restricted way, they can be estimated from a single observation of an experience and wage distribution[10] The use of multiple cross-sections is useful for providing additional variation and hence information about the parameters, but it is not strictly necessary[11]. Some of the variation in cohort sizes and wages is removed by including as explanatory variables trend(s) and the aggregate unemployment rate.

C. The Likelihood Function

In summary, the stochastic assumption is that average log annual (or weekly) earnings, $Y_{e,s,t}$, in an experience-schooling-year cell are independently and normally distributed with mean

$$
\begin{aligned}
E[Y_{e,s,t}] &= \beta_1 + \beta_2 U_t + \beta_3 t + \beta_4 \max(0,t-76) + \beta_5 \left[\frac{n^*_{e,s,t}}{n_{e,s,t}}\right] \\
&+ \beta_6 e + \beta_7 e^2 + \beta_8 (1-\max(0,e/\beta_9)) \\
&+ \beta_{10} \log(n_{e,s,t}/n_{\cdot,s,t}) + \beta_{11} \sum_{j=1}^{40} \max\left[1, \frac{|j-e|}{\beta_{12}}\right] \log(n_{e,s,t}/n_{\cdot,s,t})
\end{aligned}
\tag{8}
$$

and variance σ^2, where U_t is the unemployment rate of males 45-54 years old in year t, $n_{e,s,t}$ is the number of individuals in the sample in year t with e years of experience, and s years of schooling, $n^*_{e,s,t}$ is the number with

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[10] This is analogous to the ability to estimate the parameters of a time series process from a single (partial) time series. The ergodicity and stationarity assumptions is what makes this possible.

[11] These facts are equally true for previous work by Welch and Berger.

imputed earnings, and $n_{\cdot,s,t}$ is the sum over all experience groups. The parameter in (8) are estimated via maximum likelihood.

IV. Data[12]

A. The Sample

The sample used in the following analysis is constructed from the 1968 through 1982 March Current Population Surveys (CPS). From the full sample, out of school, not retired, civilian, white, working males between the ages of 16 and 65 are selected. Table 1 reports the number of individuals in the sample by year and schooling class. Notice that the sample increased in 1977. Information for each individual in the sample includes (1) last year's earnings, (2) last year's weeks worked, (3) usual full/part-time status, (4) years of schooling completed, (5) age, and (6) a flag "suggesting" whether the individual's earnings may have been imputed.[13] In addition, attached to each individual in the sample is a probability density for years of work experience. This density depends on years of schooling completed, age, and birth year. These data are then aggregated into year, schooling class, and experience group cells.

There are 15 years in the sample, reporting annual earnings from 1967 to 1981. Four schooling classes are used: (1) high school dropouts (8-11 years), (2) high school graduates (12 years), (3) part college (13-15 years), and (4) college graduates (16+ years). Experience classes are from 0 to 39 years of

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[12] I thank Finis Welch for providing me with these data which were constructed with incredible care from the 1968 - 1982 March CPS tapes.

[13] The flag and the imputation of earnings by the Census Bureau is discussed below.

experience by single years. There are 600 observations for each schooling class.

B. Aggregation into Experience Classes[14]

The aggregate number of workers in year t, schooling class s, and x years of experience $n_{t,s,x}$, is:

$$n_{t,s,x} = \sum_{a=16}^{65} N_{t,s,a}\; p(x|s,a)$$

where $N_{t,s,a}$ is the number in year t in schooling class s and age a, and p(x|s,a) is the probability an individual with s years of schooling and age a has x years of experience[15,16]. The aggregate log annual earnings and the aggregate number of weeks worked is calculated similarly, except it is restricted to those whose earnings are not flagged as being imputed. The aggregate log annual earnings of workers in year t, schooling class s, and experience x whose earnings have not been imputed, $w^{*}_{t,s,x}$, is:

$$w^{*}_{t,s,x} = \sum_{a=16}^{65} W^{*}_{t,s,a}\; p(x|s,a)$$

where $W^{*}_{t,s,a}$ are the aggregate non-imputed log earnings of earners in schooling class s, and age a.

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[14] This aggregation technique was developed by Finis Welch, and first used in Smith and Welch (1978).

[15] In the conventional approach, experience is simple linear function of age and schooling, so

$$p(a-s-6|s,a) = 1$$

[16] The probability distribution is calculated in Welch and Gould (1976).

V. Results

The maximum likelihood parameter estimates are summarized in tables 2 and 3 In table 2, the dependent variable is mean log annual earnings; in table 3, it is mean log weekly earnings -- annual earnings divided by annual weeks worked.

The trend in real annual earnings before 1976 is generally less than 1 percent per year, and about 1 percent for weekly earnings. After 1976 it changed dramatically to approximately -3 percent per year.

A one percentage point increase in the unemployment rate reduces annual earnings of high school graduates by 5.6 percent and of college graduates by 2.9 percent. Weekly earnings are reduced by 3.6 and 2.3 percent for high school and college graduates, respectively. This is consistent with the common finding that the earnings of college graduates is less sensitive to cyclical fluctuations than are groups with less schooling, and that most of this reduced sensitivity is in weeks worked.

With a single exception, the higher the proportion of workers in a cell with imputed earnings the lower is the average earnings of those who reported their earnings. For college graduates, for instance, the coefficients is -.565. Those who do not report their earnings, earn more than average[17].

The spline point for the early career spline is estimated to be between 6 and 7 years of experience for both annual and weekly earnings. The coefficient of the early career spline[18] is consistently negative. In the

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[17]For a close examination of the imputation of earnings issue in Census CPS data, see Lillard, Smith, and Welch (1981).

[18]Smith and Welch (1978) were the first to use this variable. I use it on the basis of their experience that a quadratic in experience in not a sufficient description of earnings-experience profiles -- early career residuals are consistently negative.

annual earnings equation it is -.550 for high school graduates and -.259 for college graduates. This result suggests the quadratic inexperience overstates early career earnings. The absolute value of the coefficient declines with education for both sets of regressions, i.e. the quadratic in experience is more appropriate for college graduates than it is for high school dropouts. The coefficients of experience are positive and of squared experience negative; earnings rise, but at a declining rate with experience.

The elasticity of annual earnings with respect to own cohort size is negative except for high school dropouts. It is -.0917 for high school graduates and -.217 for college graduates. Members of unusually large cohorts earn less, and the depressant effect is larger for college graduates. The elasticity of weekly earnings with respect to own cohort size is smaller, -.067 and -.194 for high school and college graduates, respectively. Apparently members of large cohorts work fewer weeks and are more likely to work part-time. The effect of cohort size on earnings comes through labor supply as well as through wage effects.

The effect of increases in the size of cohorts with more or less experience is, as expected, positive. The spline point for the complementarity variable, the distance in experience between cohorts at which complementarity reaches a maximum, is most precisely estimated for high school and college graduates. For these two groups it is 11.0 and 12.2, respectively.

To more clearly describe the implications of the estimated cohort size and complementarity coefficients an example is constructed. Presented in table 4 are the log differences in earnings of a member of a cohort that is 15% larger than "normal" during each year of his worklife. Two cases are calculated: (1) the cohort is on the leading edge of a permanent increase in cohort sizes,

i.e. the cohort is the first unusually large cohort, but all cohorts that follow will be equally large, and (2) the cohort is on the leading edge of a temporary increase in cohort sizes, i.e. the cohort is the first of 10 unusually large cohorts. It can be seen that in both cases the effect of belonging to the leading unusually large cohort is strongest on entry, but gradually erodes as the larger cohorts that follow increase the productivity of the leading large cohort. In the case of a permanent increase in cohort sizes, the effect erodes completely; in the case of a temporary increase, it does not.

For a cohort on the trailing edge of a baby boom the effect is opposite. The initial depressant effect grows over the individual's worklife. Upon entry there a large number of other unusually large cohorts in the market that complement the trailing cohort's productivity. However, as these large cohorts retire, the trailing cohort's earnings drop. For a cohort just preceeding a permanent decrease, the numbers are identical to those of the first cohort of a permanent increase, except read in reverse order. Similarly, for a cohort on the trailing edge of a 10 year baby boom, the numbers are identical to those of the first cohort of a baby boom, but read in reserve order.

Although the cohort size effects estimated here are not a function of experience, they imply effects that are a function of experience, because the distribution of the workforce changes as a worker gains experience. We expect the depressant effect on the earnings of early baby boom babies to erode as later large cohorts enter the market. Late baby boom babies may experience the depressant effect of belonging to a large cohort late in their work lives.

VI. Summary and Conclusions

An aggregate production function approach to understanding the effect of baby booms and busts on earnings-experience profiles is pursued. Use of the heuristic notion that workers of similar or close in experience are better substitutes than those that are dissimilar or distant in experience is made to make estimation tractable. Based on the aggregate production function, a (non-linear) wage function that depends on the full experience distribution is specified and estimated using data from the 1968-1982 March Current Population Surveys.

Life cycle earnings depend on the size distribution of experience cohorts. Members of large cohorts earn less, and enhance the earnings of other cohorts, particulary those that are some distance away in experience. Members of a single unusually large cohort will earn a constant fraction less than members of normal cohorts. Members of large cohorts on the leading edge of a baby boom earn less but much of the depressant effect erodes as other large cohorts follow them into the market. The effect is symmetric for members of large cohorts on the trailing edge of a baby boom. The initial depressant effect increases as smaller cohorts follow and larger cohorts retire.

Future research should isolate the contribution of cross-sectional and time series information in the data on the estimates. Although a time series of 15 cross-sections is used to estimate the parameters, the estimation approach would allow identification of the parameters with a single cross section.

Table 1
Sample Size by Year and Schooling Class

Year	Schooling Class: 9-11	12	13-15	16+
68	7504	8990	2953	3673
69	7284	9375	3255	3786
70	6794	9251	3266	3717
71	6619	9563	3466	3982
72	6176	9440	3427	4031
73	5756	9510	3568	4108
74	5416	9382	3652	4343
75	4969	9232	3728	4429
76	4862	9296	3775	4512
77	5719	10951	4617	5518
78	5370	10839	4644	5456
79	5062	10764	4825	5640
80	5788	12776	5797	6735
81	5619	12984	5711	6862
82	4823	11764	4947	6250

Note: Figures are the number of out-of-school, not retired, civilian, white, working males between the ages of 16 and 65 in the March Current Population Survey.

Table 2
Mean Log Annual Earnings of White Males: 1967-1981:
Maximum Likelihood Estimation Results

	Years of Schooling			
	Grade School		College	
	8-11	12	1-3	4
Cohort Size Effects:				
Own cohort size	0.068	-.0917	-.204	-.217
	(2.99)	(3.08)	(8.22)	(12.5)
Complement size	0.00137	.00207	.00038	.00114
	(12.4)	(3.25)	(1.18)	(4.10)
Spline point	30.	11.0	17.0	12.2
	(13.0)	(7.05)	(2.00)	(9.92)
Experience Effects:				
Early career spline	-0.874	-.550	-.416	-.259
	(49.7)	(19.7)	(17.6)	(17.3)
Spline point	6.70	7.21	7.29	6.35
	(77.0)	(61.8)	(55.5)	(37.7)
Experience	.057	.029	.043	.057
	(51.0)	(17.8)	(24.5)	(46.4)
Experience squared	-.0009	-.0007	-.0009	-.0015
	(40.3)	(24.0)	(27.8)	(47.6)
Year Effects:				
Trend Before 1976	.004	.009	.006	.008
	(3.48)	(7.74)	(5.72)	(8.42)
Trend After 1976	-.030	-.028	-.026	-.034
	(17.8)	(18.0)	(16.6)	(25.2)
Unemployment rate	-0.065	-.056	-.040	-.029
	(22.0)	(21.3)	(15.1)	(12.4)
Proportion Imputed	-0.029	.087	-.321	-.565
	(.312)	(.979)	(3.54)	(7.16)
Constant	8.088	8.764	8.768	9.10
	(604.6)	(418.4)	(398.8)	(444.7)
σ^2	.00184	.00153	.00164	.00129
	(54.6)	(54.5)	(54.3)	(54.6)

Table 3
Mean Log Weekly Earnings of White Males: 1967-1981:
Maximum Likelihood Estimation Results

	Years of Schooling			
	Grade School		College	
	8-11	12	1-3	4
Cohort Size Effects:				
Own cohort size	0.069	-.067	-.147	-.194
	(4.52)	(2.22)	(9.19)	(12.4)
Complement size	0.00085	.00188	.00036	.00098
	(12.7)	(1.60)	(2.02)	(3.95)
Spline point	35.0	8.9	17.0	12.5
	(5.63)	(3.60)	(3.70)	(9.34)
Experience Effects:				
Early career spline	-0.636	-.410	-.351	-.193
	(49.0)	(19.8)	(10.0)	(14.4)
Spline point	6.45	6.43	7.14	6.32
	(79.2)	(51.4)	(54.1)	(31.3)
Experience	.044	.030	.043	.056
	(53.9)	(28.1)	(28.2)	(51.1)
Experience squared	-.0007	-.0006	-.0008	-.0014
	(42.2)	(34.6)	(33.4)	(50.2)
Year Effects:				
Trend Before 1976	.011	.013	.010	.009
	(11.5)	(14.7)	(9.61)	(11.2)
Trend After 1976	-.034	-.031	-.032	-.038
	(27.0)	(27.0)	(21.5)	(31.3)
Unemployment rate	-0.036	-.036	-.031	-.023
	(16.6)	(18.4)	(13.6)	(11.0)
Proportion Imputed	-0.263	-.170	-.490	-.719
	(3.90)	(2.60)	(6.32)	(10.1)
Constant	4.362	4.805	4.841	5.16
	(453.1)	(338.8)	(245.1)	(281.2)
σ^2	.00097	.00083	.00120	.00104
	(53.7)	(52.6)	(54.2)	(54.7)

Table 4
Earnings Relative to the Normal Profile of Members of a Cohort on the Leading Edge of a Permanent and 10-yr Baby Boom

Years of Experience	High School Perm	High School 10-yr	College Perm	College 10-yr
1	-0.0137	-0.0137	-0.0319	-0.0319
2	-0.0136	-0.0136	-0.0312	-0.0312
3	-0.0134	-0.0134	-0.0305	-0.0305
4	-0.0132	-0.0132	-0.0297	-0.0297
5	-0.013	-0.013	-0.029	-0.029
6	-0.0127	-0.0127	-0.0282	-0.0282
7	-0.0124	-0.0124	-0.0274	-0.0274
8	-0.012	-0.012	-0.0266	-0.0266
9	-0.0117	-0.0117	-0.0258	-0.0258
10	-0.0113	-0.0113	-0.025	-0.025
15	-0.0092	-0.0113	-0.0207	-0.025
20	-0.007	-0.0113	-0.0164	-0.025
25	-0.0049	-0.0113	-0.012	-0.025
30	-0.0027	-0.0113	-0.0077	-0.025
35	-0.001	-0.0114	-0.0036	-0.025
40	0.0000	-0.0117	0.0000	-0.0252

Note: The own cohort size, complementarity index, and spline point for the complementarity index are -0.092, 0.00207, 11 and -0.217, 0.00114, 12.2 for high school graduates and college graduates, respectively. "Baby boom" are 15% larger than "normal" cohorts.

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