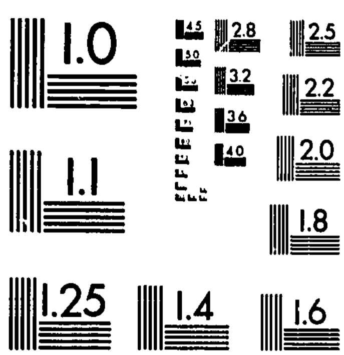

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ABSTRACT

This paper succinctly characterizes the profiles for time shifts in earnings and then focuses on the underlying determinants of the changes, in particular on the effect of cohort size. The data, drawn drom the March version of the Current Population Survey from 1968 to 1982, are described. The sample is limited to white men over the age of 14, and four educational categories are included: 8-11 years, high school graduates, 13-15 years, and college graduates. Following a presentation of the statistical methodology, the results of an interpretation of that method in an economic setting are described. Ten tables and nine figures illustrate results of the factor analyses that decomposed the earning profiles into time-specific and factor-specific effects. Variance profiles, factor profiles, elasticity of wages, and simulated wage profiles are provided. Appendixes, amounting to approximately three-fourths of the document, include a detailed analysis of the effects of cohort size (further results of the investigation reported in the main text), results concerning the determinants of college enrollments, and computation of wage elasticities. (YLB)

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COHORT SIZE AND EARNINGS

by

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1. INTRODUCTION

In the last fifteen years the structure of compensation in the labor market has shifted noticeably. As various authors have noted, wages of young workers relative to their middle-aged counterparts have decreased, and some have claimed that the relative wage of college graduates has decreased permanently. There remains considerable disagreement in the literature as to whether these shifts in the wage structure are permanent or temporary. In Figure 1, we have plotted the cross-sectional wage profile of college graduates in the years 1967 and 1977. These profiles demonstrate the empirical observation made above. In particular, notice the decline in wages for inexperienced workers over time, and the substantial increase for the prime aged workers. Figure 2 shows that this shift in the wage profile occurs among high school graduates as well. Furthermore, if we were to combine the two figures, one would notice a decline in the wage of college graduates relative to high school graduates. We illustrate this trend in Table 1 which shows the ratio of mean earnings of college graduates to mean earnings of high school graduates over the period 1967 to 1981. We exhibit this ratio for all workers, for workers with 1 to 10 years of experience and for workers with 11 to 20 years of experience. The steady decline in the relative earnings of college graduates through the 1970s leads Freeman[1] to claim that the American workforce is becoming overeducated.

Many attempts have been made to explain time series as those presented in Table 1 but there is no standard of analysis for characterizing the time series properties of the entire cross-section wage profile. Our purpose in this paper is twofold. First we want to develop a method of characterizing the changes in the wage structure succinctly, and then with that description in hand, we want to focus on the underlying determinants of those changes in particular on the effect of cohort size.

In previous work[2] we characterized earnings profiles as being generated by worker's progression from apprentice to journeyman in his profession. A worker of any given experience was viewed as a linear combination of learner and journeyman, and thus his wage rate was a linear combination of the marginal product of a worker and that of a journeyman. Here we attempt a more general specification, that does not rely on a particular functional form for the transition function from learner

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(1)Freeman, Richard B., <u>The Overeducated American</u>, (New York Academic Press, 1976).

(2)Welch, F., 'Effects of Cohort Size on Earnings: The Baby Boom Babies' Financial Bust,' <u>Journal of Political Economy</u>, vol. 87, no. 5, pt. 2 (October 1979).

TABLE 1

Ratio of Mean College Earnings to Mean High School Earnings

(Weekly Wages)

Year	All	1-10 years exp.	10-20 years exp.
1967	1.50	1.47	1.55
1968	1.48	1.48	1.51
1969	1.51	1.48	1.54
1970	1.53	1.50	1.57
1971	1.54	1.50	1.62
1972	1.52	1.47	1.61
1973	1.49	1.46	1.61
1974	1.48	1.44	1.53
1975	1.45	1.44	1.50
1976	1.43	1.40	1.48
1977	1.41	1.39	1.42
1978	1.40	1.40	1.42
1979	1.41	1.38	1.39
1980	1.44	1.41	1.45
1981	1.45	1.47	1.42

to journeyman ncr does it depend on a specific production technology. After we describe the data, we will present the statistical methodology and then return to the interpreuation of that method in an economic setting.

FIGURE 1

Weekly Wages of College Graduates in 1967 and 1977

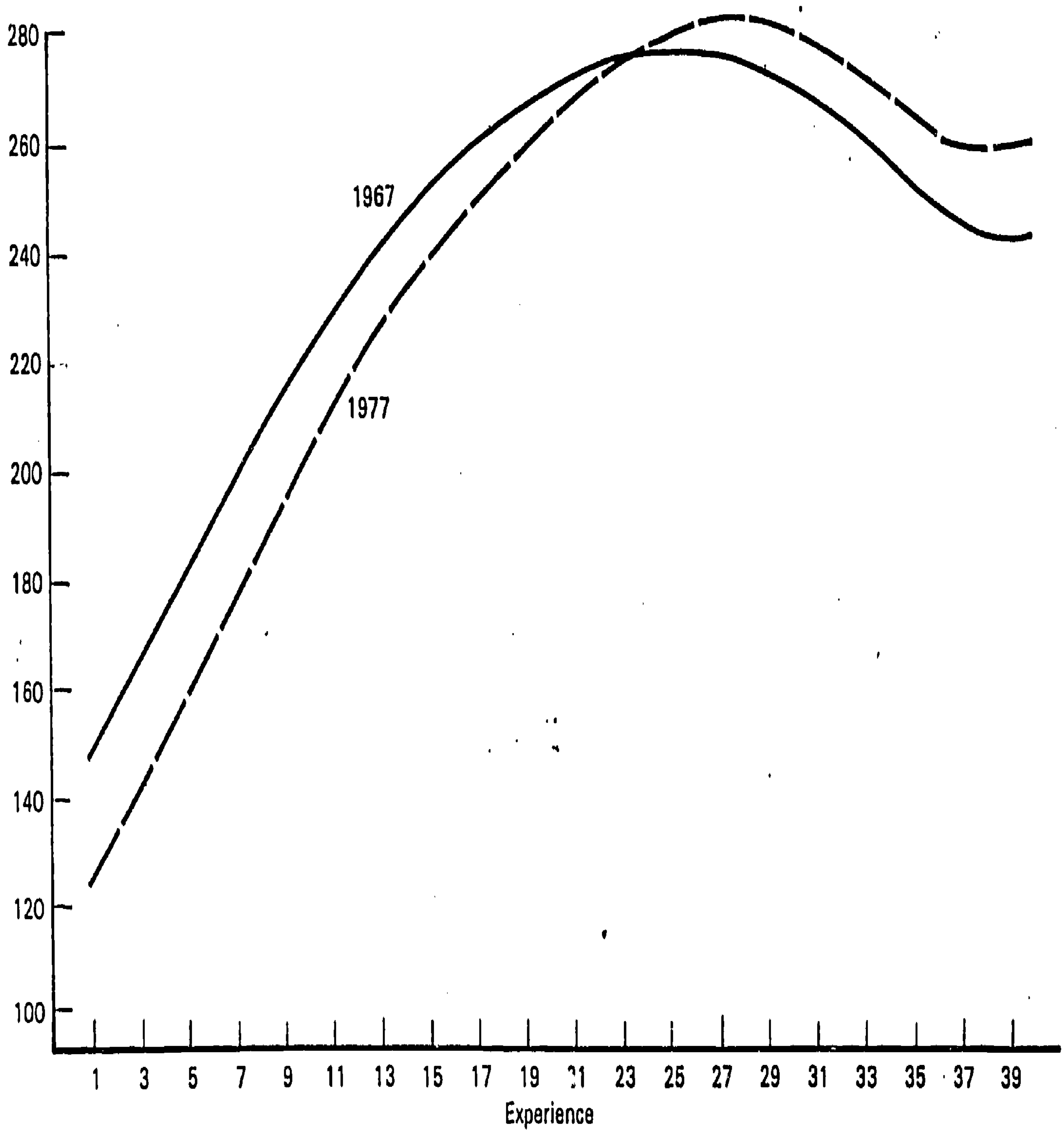

Figure 1: Weekly Wages of College Graduates in 1967 and 1977

FIGURE 2

Weekly Wages of High School Graduates in 1967 and 1977

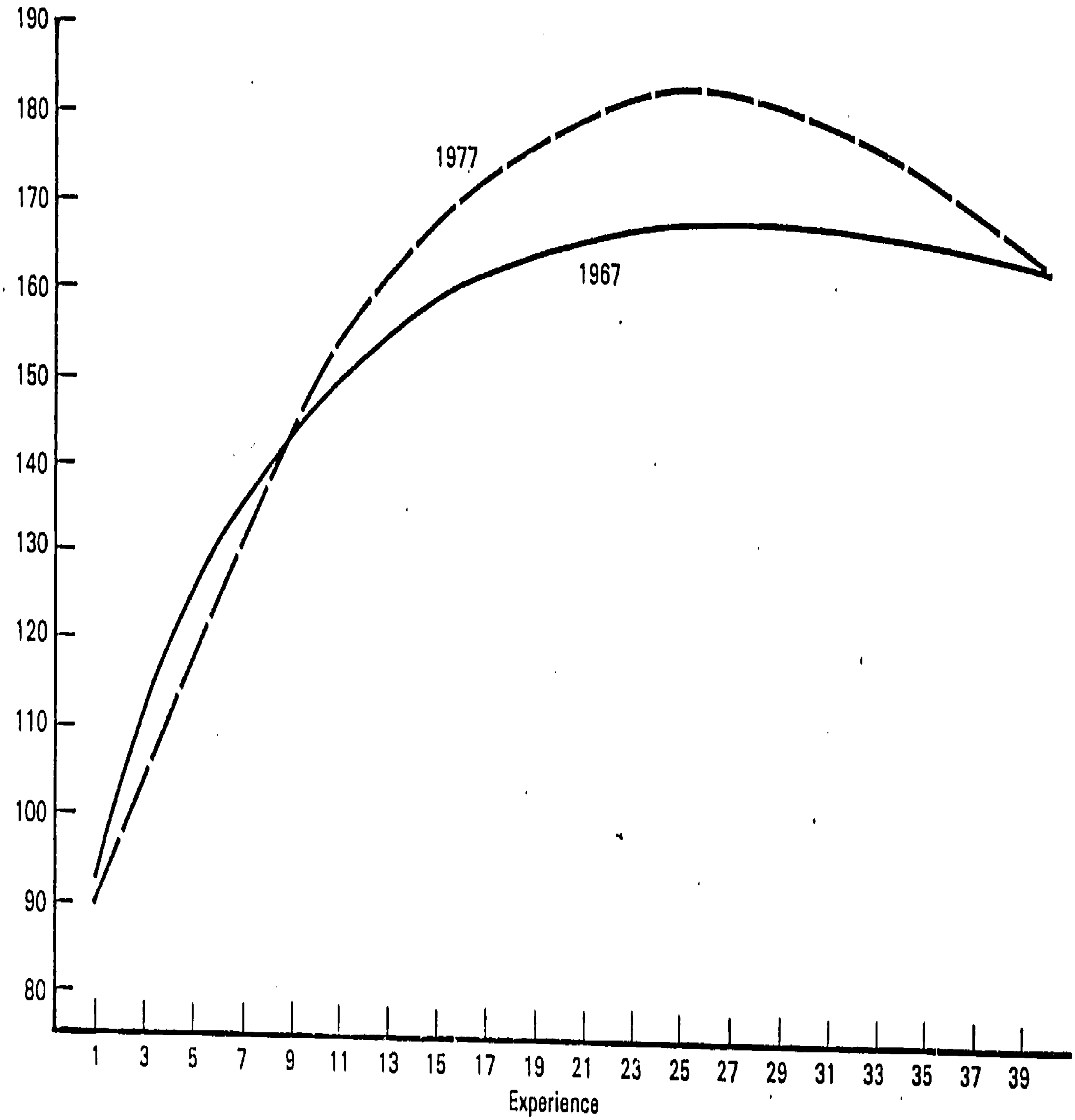

Figure 2: Weekly Wages of High School Graduates in 1967 and 1977

2. DATA DESCRIPTION

The data used in this study are drawn from the March version of the Current Population Survey from 1968 to 1982, and thus covers wage data from 1967 to 1981. We have restricted our sample to white men over the age of 14 who reported positive wage income in the year of interest. Because the sample sizes are so large in this time series of cross sectional surveys, we stratify our sample by education, experience and time, and use the mean of an education-experience cell at a given point of time as our unit of observation. The measurement of experience is not done in the standard way (Age minus Education minus 6) but instead we use a method proposed by Welch and Gould[3] and used previously by Welch[4] and Berger[5] which transforms a given age distribution of the sample into an experience distribution within education group by weighting each age cell by the probability that the age cell has a given level of experience and then summing over all ages. Thus in the end, we have 15 annual cross sections of data arrayed by experience and education. We group education into five categories: 0-7 years, 8-11 years, 12 years, 13-15 years and 16 years or more. The analyses reported here are for the latter four educational categories. We include only the the first forty years of experience in the sample. Beyond 40 years, the sample sizes are sufficiently small that the reported wages are subject to considerable sampling error. Thus our sample consists of 600 observations (40x15) for each of 4 educational levels. The measure of earnings used in weekly wages. Similar results were generated using annual earnings. We will next describe the statistical methodology for analyzing this data, and begin to describe the results of our analysis.

3. STATISTICAL METHODOLOGY

For a given level of schooling, let $y(i,t)$ denote the weekly wage of an individual with experience i in year t. We hypothesize that the wage us a weighted sum of M time varying components, denoted $w(m.t)$. The weights, $\lambda(i,m)$, represent the intensity of the m^{th} component of wages in a worker with i years of experience. Thus, $y(i,t) = \lambda(i,1)\ w(1,t) + \lambda(i,2)\ w(2,t) + \ldots + \lambda(i,M)\ w(M,t)$ for all $i = 1,\ldots,I$ and all $t = 1,\ldots,T$. Using matrix notation define

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(3) Wm. Gould, and Welch, F. 'An Experience Imputation or an Imputation Experience,' mimeograph, Rand Corp., 1976.

(4) Welch, F., 'Effects of Cohort Size on Earnings: The Baby Boom Babies' Financial Bust'.

(5) Berger, Mark C., 'The Effects of Cohort Size on Earnings Growth: A Reconsideration of the Evidence, ' University of Kentucky Working Paper No. E-60-83, 1983.

$Y = \left[y(i,t)\right]$, $L = \left[\lambda(i,m)\right]$ and $W = \left[w(m,t)\right]$,

and we can write the entire wage structure as:

$$Y = LW.$$

This is the basic form of the standard factor analysis model, where Y is observed, and the remaining components of the structure are to be estimated. The estimation of such models is the subject of a large literature, but we take a simple approach first proposed by Whittle[6] (1952). Assume the observed data is characterized by

$$Y = LW + U$$

where U is a matrix of error terms, and we choose L_{est} W_{est} to minimize the size of squared prediction errors :

$$\text{trace } (Y - L_{est}W_{est})\ (Y - L_{est}W_{est})',$$

and then we define the predicted wage profiles as

$$Y_{est} = L_{est}W_{est}$$

with residual sum of squared errors

$$\text{trace } (Y - LW)\ (Y - L_{est}W_{est})'$$

Clearly, the decomposition of the observed data, Y, into the factor loadings L and factors W is not unique. In particular given any non-singular matrix A of dimension M, we can decompose the predicted profiles in an alternate manner as

$$Y = (LA^{-1})\ (AW) = L^{*}W^{*}$$

and thus for M factors, M-squared normalizations are required. Much of the factor analysis literature is devoted to the meaningful scaling of

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(6) Whittle, P., 'On Principal Components and Least Squared Methods of Factor Analysis,' Skandinavisk Aktuarietidskript, (1952), 223-239.

the various components of the observed data. However, no matter what normalization is chosen, for a given M the predicted wage profiles, Y_{est}, will be the same. As Whittles shows, if we impose the normalizations that

$$L'L = ID$$

where I is the number of observations within a year and D is an M dimension identity matrix, then the m^{th} vector of factor loadings $\lambda(.,m)$ is the eigenvector of YY m^{th} largest eigenvalue normalized so that

$$\sum_{i} \lambda(1,m)^2 = I$$

The m^{th} vector of factors $w(m,.)$ is the eigenvector of Y'Y corresponding to the m^{th} largest eigenvalue, $e(m)$, normalized so that

$$\sum_{t} w(m,t)^2 = e(m)/I.$$

Thus, to minimize (1) we need only to decompose Y into the product of the appropriately normalized matrices of eigenvectors of YY' and Y'Y. Whittle demonstrates further that the reduction in residual sum of squares due to the introduction of M common factor is

$$\sum_{m=1}^{M} e(m)$$

where $e(m)$ denotes the m^{th} largest eigenvalue. Thus the total sum of square is

$$\sum_{m=1}^{T} e(m)$$

and the standard goodness of fit measures for M factors is

$$R^2 = \frac{\sum_{m=1}^{M} e(m)}{\sum_{m=1}^{T} e(m)}.$$

4. EMPIRICAL RESULTS

The statistical methodology described in the previous section gives us an empirically tractable way of decomposing wage profiles over time into sums of 'prices' of factors of production multiplied by 'quantities' of those factors, the prime varying over time and the 'quantities' varying over the worker's career. The difficulty comes in interpreting the arithmetical results of this decomposition in economic terms, with no explicit model of productive activity to guide us. However, careful examination of the results of the decomposition lead us to a natural economic interpretation. We first consider the case of one factor. That is, we initially estimate the wage profiles when M=1, so:

$$y(i,t) = \lambda(i,1)\ m(1,t).$$

For this simple model we need only one normalization, and we assume that the mean factor intensity across years of experience is 1:

$$\sum_{i=1}^{I} \frac{\lambda(i,1)}{I} = 1.$$

The estimated profile of wages using the one factor scheme is:

$$y(i,t) = \lambda(i,1)\ w(1,t).$$

Summing over years of experience (i) and dividing by I we find that

$$\begin{aligned}\overline{y(.,t)} &= \frac{1}{I}\sum_{i} \lambda(i,1)\ w(1,t)\\ &= w(1,t)\end{aligned}$$

and summing over years (t), we see that

$$\overline{y(i,.)} = \lambda(i,1)\ \overline{w(1,.)}\ .$$

Thus the first factor for the t^{th} year is simply the mean of fitted wage across all experience levels, and the mean wage profile is equal to the factor loadings multiplied by the mean factor. Including only one factor allows us to describe the mean shape of the wage profile across all the years in the sample. If we normalize the mean wage to 1 then the $\lambda(1,i)$ trace out this profile. Variations in the factors $w(1,t)$ simply shift this profile up or down, equiproportionately without changing the basic shape. The $w(1,t)$ can be interpreted as the year-specific change in the reference profile traced by $\lambda(i,t)$.

In Figure 3 we plot the one factor wage profiles for each of the four schooling groups, which are the reference profiles, $\lambda(1,i)$, multiplied by the mean estimated wage within education level. Numerous paper have been written about the economic determinants of the shape of these standard profiles and individual variations about them (see, for example, Mincer[7]). Except for the cohort size literature, little has been written however about changes through time in these profiles. To allow for a shift in relative wages between experience levels over time, it is necessary to increase the number of factors used to explain the data. Consider the two factor model with the normalization that the factor loadings have a mean of one and the factors are orthogonal. The fitted wage profiles are

$$y(i,t) = \lambda(i,1)\ w(1,t) + \lambda(i,2)\ w(2,t) \qquad (2)$$

Manipulating equation (2) in the appropriate manner we find that

$$\overline{y(.,t)} - w(1,t) = w(2,t)$$

and

$$\overline{y(t,.)} - \lambda(i,1)\ \overline{w(1,.)} = - \lambda(i,2)\ \overline{w(2,.)}$$

The first of these equations states that the second factor in year t is equal to the within year mean deviation of the fitted values from the first factor. The second equation shows that the second factor loading then amplifies this discrepancy differentially across experience levels, Thus, the profiles are allowed to change shape, as well as move up or down.

In Figure 4 we have illustrated the effects of pattern of the second and third factors that compose the predicted wage profiles for high school graduates. The first factor load $\lambda(i,1)$, denoted by '1',

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(7)Mincer, J., <u>Schooling Experience and Earnings</u>, (NBER, 1974).

FIGURE 3

One Factor Wage Profiles

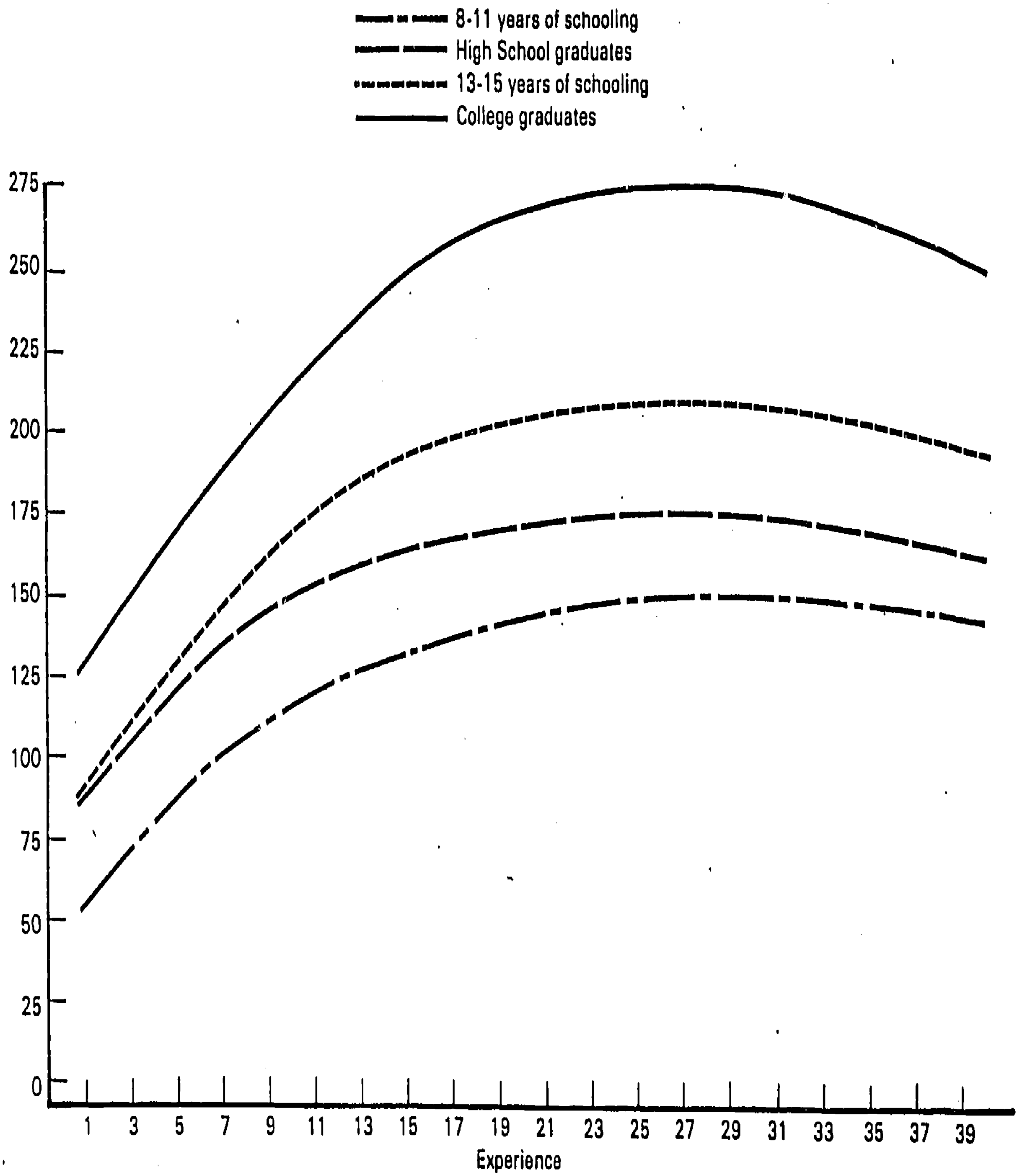

Figure 3: One Factor Wage Profiles

FIGURE 4

First Three Factors of Decomposition
(Units of Measurement are Standard Deviations from Mean of Factor)

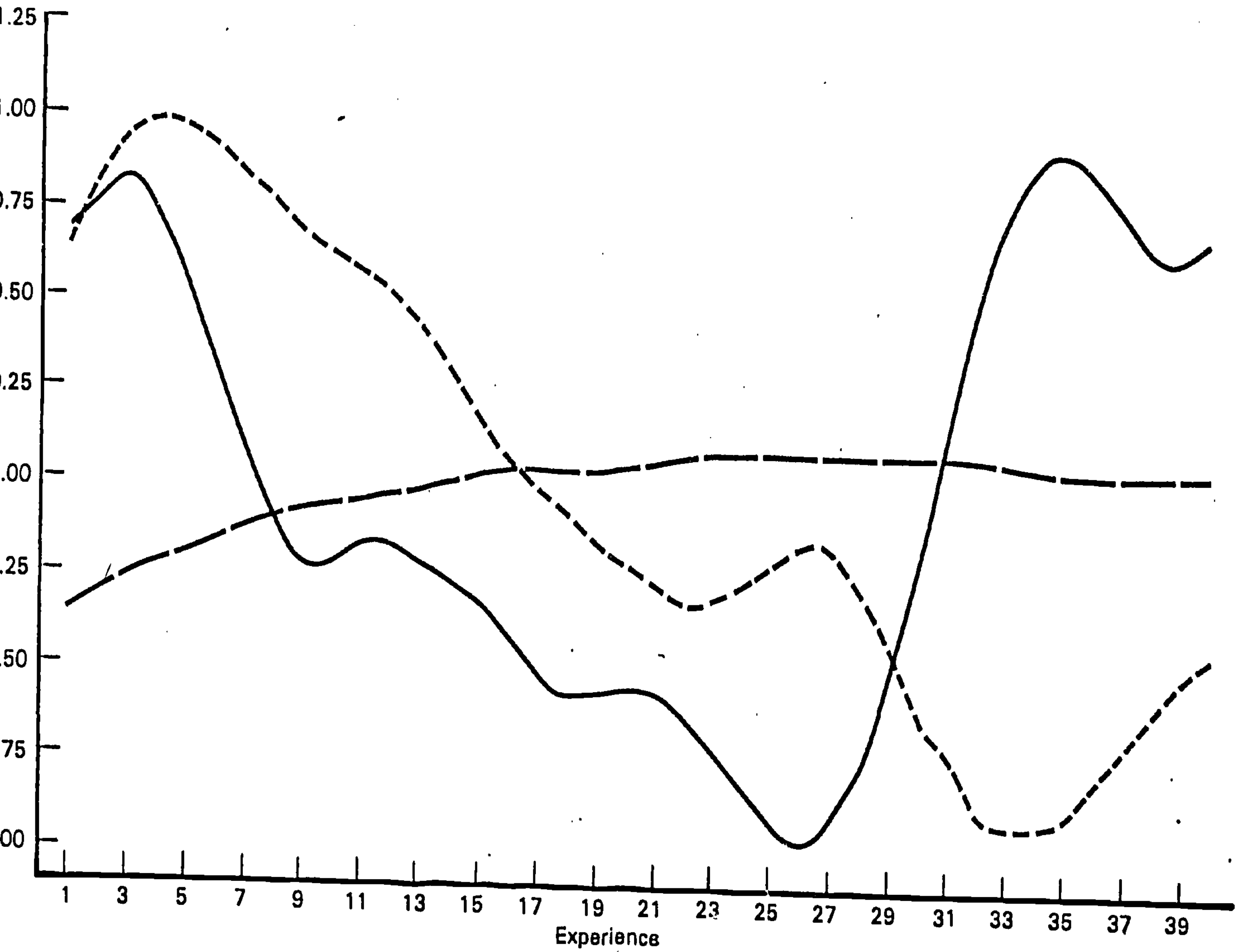

Figure 4: First Three Factors of Decomposition

FIGURE 5

Predicted Wage Profiles

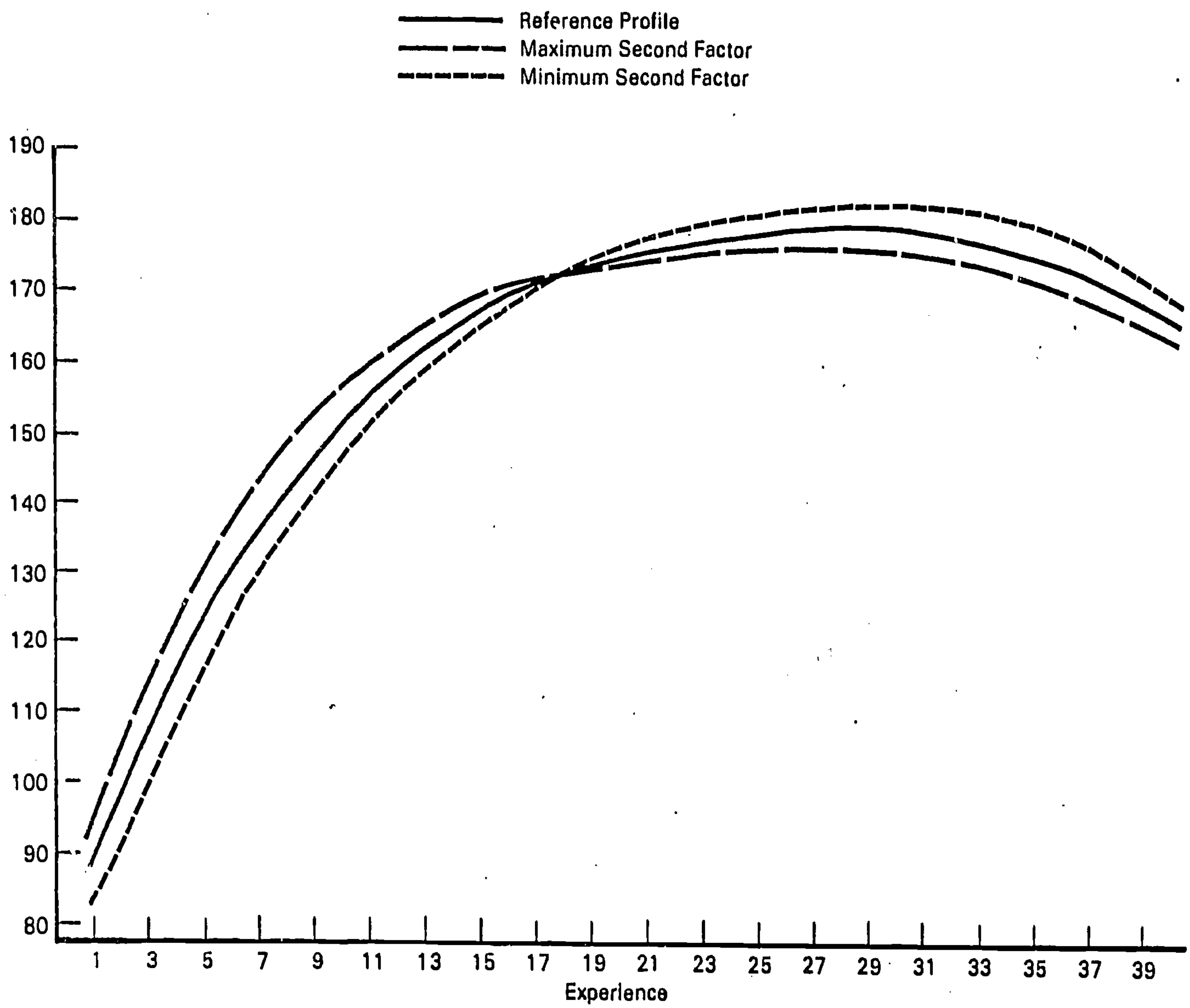

Figure 5: Predicted Wage Profiles

traces the mean profile for high school graduates. The second factor load, $\lambda(i,2)$ is plotted with '2', and the third, $\lambda(i,3)$, with '3'. The loads are rescaled in standard deviations from mean. This second and third factor loads are weighted by $w(2,t)$ and $w(3,t)$ for each year and then added to $\lambda(i,1)$ $w(1,t)$ to trace out the t^{th} year profile. In Figure 5 we have plotted two profiles using two factors, one for both the minimum and maximum factor value $w(2,t)$ and the reference profile. Note that this second factor introduces variance at the extreme experience levels rather than at the mid-career levels. Higher order factors have the ability to focus variation in the wage profiles in localized areas, until 15 factors are included at which time each profile is fit perfectly by the data. The natural question is how localized is the variation in the wage profiles over time, and how many factors are needed to summarize the changes in the profiles.

We approach this question by doing some simple variance accounting within experience levels, In Figure 6 we have plotted the residual variance in wages after each of the first five factors is introduced sequentially. Thus the uppermost line represents the mean squared error of estimation within each year of experience across the 15 years of the sample, when a one factor scheme is used to fit the data. This shows clearly that most of the variation in the data is at either extreme of the worker's career. The line beneath is the plot of mean squared errors when two factors are included in the analysis. The variance of the prediction error is reduced substantially especially at low and high levels of experience. The introduction of the third factor reduces the residual variance substantially, and the remaining factors do little to explain the initial variance in the data. This plot illustrates that the variation in wage profiles over time is concentrated in the early and late stages of the career, and that a three factor model explains a substantial portion of that variation. Visual inspection seems an inadequate way of gauging the importance of each factor, so we have also characterized the contribution of each factor by a partial R-squared method. Recall that the first factor accounts for the parallel shift in the mean profiles and is thus finding in the data the year specific effects. In constructing the data we deflated reported wages by the Consumer Price Index, and to the extent that the index is the incorrect deflater, business cycle effect may still remain in the data. Thus we expect the first factor to explain a good portion of variation in the data, and want to measure the importance of including additional factors based on the amount of the residual variance explained after the first factor is included. In Table 2 we exhibit these R-squared measures for the second through fourteenth factor for each of the four educational levels. Consider high school graduates. The first factor explains 99.9% of the variance in the profiles over time. The second factor explains 63.3% of the residual variance. The third factor raises this figure to 77.4% and by the time the sixth factor is included, 95.1% of the residual variance is explained. As can be seen from Table 2, for three of the four groups, at least 75% of the residual variance is explained by the addition of a second and third factor. The exception are those who graduate from high school, completed one or more years of college but did not complete their college careers.

FIGURE 6

Residual Variance After

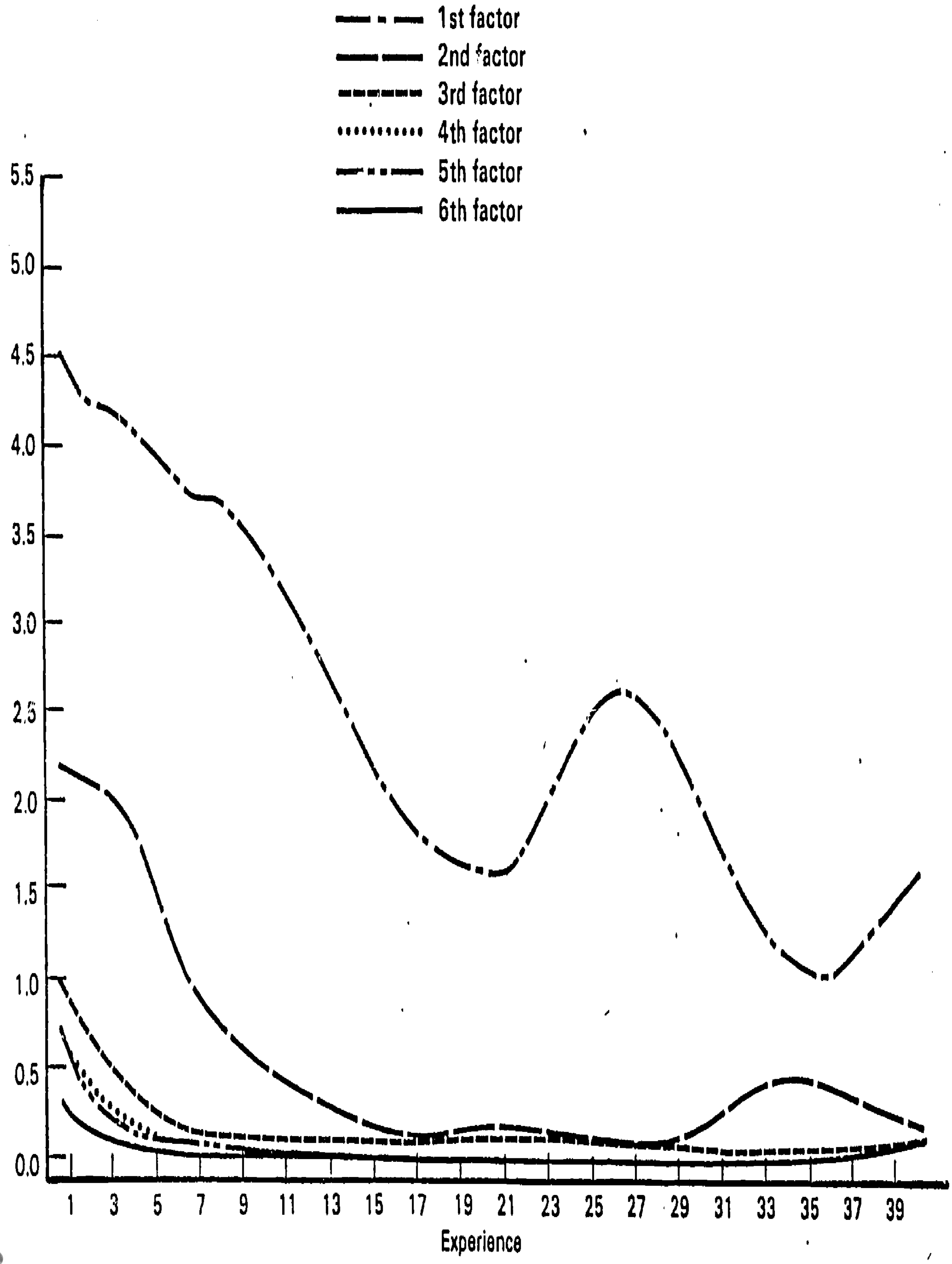

Figure 6: Residual Variance

TABLE 2

Fraction of Variance Explained by Factor Decomposition

Numbers of Factors	8-11 Years (a)	8-11 Years (b)	High School Graduates (a)	High School Graduates (b)	13-15 Years (a)	13-15 Years (b)	College Graduates (a)	College Graduates (b)
1	0.998		0.999		0.999		0.999	
2	0.999	0.638	0.999	0.633	0.999	0.479	0.999	0.535
3	0.999	0.813	0.999	0.774	0.999	0.692	0.999	0.809
4	0.999	0.871	0.999	0.864	0.999	0.811	0.999	0.924
5	0.999	0.923	0.999	0.910	0.999	0.904	0.999	0.965
6	0.999	0.950	0.999	0.951	0.999	0.947	0.999	0.976
7	0.999	0.974	0.999	0.972	0.999	0.979	0.999	0.985
8	0.999	0.985	1.000	0.989	1.000	0.993	0.999	0.991
9	0.999	0.992	1.000	0.994	1.000	0.997	1.000	0.995
10	1.000	0.995	1.000	0.997	1.000	0.999	1.000	0.997
11	1.000	0.997	1.000	0.998	1.000	0.999	1.000	0.998
12	1.000	0.998	1.000	0.999	1.000	0.999	1.000	0.999
13	1.000	0.999	1.000	0.999	1.000	0.999	1.000	0.999
14	1.000	0.999	1.000	0.999	1.000	0.999	1.000	0.999

(a) Fractions of variance explained.

(b) Fractions of residual variance explained after 1 factor included.

The factor analyses reported thus far were done separately for educational groups, but the similarity in variance profiles for the groups, and the fact that most variation in wages can be explained by three factors raises the question whether the determinants of the shifts in wage profiles are correlated across educational levels. To gauge this correlation we computed the difference between the one-factor reference profile and the three factor predicted profile. For each level of experience we then computed the pairwise correlation coefficients between schooling groups, across the fifteen years of the sample. In Table 3 we present the mean correlation for experience levels 0 and 5, between the various schooling levels. These correlation coefficients are reasonably high indicating that in fact the wage profiles, at least at low experience levels fluctuate away from the reference profile in a similar manner.

The preponderance of descriptive evidence offered by this decomposition of the cross sectional wage profiles suggests that across schooling classes, over the fifteen years in question profiles shifted in a similar manner. Although this factor decomposition provides a useful manner of summarizing the observed data, it alone cannot provide a cogent explanation of why the profiles shift as they do. In Table 4 we show the time profile of the three factor wage profile shifts away from the ref-

TABLE 3

Mean Correlation of Three Factor Profile Deviations From Reference Profile

For 0 to 5 Years of Experience

Education Level	High School Graduate	13-15	College Graduate
8-11	0.872	0.644	0.761
High School Graduate		0.819	0.791
13-15			0.676

erence one-factor profile for high school and college graduates of various experience levels. As is evident from this table, the early years of the sample (1967 to 1971) were favorable years for young, inexperienced workers, less favorable for mid-career workers, and favorable for older workers. That is, when viewed across experience levels, the early data show profiles that are less concave than those found later. In the mid-1970s, the younger worker's relatively high wages, and the older workers were mimicking the younger workers. Given the changing labor force composition of that period of time and our previous work, it is natural to consider the possibility of cohort size affecting the cross sectional profiles. We assume that the three factors loadings $\lambda(i,1)$, $\lambda(i,2)$ and $\lambda(i,3)$ represent the intensity of an individual worker in one of the three productive activities, and the wages $w(1,t)$, $w(2,t)$ and $w(3,t)$ are the marginal products of one unit of these productive activities in a given year. Thus the wage of the worker is a weighted sum of the three marginal products, the weights being the factor loadings. In any given year we can compute the aggregate number of units of any of the three basic factors production by summing across all experience levels the number of workers at each level multiplied by the factor intensity for that level. Letting $n(m,t)$ denote the total number of workers engaged in activity m in year t, we have that

$$n(m,t) = \sum_{i=1}^{I} \lambda(i,m)\, p(i,t) \quad \text{for } m = 1,2,3, \text{ and } t = 1,\ldots,15$$

Here $p(i,t)$ is the total population, within the relevant schooling group, with i years of experience in calendar year t. The cohort size question in this model is simply whether $n(m,t)$ affects $w(1,t)$, $w(2,t)$, $w(3,t)$. If we think of production as using these three basic factors, then the marginal product of each will be related to the amount of the other factors. Since factor intensities vary over the working life, varying cohort size will result in varying marginal products of those factors.

TABLE 4

Deivations of Three-Factor Wage Profile From One-Factor Reference Profile

	High School Graduates				College Graduates			
	Years of Experience							
Calendar Year	0	5	15	30	0	5	15	30
1967	6.78	6.53	-0.72	-2.47	7.72	11.26	4.02	-8.62
1968	5.27	6.62	0.72	-3.84	12.12	15.30	2.66	-10.73
1969	5.34	6.88	0.87	-4.10	14.37	11.88	-6.40	-5.34
1970	1.21	3.43	1.75	-3.25	8.85	9.62	-0.42	-6.01
1971	0.37	1.17	0.64	-1.14	1.22	4.32	4.21	-4.35
1972	-0.61	0.22	0.75	-0.78	-3.01	1.71	7.52	-3.84
1973	-1.89	-1.90	0.14	0.78	1.26	1.50	0.07	-1.01
1974	-0.45	-0.52	-0.03	0.28	-8.42	-9.52	0.27	6.15
1975	-1.34	-1.36	0.91	0.57	-5.43	-4.15	2.94	1.62
1976	-1.94	-2.37	-0.20	1.33	-10.91	-10.35	2.82	5.62
1977	-3.32	-2.63	0.82	0.51	-6.65	-9.45	-3.08	7.13
1978	-2.35	-4.18	-1.33	3.22	-3.46	-7.11	-4.95	6.30
1979	-0.68	-1.12	-0.31	0.82	-5.45	-8.75	-4.04	7.02
1980	-1.72	-4.48	-2.17	4.13	-4.28	-7.22	-3.72	5.94
1981	-4.96	-7.11	-1.41	4.70	-0.18	-2.69	-3.80	3.07

To see if such a relationship exists, indeed if the interpretation of this factor analytic decomposition can be interpreted in as a model of production, we analyzed the generated marginal product profiles $w(1,t)$, $w(2,t)$ and $w(3,t)$ over the fifteen years of the sample. Because $w(1,t)$ is basically a wage index that nets out business cycle effects, rather than doing direct regressions of the marginal product on the number of units of each factor, we regressed relative to the first factor.

Thus we estimated:

$$\frac{w(2,t)}{w(1,t)} = a_0 + a_1 \frac{n(2,t)}{n(1,t)} +$$

$$a_2 \frac{n(3,t)}{n(1,t)} + u(t)$$

and

$$\frac{w(3,t)}{w(1,t)} = b_0 + b_1 \frac{n(2,t)}{n(1,t)} +$$

$$b_2 \frac{n(3,t)}{n(1,t)} + v(t)$$

The results of those regressions are shown in Table 5 for all four education levels. The own coefficients are strongly negative, but generally not symmetric. In particular, the third factor generally has a strong negative effect on the second, but not vice-versa. We interpret this as being strong evidence that in fact the cohort size interpretation of this model is valid.

If we take the estimated equations as the actual relationships between factor ratios and relative wages we can compute the elasticities of the wage of a worker at a given experience level with respect to a change in the number of workers at any other given experience level (for computation formulas see Appendix C). In Table 6 we exhibit the own elasticities evaluated at the mean wage and mean number of workers at various experience levels for all four education levels. As can be seen, the own effects are much more pronounced for both older and younger workers, with the younger workers having a strong effect. We plot the own wage elasticity for college graduates over the working life in Figure 7. This pattern of elasticities is typical as can bee seen from Table 6 The implications of this pattern of elasticities is that the wage depressive effect of cohort size are concentrated at the beginning and end of the life cycle, and dissipate substantially during the midstages of the career. This confirms our earlier findings[8] that cohort size effects are short-lived, with which Berger[9] has disagreed. In Table 7 we show the cross elasticity of wages in various experience levels with the size of the first year cohort. The cross elasticity pattern for college graduates is plotted in Figure 8. For early years of the working life, this elasticity is negative, increases until it becomes zero around the tenth year of experience, remains positive until about the thirtieth year of experience at which point there is a decline

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(8)Welch, F., 'Effects of Cohort Size on Earnings: The Baby Boom Babies' Financial Bust'.

(9)Berger, Mark C., 'The Effect of Cohort Size on Earnings Growth: A Reconsideration of the Evidence'.

FIGURE 7

**Elasticity of Wages With Respect to Own Cohort Size—
College Graduates**

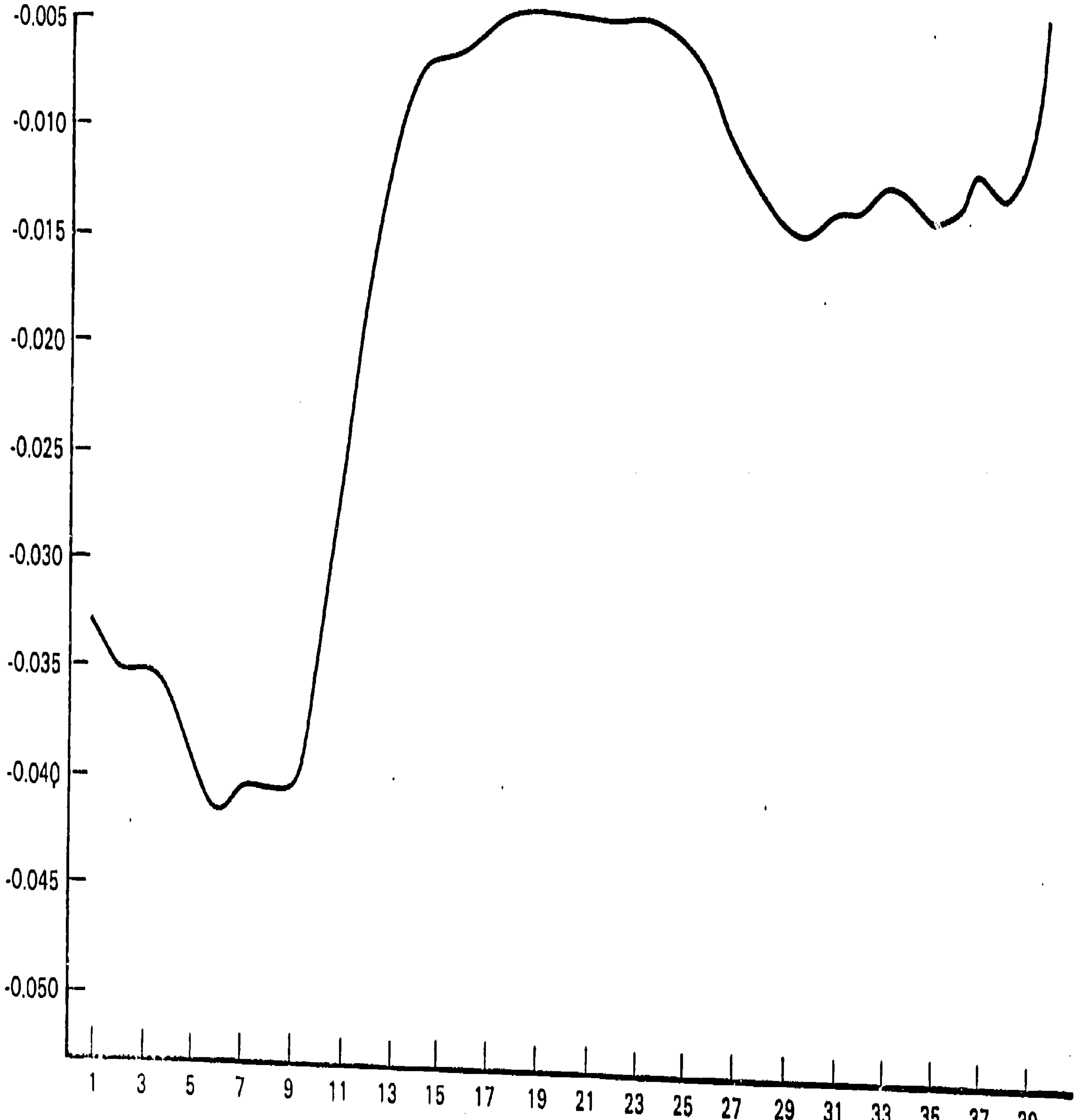

Figure 7: Elasiticty of Wages With Respect to Own Cohort Size

FIGURE 8

Elasticity of Wages With Respect to Size of Youngest Cohort—College Graduates

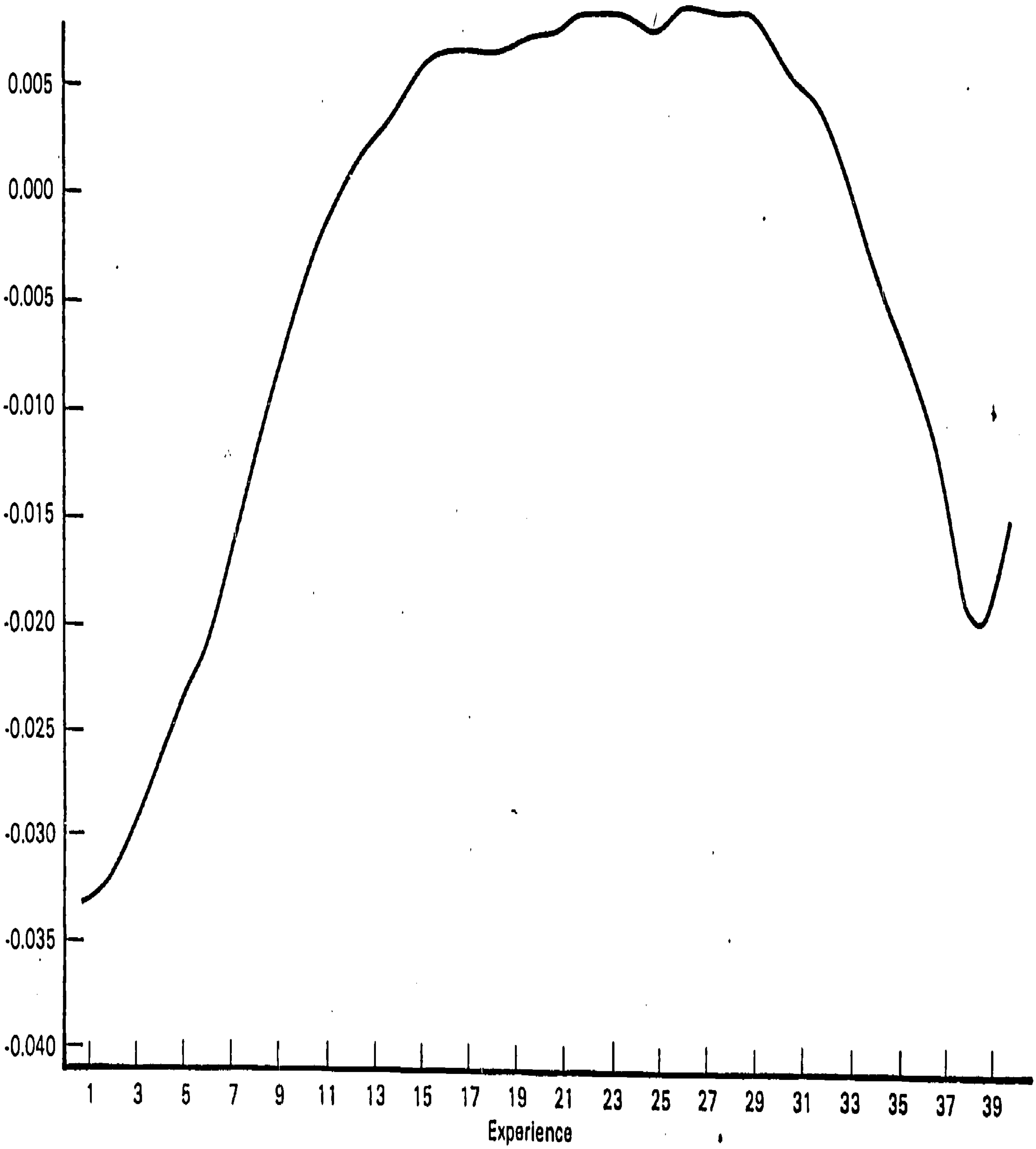

Figure 8: Elasiticty of Wages With Respect to Size of Youngest Cohort

TABLE 5

Regressions of Relative Factor Marginal Products On Relative Cohort Size

	Educational Level			
	8-11	12	13-15	16 +
W2/W1 on				
Constant	0.00293	0.00818	0.0124	0.0456
	(0.00129)	(0.00187)	(0.00456)	(0.0140)
N2/N1	-0.00365	-0.00201	-0.00227	-0.00946
	(0.00123)	(0.000653)	(0.00114)	(0.00290)
N3/N1	-0.000863	-0.000352	-0.000435	0.00230
	(0.00129)	(0.000488)	(0.000735)	(0.00182)
R Squared	0.898	0.8479	0.585	0.666
W3/W1 on				
Constant	0.00425	0.00211	0.000256	-0.00434
	(0.00171)	(0.0010)	(0.00316)	(0.00767)
N2/N1	0.00395	0.000851	0.0000466	0.000904
	(0.00162)	(0.000365)	(0.000796)	(0.00159)
N3/N1	-0.00435	-0.000729	-0.000199	-0.00146
	(0.00171)	(0.000272)	(0.000509)	(0.000995)
R Squared	0.353	0.374	0.027	0.296

Note: n = 15 for all regressions, Based on decomposition of weekly wages. Standard errors in parentheses.

below zero. This graph illustrates our basic premise about a worker's career. Workers of adjacent years are good substitutes, young workers complements with middle aged workers, and substitutes with older workers. Thus we picture a career as being a simultaneous process of growth of human capital and decay of that capital, with the growth dominating in in the early years and decay dominating later. The influx of large cohorts will initially depress the wages of young and old workers, and as those workers are absorbed into the labor force the depressive effects of large cohorts diminish.

To illustrate the results of our analysis in a more intuitive way we ran some simulations of increasing cohort size on the lifetime wage pro-

TABLE 6

Own Wage Elasticities*

Years of Experience	8-11 Years	High School Graduates	13-15 Years	College Graduates
	Education Level			
0	-0.0623	-0.0237	-0.0186	-0.0331
4	-0.0124	-0.0199	-0.0220	-0.0391
8	-0.0059	-0.0064	-0.0077	-0.0395
12	-0.0097	-0.0014	-0.0000	-0.0119
16	-0.0125	-0.0012	-0.0006	-0.0051
20	-0.0119	-0.0017	-0.0007	-0.0037
24	-0.0078	-0.0044	0.0003	-0.0045
28	-0.0044	-0.0021	0.0000	-0.0135
32	-0.0124	-0.0113	-0.0036	-0.0125
36	-0.0188	-0.0086	-0.0058	-0.0111

* Based on Regression Results of Decomposition of Weekly Earnings

files of a worker using the results for college educated workers. We began by assuming a steady state distribution of the population equal to the distribution in 1968. We then introduce the first year of a baby boom by assuming a growth in the number of first year workers of 2%. With this new population distribution, we compute the number of each productive factor in the work force, computed the resultant marginal products from the wage regression estimates in Table 5 and then computed the cross-sectional wage profile. The following year we aged the first year cohort one year by assuming the reference second year cohort increased by 2%, and introduced a new first year cohort 4% larger than the steady state. We increased the percentage growth in the number of first year workers for five years at a rate of 2% per year, then diminished the growth percentage by 2% per year for four years. Thus the simulated baby boom is nine years long and shaped like an inverted V, increasing population by 10% during the fifth year of the boom, with the percentage increases diminishing by 2% per year away from the peak. We passed the nine year bulge through the working population and generated the resulting wage profiles for workers of various years of birth. In Table 8 we show several lifetime profiles, In column 1, we present the profile of the worker in this steady state population. We have normalized the wage profile by assuming that the marginal product of the first factor is one. In so doing, we ignore the possibility that the simulated baby boom can affect the average compensation of labor. Estimation of these effects would require a very different model from the one estimated and is beyond the scope of this paper. We assume the main profile is stable and fluctuations in the age distribution of the population only affect

TABLE 7

Cross Elasticities of Wages With Respect to Size Of The First Year Cohort

	Education Level			
Years of Experience	8-11 Years	High School Graduates	13-15 Years	College Graduates
0	-0.0623	-0.0237	-0.0186	-0.0331
4	-0.0257	-0.0217	-0.0173	-0.0234
8	-0.0183	-0.0102	-0.0111	-0.0079
12	-0.0086	-0.0058	-0.0039	-0.0029
16	-0.0040	-0.0011	-0.0005	-0.0069
20	-0.0098	-0.0046	-0.0011	-0.0078
24	-0.0127	-0.0054	0.0038	-0.0083
28	-0.0066	-0.0060	0.0002	-0.0089
32	-0.0018	-0.0060	-0.0110	-0.0021
36	-0.0004	-0.0031	-0.0111	-0.0012

'prices' of the second and third factors of production. In column 2, we show the wage pattern of a worker born five years before the baby boom. Column 3 is the profile of a worker born in the first year of the boom. Column 4 shows the profile of a worker born in the peak year of the boom, column 5, the profile of a worker born in the final year. Finally, column 6 shows the profile of a worker born five years after the boom. To get a better idea of how increases in cohort size shift profiles away from the steady state, we present in Table 9 the ration of wages of the various birth years presented in Table 8 to the steady state profile. There are several characteristics of Table 9 worth noting. First, members of the baby boom initially have wages that are 2-3% lower than young workers in the steady state. Their wage profiles are steeper than the steady state profile, so that wages are as much as 1% higher in the middle years of the working life. Secondly, the impact of the increase in cohort size is felt most severely by workers born late in the baby boom. Even for workers born five years after the baby boom, the initial wage is 3% lower than in the steady state, and although the wage profile is relatively steep, the gains are small and brief. These workers, when young, are very good substitutes for their slightly older peers and thus they reap the rewards of being a scarce fact of production.

To evaluate the lifetime effects of the increase in cohort size more succinctly, we need to calculate the present value of lifetime earnings streams. In Table 10 we present the ratio of the present value of lifetime earnings for various cohorts to the present value of the steady-

TABLE 8

Simulated Wage Profiles Assuming Nine Year Baby Boom

	Steady State	Born 5 Years Before	Born 1st Year	Born Peak Year	Born Last Year	Born 5 Years After
1	0.579	0.579	0.579	0.573	0.564	0.562
2	0.623	0.623	0.622	0.615	0.606	0.608
3	0.665	0.665	0.663	0.654	0.647	0.653
4	0.703	0.703	0.699	0.691	0.686	0.695
5	0.740	0.740	0.735	0.728	0.726	0.736
6	0.776	0.776	0.770	0.765	0.766	0.775
7	0.809	0.808	0.802	0.800	0.804	0.810
8	0.837	0.836	0.832	0.834	0.837	0.839
9	0.865	0.864	0.863	0.867	0.868	0.868
10	0.894	0.893	0.896	0.900	0.898	0.896
11	0.923	0.923	0.929	0.931	0.927	0.924
12	0.951	0.953	0.960	0.959	0.954	0.951
13	0.977	0.981	0.988	0.985	0.980	0.975
14	1.002	1.009	1.013	1.008	1.003	0.998
15	1.024	1.034	1.036	1.029	1.024	1.019
16	1.043	1.056	1.054	1.047	1.042	1.037
17	1.060	1.073	1.068	1.062	1.058	1.052
18	1.073	1.087	1.080	1.074	1.070	1.064
19	1.084	1.097	1.088	1.083	1.079	1.074
20	1.092	1.105	1.095	1.081	1.086	1.082
21	1.101	1.112	1.102	1.098	1.093	1.090
22	1.109	1.117	1.109	1.105	1.100	1.098
23	1.115	1.121	1.114	1.110	1.106	1.106
24	1.122	1.125	1.120	1.116	1.113	1.113
25	1.126	1.128	1.124	1.120	1.118	1.120
26	1.129	1.129	1.126	1.123	1.122	1.124
27	1.130	1.129	1.126	1.123	1.123	1.125
28	1.130	1.128	1.126	1.124	1.125	1.127

(Continued)

TABLE 8

Simulated Wage Profiles Assuming Nine Year Baby Boom
(Continued)

	Steady State	Born 5 Years Before	Born 1st Year	Born Peak Year	Born Last Year	Born 5 Years After
29	1.129	1.127	1.125	1.124	1.125	1.128
30	1.130	1.128	1.127	1.127	1.128	1.130
31	1.128	1.126	1.126	1.126	1.127	1.128
32	1.123	1.123	1.124	1.125	1.125	1.124
33	1.124	1.125	1.128	1.128	1.127	1.125
34	1.124	1.129	1.132	1.131	1.129	1.124
35	1.117	1.126	1.129	1.127	1.122	1.118
36	1.113	1.125	1.127	1.124	1.117	1.113
37	1.115	1.133	1.133	1.127	1.119	1.115
38	1.118	1.143	1.140	1.131	1.121	1.118
39	1.110	1.136	1.132	1.121	1.112	1.110
40	1.090	1.109	1.104	1.095	1.090	1.090

state earnings stream. We assume a 5% rate of discount. Column 1 presents the birth year, year 1 being the first year of the simulated baby boom. The relative present value is presented in column 2. We have plotted a complete set of these relative present values in Figure 9. This figure illustrates the intergenerational effects of the baby-boom. When the baby boom enters the labor market, workers born in or before year -30 are in the last ten years of their working life. The impact on that generation of workers is to lower the present value of thier lifetime earnings, since as we saw before, older workers and younger workers appear as substitutes in production. Those who are in the middle of their career when the baby boom enters (birth -10 to -20), show an increase in lifetime earnings, essentially because they are complementary factors of production to the large cohorts of new entrants. The workers born in and around the baby boom are most severely hurt by the large cohorts, although the depression in lifetime income is less than 1%. Earnings then climb for those born after the baby boom, because there will be a relatively scarce source of new entrants when the baby boom babies are prime aged workers. After peaking out at roughly .4% above steady state levels, the present value of lifetime earnings return to normal as the baby boom ages and leaves the workforce. The effects of the baby boom are very small, but this is a short lived increase in cohort size. In Appendix A, we present the results of a 31 year baby boom, with a maximum increase in cohort size of 39%. In these simulations earnings are changed by as much as 5%.

TABLE 9

Simulated Wage Profiles Relative to Steady State Profile

	Born 5 Years Before	Born 1st Year	Born Peak Year	Born Last Year	Born 5 Years After
1	1.000	0.999	0.990	0.974	0.971
2	1.000	0.998	0.986	0.972	0.975
3	1.000	0.996	0.984	0.973	0.982
4	1.000	0.994	0.983	0.976	0.989
5	1.000	0.992	0.983	0.981	0.994
6	0.999	0.991	0.985	0.987	0.998
7	0.999	0.991	0.989	0.993	1.001
8	0.998	0.993	0.995	0.999	1.002
9	0.998	0.997	1.002	1.003	1.002
10	0.998	1.002	1.006	1.004	1.002
11	0.999	1.006	1.008	1.004	1.000
12	1.001	1.009	1.008	1.003	0.999
13	1.004	1.011	1.007	1.002	0.998
14	1.006	1.011	1.006	1.001	0.996
15	1.009	1.011	1.004	1.000	0.995
16	1.011	1.010	1.003	0.999	0.993
17	1.012	1.008	1.001	0.998	0.992
18	1.013	1.006	1.000	0.997	0.991
19	1.012	1.004	0.999	0.995	0.991
20	1.011	1.002	0.998	0.994	0.990
21	1.009	1.001	0.997	0.993	0.990
22	1.007	1.000	0.996	0.992	0.990
23	1.005	0.999	0.995	0.991	0.991
24	1.003	0.998	0.995	0.992	0.992
25	1.001	0.997	0.994	0.992	0.994
26	1.000	0.997	0.994	0.993	0.995
27	0.999	0.996	0.994	0.994	0.996
28	0.998	0.996	0.995	0.995	0.997

(Continued)

TABLE 9 .

Simulated Wage Profiles Relative to Steady State Profile
(Continued)

	Born 5 Years Before	Born 1st Year	Born Peak Year	Born Last Year	Born 5 Years After
29	0.997	0.996	0.995	0.996	0.998
30	0.997	0.997	0.997	0.998	0.999
31	0.998	0.998	0.998	0.999	1.001
32	0.999	1.000	1.000	1.001	1.001
33	1.001	1.003	1.003	1.002	1.001
34	1.004	1.007	1.006	1.004	1.001
35	1.007	1.010	1.008	1.004	1.001
36	1.010	1.012	1.009	1.003	1.000
37	1.015	1.015	1.010	1.002	1.000
38	1.021	1.019	1.011	1.002	1.000
39	1.023	1.019	1.009	1.000	1.000
40	1.017	1.012	1.004	1.000	1.000

CONCLUSION

In this paper we have attempted to characterize the time shifts in earnings profiles in a succinct and meaningful way. Using factor analytic techniques, we were able to describe the time pattern of these profiles by decomposing them into time-specific and factor-specific effects. This type of decomposition lends itself readily to interpretation within a model of production. Workers are linear combinations of several basic factors of production and thus a worker's wage is a linear combination of the marginal products of factors. Over a worker's lifetime the composition of the worker changes. As calendar time passes, the marginal product of each basic factor changes. Thus earnings profiles depend on a career-varying worker-specific effect and a time-varying aggregate effect. The factor decomposition of repeated annual cross-section profiles separates these two components. Furthermore, if we assume the only reason for variations in the marginal product of the underlying basic factors is the relative scarcity of those factors, then we can readily discern the effects of cohort size on wage profiles. We believe this methodologyical innovation will facilitate the analysis of such data considerably.

The results of applying our method to the CPS are perhaps best summarized in Tables 9 and 10 and Figure 8. First, young workers and old workers appear to be good substitutes. Both these groups appear to be complements with prime-age workers. Thus the effect of increased cohort

FIGURE 9

**Normalized Present Value of Earnings Under Simulated 9-Year Baby Boom—
College Graduates**

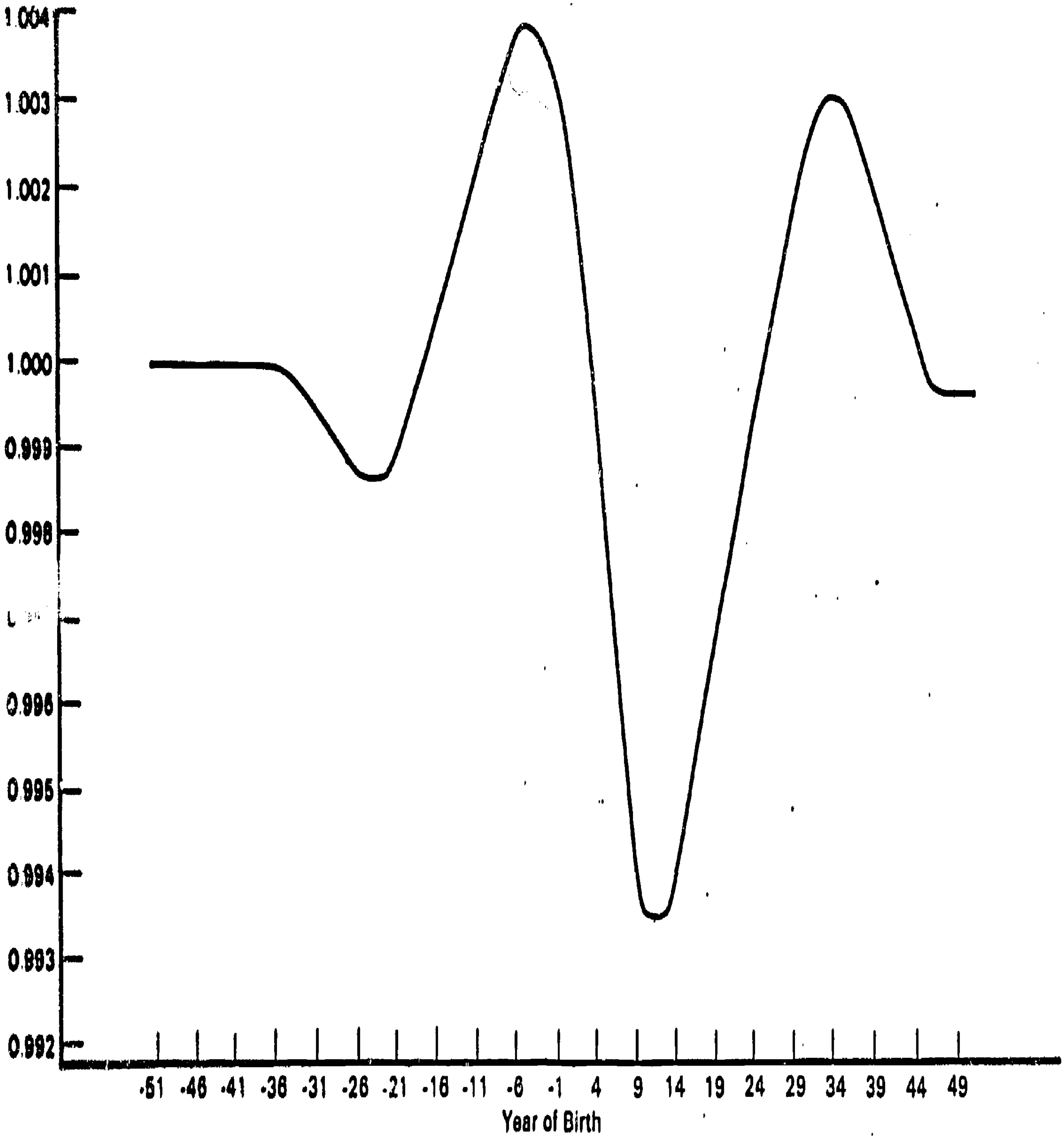

Figure 9: Normalized Present Value of Earnings Under Simulated 9-Year Baby Boom

TABLE 10

Relative Present Value of Lifetime Earnings for Various Cohorts

Birth Year	Relative Present Value of Earnings
-40	1.0000
-35	0.9999
-30	0.9994
-25	0.9986
-20	0.9992
-15	1.0001
-10	1.0027
-5	1.0039
-4	1.0039
-3	1.0038
-2	1.0035
-1	1.0031
0	1.0026
1	1.0019
2	1.0010
3	1.0000
4	0.9989
5	0.9977
10	0.9938
15	0.9951
20	0.9978
25	1.0003
30	1.0027
35	1.0030
40	1.0016
45	1.0002
50	1.0000

size will be felt over a long period of time and by workers who are not members of the large cohorts. Members of the 'baby-booms' will suffer decreased wages immediately upon entrance into the labor force. They will recoup some of these losses later in their careers, but not enough to bring lifetime earnings up to steady state values. The workers who enter the labor force when the large cohorts are prime-age will benefit due to a relative scarcity of young and very old workers. Likewise the workers who are prime aged when the baby-boom is young will benefit. Although these effects are evident, the change in lifetime earnings is quite small.

These results, both methodologyical and empirical, certianly call for more work. Our empirical analysis is restricted to males and treats each education group as being a separate factor of production. An analysis that incorporated females and allows for interaction of education cohorts is necessary if we are to understand the wage phenomena of the baby-boom era. Also, the statistical properties of our estimates warrant further investigation and elucidation.

Appendix A

DETAILED ANALYSIS OF THE EFFECTS OF COHORT SIZE

In this appendix we present further results of the investigation reported in the main text. In the main text results are presented only for high school or college graduates, and the measure of earnings used is weekly wages. The analyses we performed also included workers who completed the eighth grade but did not complete high school (referred to hereafter as high school dropouts) as well as those who completed high school, had some post-secondary education but did not complete college (referred to as college dropouts). For each of the educational groups, we analyzed annual income as well as weekly wages. The purpose in this appendix, then is twofold. First, we will present some of the numbers used to draw the figures presented, Secondly, we will present a complete set of results for all educational groups and for both measures of earnings.

We first present the detailed decompositions of the wage profiles into their underlying factor components. In tables A.1 through A.4 we present the first three factors of decomposition for weekly wages measured in units of standard deviations about the means. Thus, for example in table A.1, column 1 is the first factor (or reference wage profile) for high school dropouts, column 2 is the second factor and column 3 is the third factor. Tables A.5 through A.8 present the decomposition for annual earnings. Comparison between these decompositions is facilitated by plotting the factor weight by experience level, which is done in figures A.1 to A.8. Considering the first four figures, which represent the decomposition of weekly wages, we note that all four schooling groups have basically the same shaped reference profile, with a positive but declining derivative of earnings with respect to experience. At high levels of experience earnings begin to decline. The standard shape of the second factor profile is best illustrated in figure A.4, for college graduates. It is a youth intensive factor, being high in the early years of the work career and declining in the later years. In the extreme late years of the career there is an increase in the second factor which is more pronounced in the high school profile (figure A.2). The third factor reflects the notion that young workers and old workers are good substitutes, since workers have high levels of this factor at either end of their career. Again this is particularly pronounced for the high school graduates and the college graduates. The results using annual income instead of weekly wages exhibit the same properties and deserve no special comment.

These figures illustrate a problem we had with some of the data throughout our investigation. For the high school dropout category and the college dropout category the second and third factors are a more erratic. The intertemporal wage patterns of these two groups were difficult to characterize with our three factor model. Our hypothesis is that this difficulty stems from the individuals in these groups being less homogeneous than high school graduates and college graduates especially across age. For example, a high school dropout born in the early 1900's would have an entirely different set of opportunities available to him when he was entering the labor force, than would a high school dropout born in 1960. Thus the characterization of the wage profiles from a series of recent cross-sections might be difficult due to this heterogeneity. We have no real way of testing this hypothesis except to note that these two groups are more difficult to characterized and to simulate.

The predicted wage profiles that result from these factor schemes are illustrated in figures A.9 through A.16 in which the reference one-factor profile is graphed along with the profiles resulting from using the maximum and minimum second factor loadings and using a zero third factor loading. The factor loadings for each of the three factors over the fifteen years of the sample are presented in tables A.9 to A.16. For ease of comparison, these factor loads assume that the factors are rescaled so that the mean factor over the experience profile is equal to one. Recall that these factors represent the "value of marginal product" of one unit of the corresponding factor in the given year. It is these numbers that are used to form the dependent variables in the wage regressions below.

In figures A.17 to A.24 we present the residual variance after the inclusion of the first six factors. Consider first figure A.17, the residual variances for the decomposition of weekly wages for persons with 8-11 years of education. Unlike the high school or college graduates, after the inclusion of three factors there is still substantial variation of wages in the early years of the career, and inclusion of a fourth factor seems to remedy this considerably. The remainder of the profile seems well-explained by only three factors. For high school graduates (figure A.18) three factors seem sufficient to explain the variations in the profile over time, with the third factor adding explanatory power primarily at either end of the career. In figure A.19 we note that although the third factor adds substantially to the explanatory power of the factor analytic model for workers with 13 to 15 years of schooling, the early part of the experience profile is not completely explained by even six factors. In figure A.19, the decomposition for college graduates, the standard three-factor structure is evident. The decompositions of annual income (figures A.20 to A.23) look much the same as that for weekly wages, with the three-factor structure being much more distinct for all four groups. Annual income also shows more variation in the later years of the profile. The R-squared variance accounting for the decomposition of weekly wages is presented in the text (Table 2) and we present as table A.17 the equivalent table for annual earnings.

The sensitivity of relative wages to cohort size are estimated in the text using a set of regressions which estimated the relative marginal products of the second and third factors as a function of the relative numbers of those factors. The results of these regressions were used as the basis for computation of elasticities and for simulations. In table A.18 we present similar regressions for the marginal products derived from annual income. In each regression the marginal product of the factor in question is divided by the marginal product of the first factor. This ratio is the dependent variable. The independent variables are the ratio of the total amount of each factor to the amount of factor one. The formulae for these computations are given in the main text. Note that in all regressions the own effects are negative, and usually significant. The exception is the regression of the third factor relative marginal product for the college dropouts in which the own effect is positive. In this regression the R-squared is very small, and the regression is nearly insignificant. In tables A.19 to A.22 we report similar regressions, but we include as explanatory variables two different measures of the business cycle: the change in real gross national product and the prime-age male unemployment rate. We include these variables because annual earnings will have a cyclical labor supply component (hours of work) that may not be netted out by the first factor, and would thus bias the estimates of the coefficients on cohort size. The results in these tables show that while the inclusion of these business cycle variables significantly increases the explanatory power of the regressions, these components are essentially orthogonal to the cohort size measures, and thus the behavioral coefficients do not change. In further analysis of the annual income results we use the estimates reported in table A.18.

The importance of these regressions is their use in calculating the response of relative wages to the changes in cohort size. In the main text we illustrate these effects three different ways: own elasticities, cross elasticities and simulations. The method of computing the elasticities is given in Appendix C. The results of these computations are illustrated in the next sixteen figures. In figures A.25 to A.28, we present the own elasticities calculated using weekly wages. The typical pattern in these illustrations is that early and late in the career workers wages are sensitive to their own cohort size. This is particularly evident for high school and college graduates. The late-career sensitivity is less pronounced for the high school dropouts. Much the same pattern is evident in figures A.29 to A.32 where the computations are made using annual income instead of weekly wages.

In figures A.33 to A.40 we plot the elasticity of earnings with respect to a change in the number of workers with one year of experience to get some gauge of the effect of large young cohorts on the earnings of other workers. The first four figures are for weekly wages, and the second four are for annual income. The largest negative effects are on workers close to the first year entrants in experience indicating substitutability in production. The cross-effects become positive in the mid-career range and are slightly negative in the late years of the life cycle. This reflects what we saw earlier--that young workers and old workers share some common factor of production that makes them appear as if they were substitutes. The cross-effects for annual income are somewhat more pronounced than those for weekly wages.

In the text we presented a simulation of a nine year baby boom with a maximum increase of 10% in the peak year of the boom. The results of this simulation performed on weekly wages for each demographic group are presented in figures A.41 to A.44. The basic observation to be made is same throughout. Those who are old when the baby boom enters the labor force will have lower earnings since they are substitutes with the young. Those who are prime-aged workers when the baby boom enters will have increased earnings, because theirs is the relatively scarce factor during this period. The depressive effects of the baby boom on own earnings continues after the boom ends, however workers who are young when the baby boom enters the middle of its career benefit because youth is now the scarce factor of production. The simulation for high school dropouts indicates that the depressive effect on earnings is in later years. In fact the baby boom does relatively well. In the simulation for college dropouts, there is an anomalous dip in the present value of earnings for those born 10-15 years after the baby boom. In figures A.45 to A.48, we present the simulations for annual income, noting again the intergenerational effects of the baby boom on earnings. The results for high school dropouts (figure A.45) show the same anomalous result as with weekly wages.

In all eight of these simulations it should be noted that the absolute effects of the simulated baby boom are small. The present value of lifetime earnings is changed by at most 0.5%. These small effects are due to the short period of the simulation--nine years, and the small size of the increase in cohorts--10% at most. To paint a more realistic picture o. the current demographic situation in the labor force we ran a second series of simulations. In these simulations, we increased cohort size by a percentage that increased 2.6% per year, reaching a maximum of 39% in the 16th year. The percentage increase then declined by 2.6% per year for another 15 years. Thus we simulated a baby boom that was 31 years in length with a maximum cohort size 39% higher than the normal in the 16th ye r. This simulation more closely mimics the actual baby boom which began in the early 1940's, had a peak number of births in 1957 which was about 40% higher than normal, and ended by the early 1970's. Following th procedure in the ten year simulation, we computed wages yearly for .hose born anytime from 45 years before the initial year of the baby om to those born up to 45 years after the baby boom. The results . .e simulations are illustrated in figures A.49 to A.56.

Consider figure A.52, the simulation for weekly wages for college graduates. This simulation shows the same "inverted W" shape as did the shorter simulations. To give some concreteness to our explanation let us assume the baby boom began in 1942 (year 1 on the figure), peaked in 1957 and ended in 1972. Reading from figure A.52 then, workers born in 1917, who are in the last phase of their career when the 1942 babies enter the labor market, get slightly lower earnings than their older counterparts. Those born between 1932 and 1942 benefit from being prime-aged workers when the baby boom enters the labor market. The depressive effect of the baby boom is worst for workers born about 22 years after it begins--approximately 1962. Workers born in 1982 roughly break even, and those born after 1982 benefit from there being large numbers of workers in the prime-age portion of the labor force. Finally as the last of the baby boom retires some 70 years after the first large cohort enters the labor force the effect disappears. Obviously too much credence should not be placed in the exact dates especially since this simulation ignores many of the demographic, economic and sociological changes that have occured in the market place. It does illustrate cogently our basic point--that because workers of different ages are combinations of different factors of production, the effects of large cohorts will be intergenerational. Note also, that the effects of the simulated changes in cohort sized are almost ten times as large as they were in the shorter simulation, changing the present value of earnings by as much as 4%.

This appendix has presented a catalogue of results that confirm the major results presented in the main text. We present these results to show the robustness of our method, and also to give the interested reader a more complete picture of the effects of cohort size on the male labor force. Any specific numbers not presented here are available from the authors upon request.

TABLE A.1

Factor Profiles For 8-11 Years Of Schooling

(Weekly Wage Measured in Standard Deviations)

Experience	Factor 1	Factor 2	Factor 3
1	-2.87757	0.414298	1.98019
2	-2.59104	0.607909	1.90144
3	-2.24107	0.853735	1.64445
4	-1.86099	1.08581	1.19651
5	-1.50028	1.20112	0.778687
6	-1.20186	1.14334	0.55726
7	-0.970424	0.991484	0.581561
8	-0.783333	0.847981	0.718531
9	-0.618814	0.78607	0.83929
10	-0.466683	0.820389	0.882307
11	-0.330888	0.967881	0.7504
12	-0.210661	1.16344	0.393012
13	-0.0998684	1.27518	-0.144576
14	0.00928138	1.23428	-0.628752
15	0.113779	1.09892	-0.993928
16	0.212226	0.940025	-1.13471
17	0.295377	0.807857	-1.06077
18	0.356075	0.694427	-0.949075
19	0.400177	0.564759	-0.980507
20	0.439858	0.436602	-1.14022
21	0.487822	0.309586	-1.37859
22	0.54507	0.155752	-1.57467
23	0.605016	-0.0339692	-1.64704
24	0.660803	-0.22349	-1.53764
25	0.708733	-0.396943	-1.32894
26	0.740617	-0.525287	-1.14077
27	0.758466	-0.61687	-0.968775
28	0.774442	-0.782808	-0.720093
29	0.794021	-1.03544	-0.324356
30	0.812423	-1.29375	0.0573685
31	0.816107	-1.43759	0.305244
32	0.805277	-1.4252	0.37479
33	0.785543	-1.32386	0.352311
34	0.756593	-1.24294	0.348308
35	0.721838	-1.2497	0.39226
36	0.691553	-1.33906	0.531308
37	0.665225	-1.43285	0.661889
38	0.635975	-1.46587	0.757983
39	0.601013	-1.38886	0.825972
40	0.560184	-1.18637	0.822338

TABLE A.2

Factor Profiles For 12 Years Of Schooling

(Weekly Wage Measured in Standard Deviations)

Experience	Factor 1	Factor 2	Factor 3
1	-2.96219	1.06678	1.13126
2	-2.59776	1.3561	1.37263
3	-2.22075	1.57039	1.42244
4	-1.86157	1.65984	1.24376
5	-1.54064	1.63003	0.918853
6	-1.26098	1.52895	0.519268
7	-1.01845	1.4064	0.139049
8	-0.803474	1.28652	-0.161415
9	-0.606255	1.18013	-0.293191
10	-0.420976	1.08231	-0.289997
11	-0.248136	0.984999	-0.224733
12	-0.0908459	0.873246	-0.22293
13	0.0465225	0.727474	-0.286487
14	0.163787	0.542025	-0.389655
15	0.263224	0.346631	-0.512117
16	0.348349	0.170385	-0.674215
17	0.421251	0.01715	-0.813069
18	0.480769	-0.122546	-0.904203
19	0.52843	-0.248533	-0.914762
20	0.568369	-0.358526	-0.896142
21	0.606189	-0.429171	-0.916565
22	0.644324	-0.462625	-1.00696
23	0.683842	-0.453483	-1.15541
24	0.72581	-0.408279	-1.31089
25	0.765494	-0.332158	-1.46523
26	0.794225	-0.258761	-1.54986
27	0.805668	-0.277881	-1.48791
28	0.799363	-0.433984	-1.22671
29	0.778449	-0.68364	-0.82767
30	0.749528	-0.949392	-0.32323
31	0.718764	-1.18346	0.193797
32	0.687909	-1.37069	0.692569
33	0.657255	-1.4821	1.1105
34	0.624529	-1.51341	1.39436
35	0.586086	-1.44495	1.52274
36	0.541998	-1.31376	1.48623
37	0.492622	-1.1484	1.3428
38	0.439739	-0.997804	1.12351
39	0.384544	-0.856332	1.06153
40	0.324988	-0.699461	1.17805

TABLE A.3

Factor Profiles For 13-15 Years Of Schooling

(Weekly Wage Measured in Standard Deviations)

Experience	Factor 1	Factor 2	Factor 3
1	-2.80626	0.933068	0.785181
2	-2.50337	1.03458	0.912903
3	-2.19357	1.20778	0.95296
4	-1.89632	1.28268	1.00559
5	-1.61771	1.27779	1.11485
6	-1.35878	1.23945	1.19569
7	-1.11864	1.18949	1.19445
8	-0.897576	1.11369	1.08913
9	-0.688501	0.99472	0.792302
10	-0.491113	0.837907	0.783638
11	-0.305117	0.676523	-0.0357972
12	-0.13169	0.553047	-0.490998
13	0.0234656	0.480784	-0.998689
14	0.158463	0.457047	-1.45262
15	0.276268	0.411343	-1.70789
16	0.370611	0.303606	-1.72339
17	0.442687	0.122629	-1.48755
18	0.502425	-0.0671626	-1.25105
19	0.551469	-0.200414	-1.18134
20	0.586797	-0.222836	-1.17156
21	0.611388	-0.146353	-1.13542
22	0.626687	0.0109636	-1.02252
23	0.636739	0.201582	-0.834799
24	0.648143	0.357375	-0.586333
25	0.662016	0.444313	-0.320385
26	0.677877	0.442899	-0.098919
27	0.698348	0.360278	-0.0116379
28	0.721321	0.184611	-0.0344078
29	0.741156	-0.0823321	-0.156329
30	0.757397	-0.430176	-0.289166
31	0.768193	-0.851729	-0.346774
32	0.766889	-1.29434	-0.346665
33	0.754604	-1.68169	-0.198642
34	0.729462	-1.99189	0.0497589
35	0.692259	-2.14709	0.383833
36	0.637917	-2.05957	0.745594
37	0.576697	-1.80421	1.15338
38	0.517018	-1.45365	1.44108
39	0.459047	-1.05455	1.7486
40	0.413303	-0.630169	1.93394

TABLE A.4

Factor Profiles For 16 Years Of Schooling

(Weekly Wage Measured in Standard Deviations)

Experience	Factor 1	Factor 2	Factor 3
1	-2.57652	1.03217	1.16756
2	-2.33934	1.06875	1.21467
3	-2.10182	1.14034	1.16399
4	-1.87662	1.25324	1.02943
5	-1.65431	1.38191	0.866784
6	-1.43497	1.46968	0.720502
7	-1.22464	1.49366	0.49848
8	-1.02211	1.48825	0.161605
9	-0.824496	1.44616	-0.139091
10	-0.625922	1.34035	-0.37796
11	-0.430347	1.14109	-0.552913
12	-0.247047	0.934491	-0.684309
13	-0.0780628	0.726736	-0.769899
14	0.0786717	0.532021	-0.845159
15	0.219371	0.401656	-0.906083
16	0.340725	0.312386	-0.985633
17	0.438913	0.22789	-1.00301
18	0.516988	0.169794	-0.996158
19	0.580316	0.116683	-1.01368
20	0.634993	0.0584595	-1.039
21	0.688686	-0.050542	-1.04991
22	0.738362	-0.165759	-1.04043
23	0.778875	-0.279845	-1.02151
24	0.810134	-0.385064	-0.950156
25	0.831088	-0.589624	-0.831189
26	0.846794	-0.792913	-0.758435
27	0.856181	-0.981095	-0.733206
28	0.853207	-1.16278	-0.624075
29	0.848656	-1.32586	-0.559463
30	0.833396	-1.36517	-0.386062
31	0.803227	-1.3365	-0.267098
32	0.752061	-1.36188	-0.0506159
33	0.718114	-1.2992	0.219691
34	0.653639	-1.1786	0.641232
35	0.582528	-1.20611	0.928829
36	0.517053	-1.13821	1.20732
37	0.463416	-0.886317	1.62265
38	0.404047	-0.822501	2.18372
39	0.351648	-0.909242	2.28248
40	0.295123	-0.498499	1.6761

TABLE A.5

Factor Profiles For 8-11 Years Of Schooling

(Annual Income Measured in Standard Deviations)

Experience	Factor 1	Factor 2	Factor 3
1	-2.81234	0.487591	1.31181
2	-2.56258	0.659139	1.24794
3	-2.24827	0.905178	1.21238
4	-1.89027	1.18355	1.12441
5	-1.53839	1.37504	1.07035
6	-1.2369	1.39241	1.03975
7	-0.996562	1.29109	1.05262
8	-0.802193	1.13971	1.0471
9	-0.636148	1.0142	1.00544
10	-0.48611	0.95918	0.843641
11	-0.348703	1.01611	0.491679
12	-0.218595	1.11648	-0.00812159
13	-0.0935722	1.14595	-0.53923
14	0.0259684	1.04982	-0.939656
15	0.133551	0.881337	-1.20201
16	0.230191	0.704012	-1.28918
17	0.310611	0.560666	-1.22454
18	0.371877	0.438082	-1.11823
19	0.419151	0.31451	-1.12353
20	0.46124	0.206757	-1.23644
21	0.504934	0.117406	-1.38379
22	0.55288	0.0322205	-1.46535
23	0.605032	-0.0754543	-1.48698
24	0.656731	-0.209111	-1.42832
25	0.701918	-0.361018	-1.27324
26	0.731387	-0.487561	-1.03044
27	0.749042	-0.56855	-0.78441
28	0.765875	-0.695885	-0.548384
29	0.788659	-0.920198	-0.279167
30	0.809083	-1.18137	0.00484949
31	0.814173	-1.36822	0.203398
32	0.803056	-1.3985	0.2814
33	0.782273	-1.31822	0.327035
34	0.755288	-1.2313	0.484053
35	0.724746	-1.21608	0.708543
36	0.695052	-1.28361	0.928686
37	0.66763	-1.37835	1.0192
38	0.638087	-1.45445	1.00652
39	0.605333	-1.46202	0.989906
40	0.566859	-1.38054	0.960299

TABLE A.6

Factor Profiles For 12 Years Of Schooling

(Annual Income Measured in Standard Deviations)

Experience	Factor 1	Factor 2	Factor 3
1	-2.93798	1.00514	1.78347
2	-2.59516	1.26955	1.90386
3	-2.23225	1.48538	1.79867
4	-1.87818	1.60654	1.42241
5	-1.55518	1.62241	0.918987
6	-1.27002	1.55596	0.400376
7	-1.0218	1.4508	-0.0708029
8	-0.802802	1.34575	-0.455017
9	-0.603994	1.25797	-0.666783
10	-0.418572	1.17388	-0.697645
11	-0.24483	1.07709	-0.613749
12	-0.0844754	0.944748	-0.542344
13	0.0589267	0.766084	-0.523332
14	0.182937	0.550925	-0.578221
15	0.287901	0.341706	-0.699256
16	0.376767	0.177022	-0.85705
17	0.451202	0.0552178	-0.981771
18	0.509811	-0.0476266	-1.02743
19	0.553999	-0.141422	-0.959379
20	0.58868	-0.235461	-0.834331
21	0.621546	-0.322185	-0.745023
22	0.657399	-0.400235	-0.757387
23	0.697638	-0.461748	-0.867411
24	0.739994	-0.501419	-1.02379
25	0.776492	-0.502384	-1.1719
26	0.798611	-0.48067	-1.238
27	0.802989	-0.501454	-1.18166
28	0.791319	-0.603252	-0.968462
29	0.767317	-0.774419	-0.636715
30	0.736309	-0.967112	-0.202679
31	0.704196	-1.14199	0.263771
32	0.6721	-1.27886	0.715914
33	0.64029	-1.36388	1.0694
34	0.605741	-1.38853	1.26844
35	0.565508	-1.34128	1.31474
36	0.519342	-1.25667	1.25181
37	0.468038	-1.15688	1.14875
38	0.414304	-1.05854	1.00755
39	0.358091	-0.952034	0.971754
40	0.29779	-0.808623	1.06023

TABLE A.7

Factor Profiles For 13-15 Years Of Schooling

(Annual Income Measured in Standard Deviations)

Experience	Factor 1	Factor 2	Factor 3
1	-2.81954	1.39561	0.80739
2	-2.51575	1.46408	0.811822
3	-2.20414	1.58572	0.682549
4	-1.90489	1.66659	0.585147
5	-1.62274	1.63082	0.608507
6	-1.35969	1.52564	0.643139
7	-1.11492	1.40372	0.634344
8	-0.888859	1.28198	0.582863
9	-0.675566	1.11666	0.427832
10	-0.47491	0.934891	0.205278
11	-0.287517	0.764803	0.0503288
12	-0.113726	0.612651	-0.0448092
13	0.0412648	0.494477	-0.146613
14	0.176964	0.405265	-0.310222
15	0.296873	0.311823	-0.508286
16	0.396576	0.195648	-0.71564
17	0.476349	0.0670119	-0.942975
18	0.539842	-0.0656512	-1.13419
19	0.586311	-0.163487	-1.31231
20	0.617276	-0.206548	-1.44206
21	0.638898	-0.232869	-1.47879
22	0.652614	-0.227136	-1.39936
23	0.662012	-0.212397	-1.21559
24	0.671391	-0.239395	-0.937859
25	0.680514	-0.295517	-0.639823
26	0.689987	-0.344235	-0.422339
27	0.703062	-0.389978	-0.354427
28	0.716624	-0.454556	-0.374329
29	0.72677	-0.557766	-0.468123
30	0.733879	-0.696091	-0.581441
31	0.733294	-0.862179	-0.612439
32	0.721508	-1.05412	-0.580137
33	0.701005	-1.20977	-0.38285
34	0.671123	-1.3628	-0.0526628
35	0.633979	-1.46423	0.413568
36	0.58923	-1.52421	0.960886
37	0.541571	-1.49573	1.56054
38	0.499237	-1.41814	2.00265
39	0.458963	-1.28803	2.39895
40	0.42514	-1.09257	2.68148

TABLE A.8

Factor Profiles For 16 Years Of Schooling

(Annual Income Measured in Standard Deviations)

Experience	Factor 1	Factor 2	Factor 3
1	-2.61055	1.07252	1.63839
2	-2.3634	1.11276	1.6204
3	-2.11718	1.17561	1.48107
4	-1.883	1.2798	1.2346
5	-1.65352	1.39289	0.993023
6	-1.42926	1.46075	0.785093
7	-1.2143	1.48149	0.52143
8	-1.00554	1.484	0.170478
9	-0.800761	1.45039	-0.167033
10	-0.597353	1.34559	-0.455567
11	-0.398849	1.14757	-0.687923
12	-0.214177	0.941109	-0.854826
13	-0.0444065	0.738676	-0.963143
14	0.112162	0.555762	-1.06109
15	0.252581	0.424988	-1.17056
16	0.372979	0.320524	-1.27755
17	0.46945	0.204406	-1.29649
18	0.544764	0.116852	-1.27264
19	0.604282	0.0416795	-1.26397
20	0.655556	-0.0300658	-1.24361
21	0.705928	-0.136395	-1.19837
22	0.752236	-0.236353	-1.12548
23	0.787951	-0.341513	-1.02424
24	0.813907	-0.433207	-0.828365
25	0.829191	-0.609547	-0.622031
26	0.839153	-0.778968	-0.441991
27	0.842021	-0.956525	-0.309695
28	0.837425	-1.12466	-0.170085
29	0.831217	-1.27963	-0.119728
30	0.813327	-1.31955	0.0877037
31	0.781144	-1.32542	0.128462
32	0.733312	-1.36917	0.186545
33	0.693408	-1.25357	0.465236
34	0.630535	-1.21763	0.668653
35	0.559436	-1.23977	0.783808
36	0.492948	-1.1197	0.917323
37	0.435237	-0.889423	1.2787
38	0.371591	-0.854543	1.7588
39	0.313964	-0.876745	1.5669
40	0.256591	-0.354975	1.26779

Figure A.1: Factor Profiles for Persons with 8-11 Years of Schooling
(Weekly Wages -- Measured in Standard Deviations About the Mean)

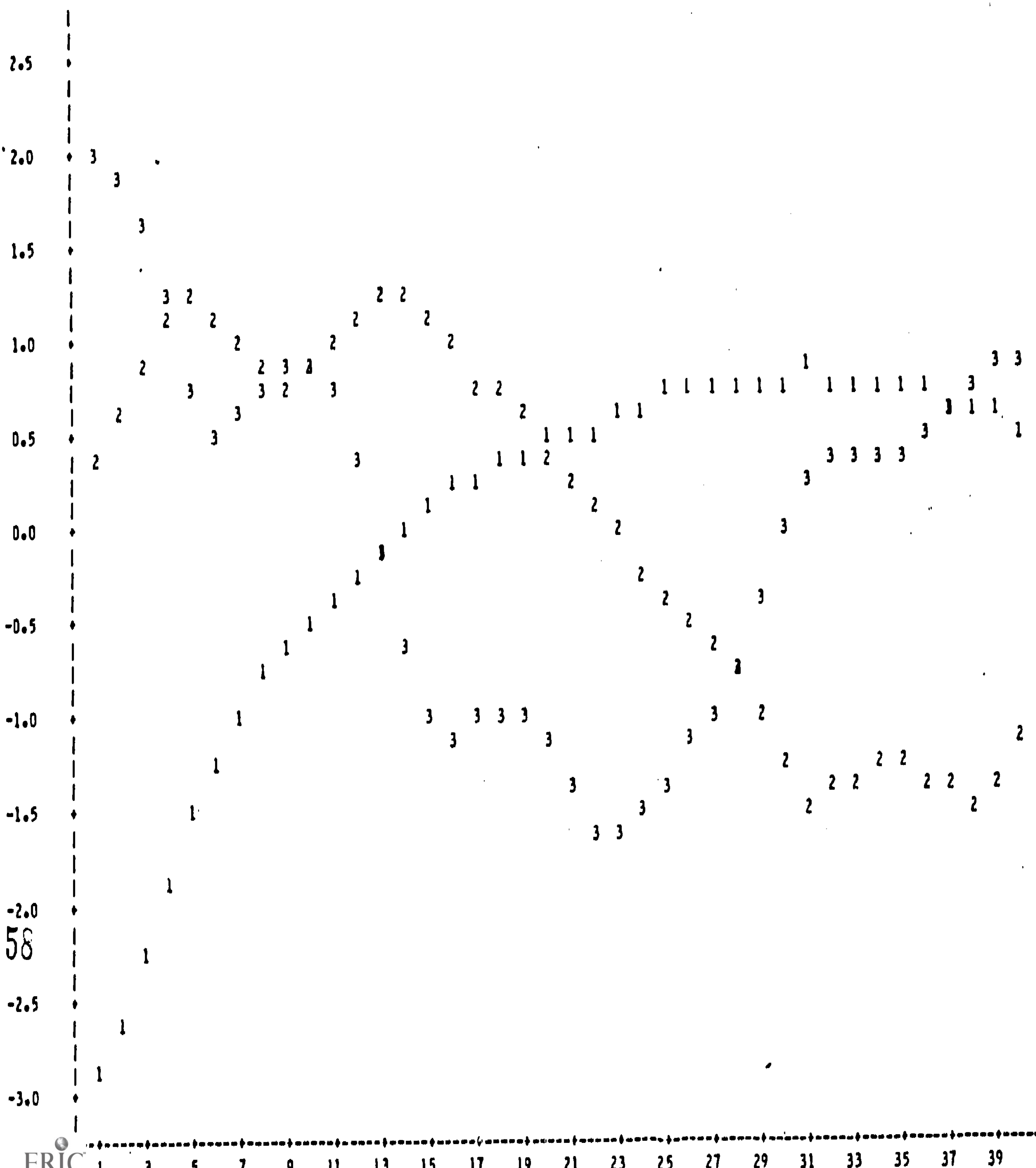

Figure A.2: Factor Profile for Persons with 12 Years of Schooling
(Weekly Wages--Measured in Standard Deviations About the Mean)

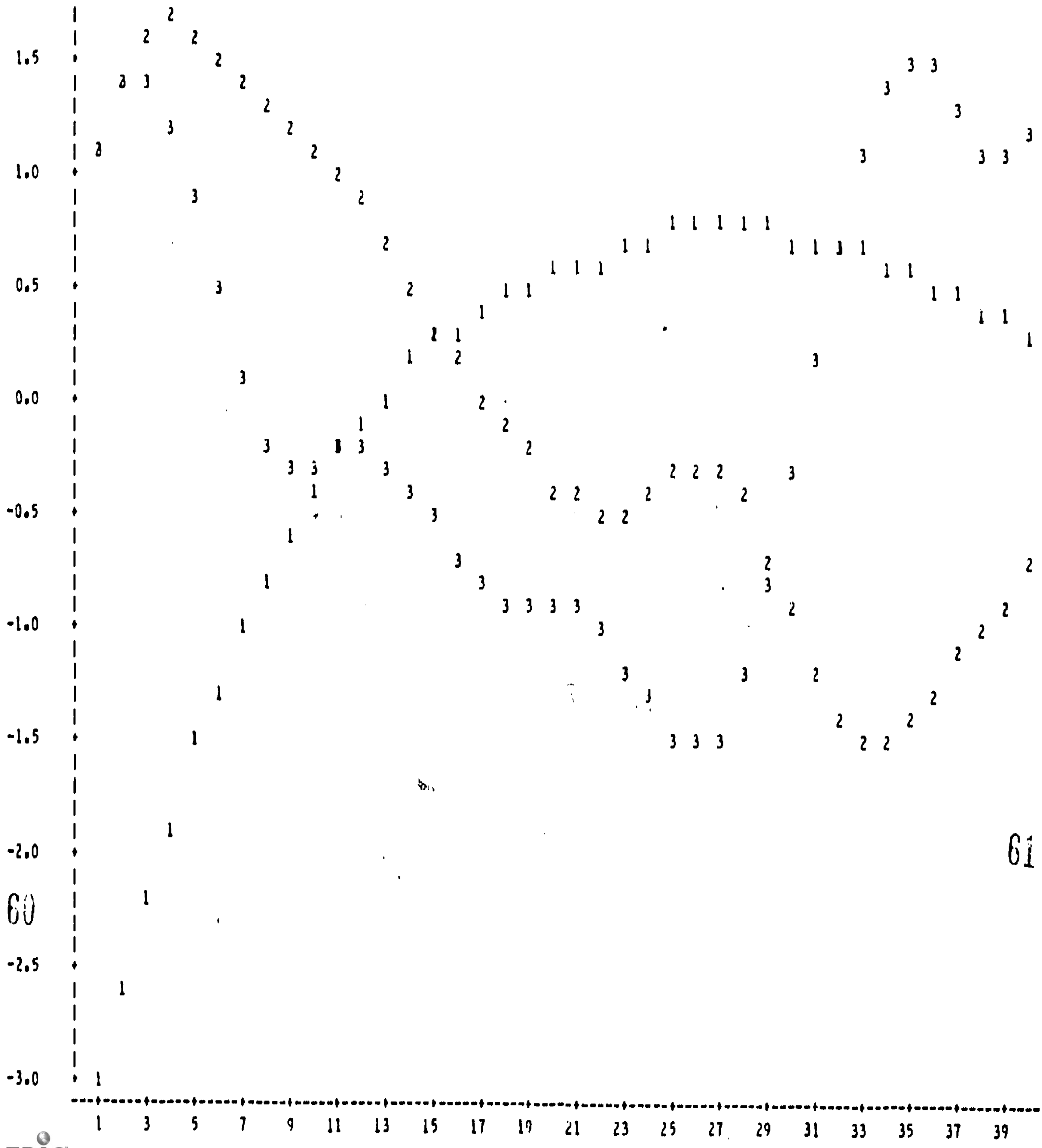

Figure A.5: Factor Profile for Persons with 13-15 Years of Schooling
(Weekly Wages -- Measured in Standard Deviations About the Mean)

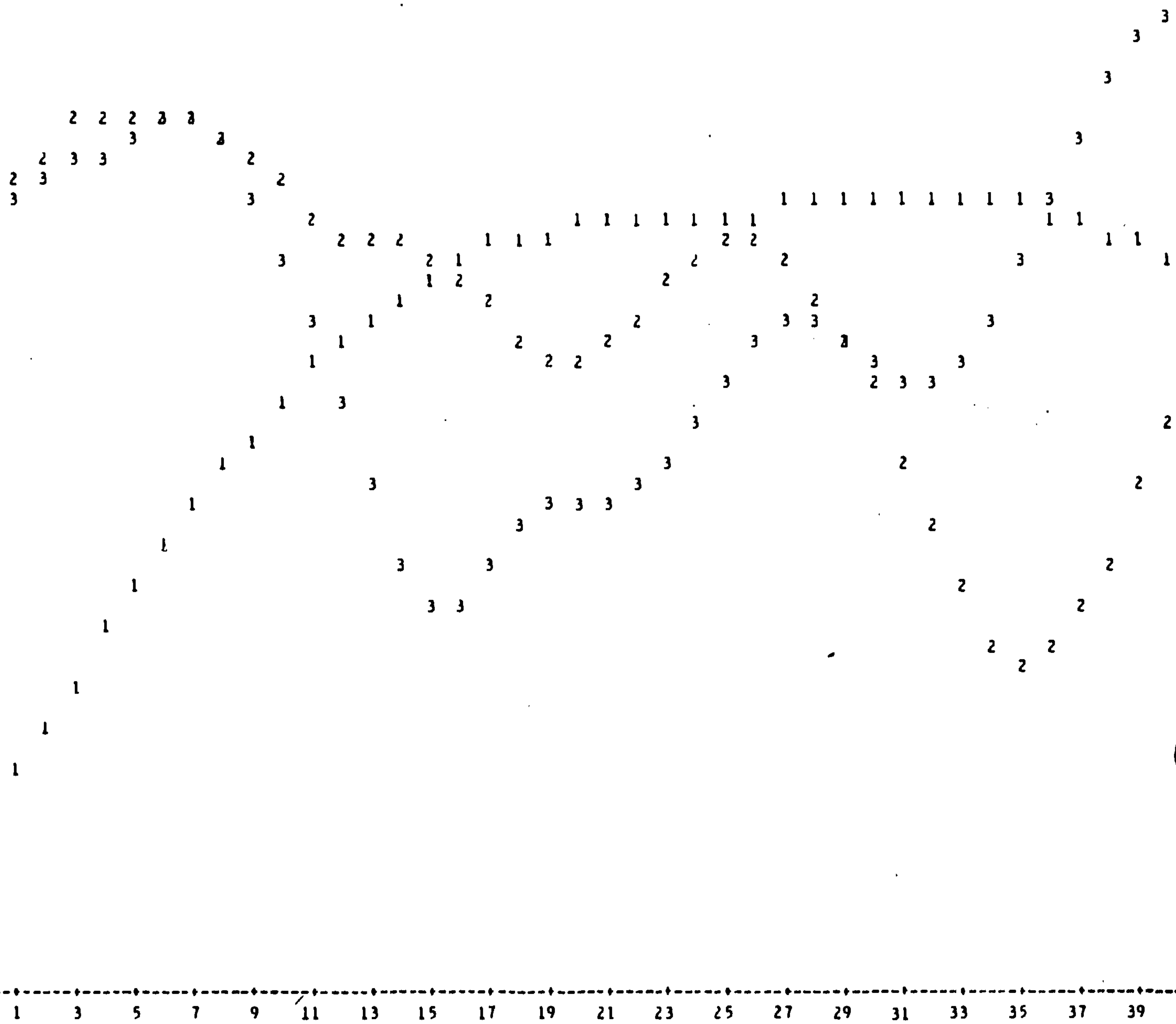

Figure A.4: Factor Profiles for Persons with 16 Years or More of Schooling
(Weekly Wages -- Measured in Standard Deviations About the Mean)

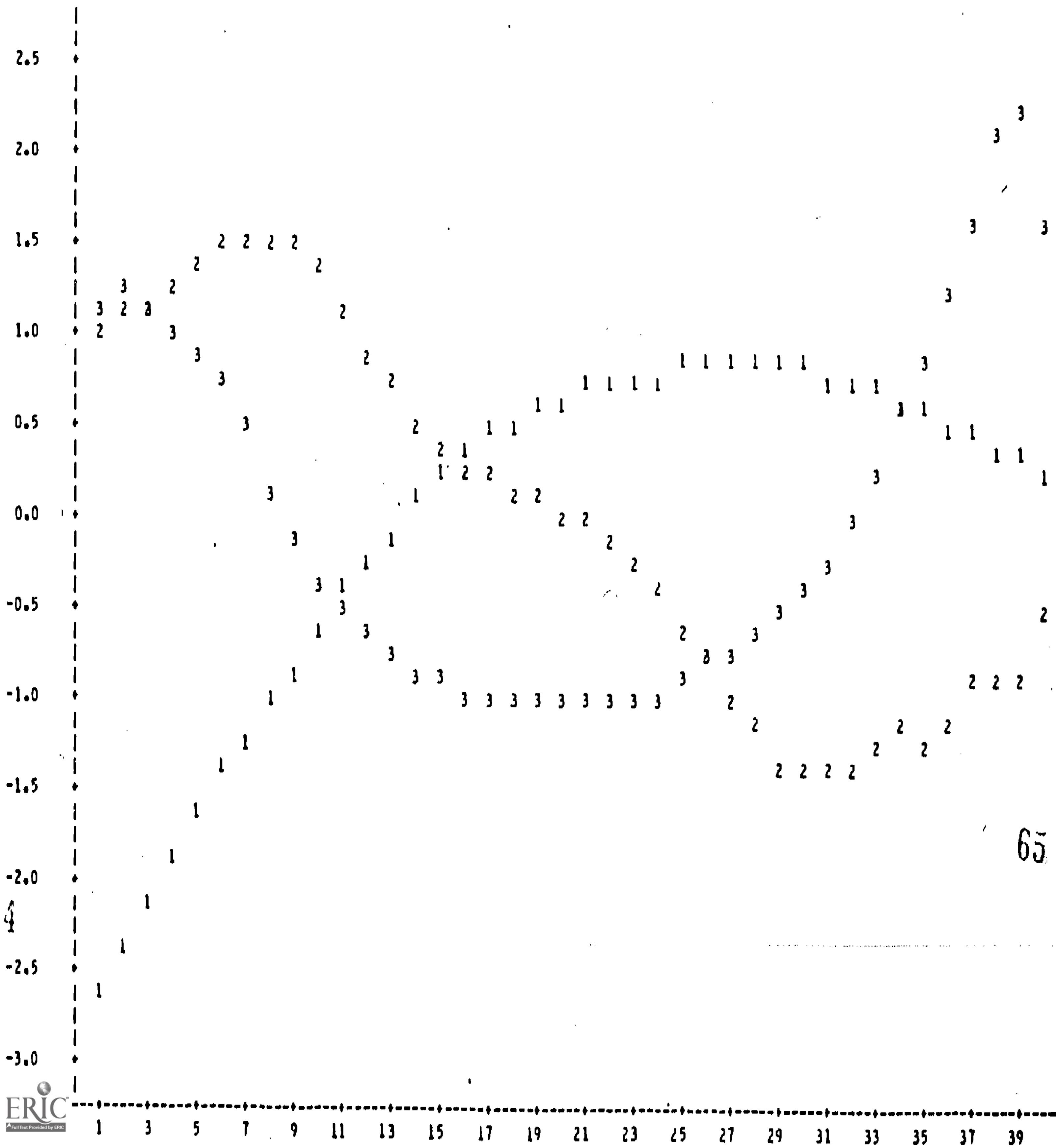

Figure A.9. Factor Profiles for Persons with 8-11 Years of Schooling
(Annual Earnings -- Measured in Standard Deviations About the Mean)

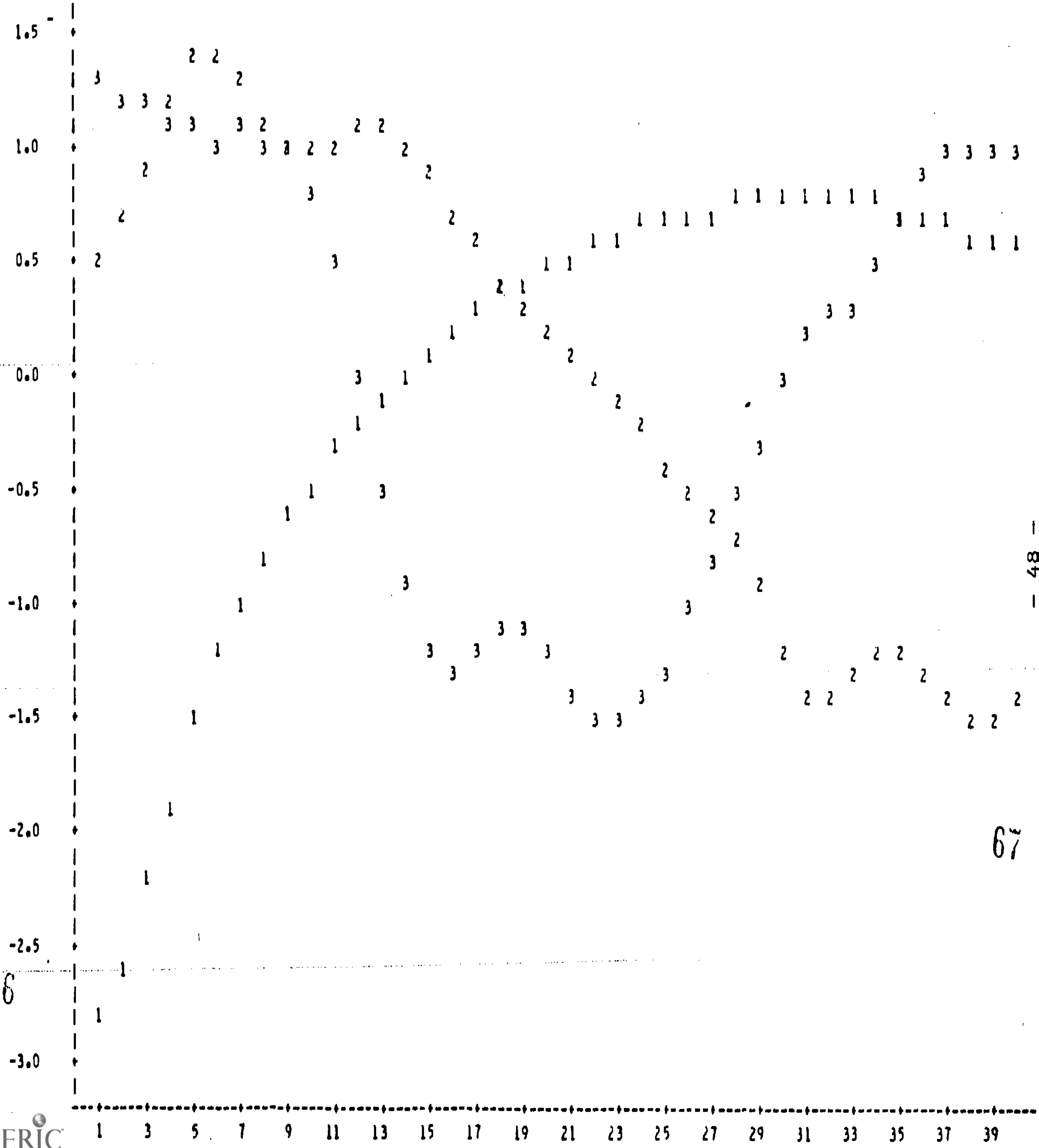

Figure A.6: Factor Profiles for Persons with 12 Years of Schooling
(Annual Earnings -- Measured in Standard Deviation About the Mean)

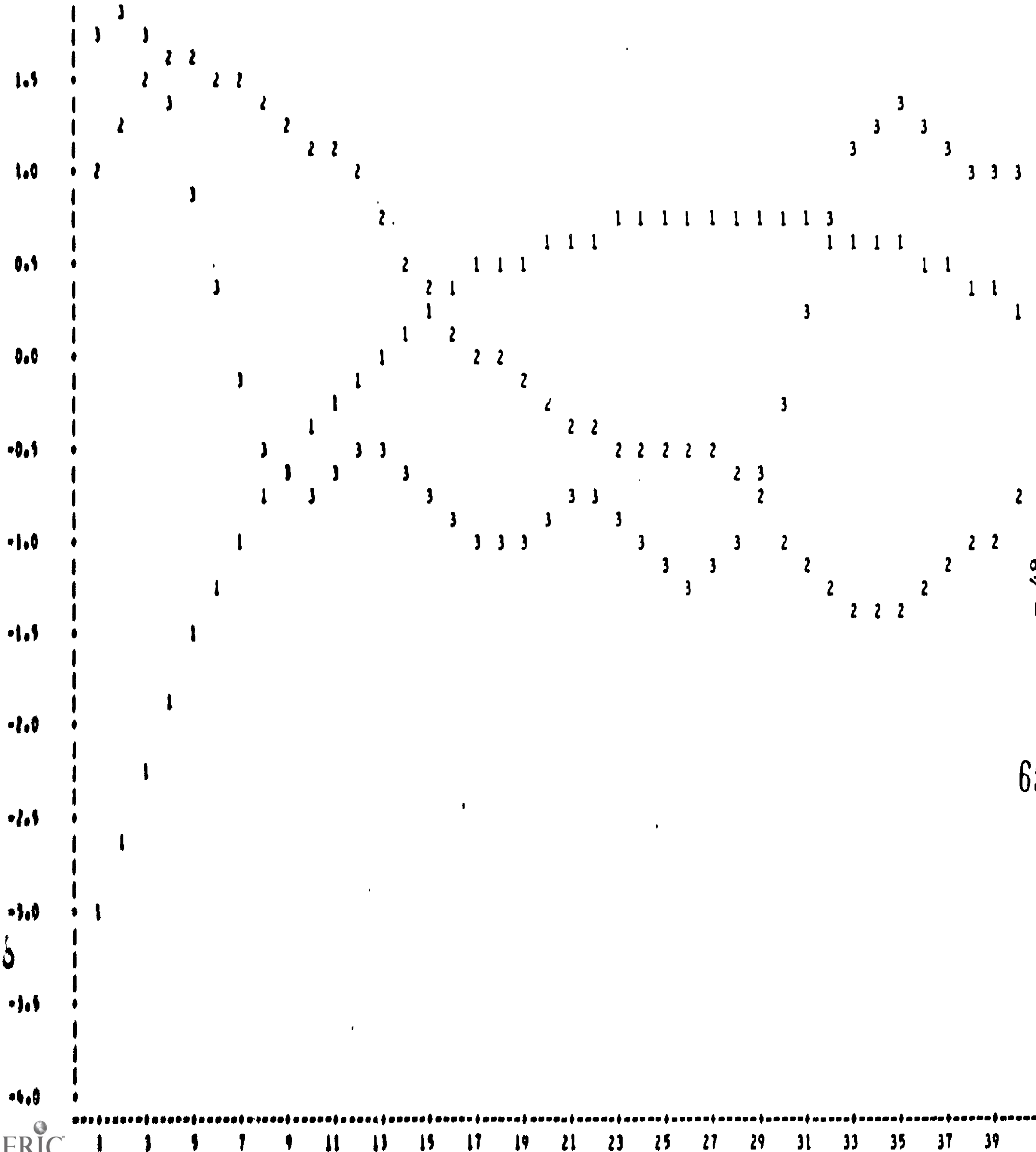

Figure A.7: Factor Profiles for Persons with 13-15 Years of Schooling
(Annual Earnings -- Measured in Standard Deviations About the Mean)

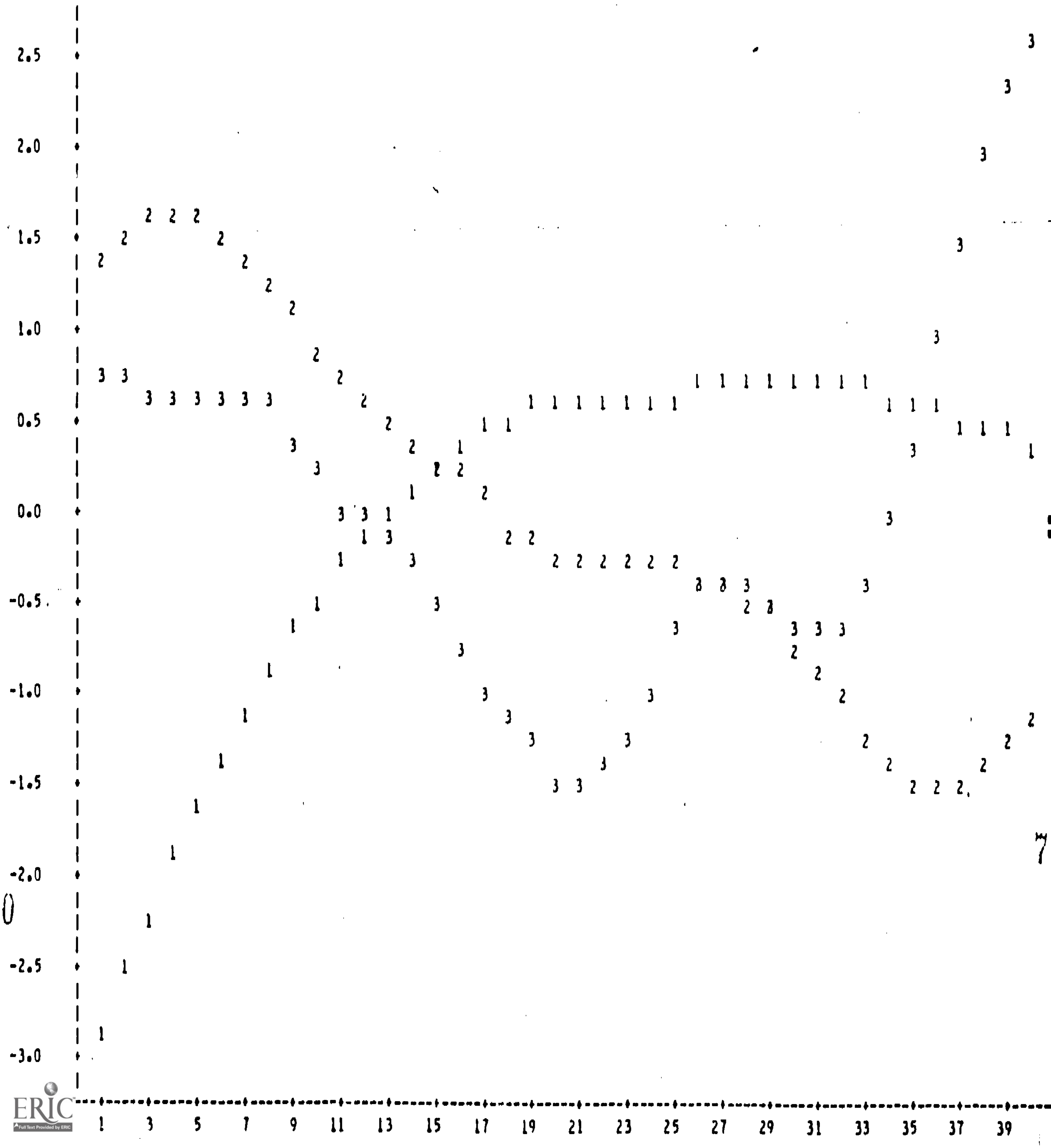

Figure A.8: Factor Profiles for Persons with 16 or More Years of Schooling
(Annual Earnings -- Measured in Standard Deviations About the Mean)

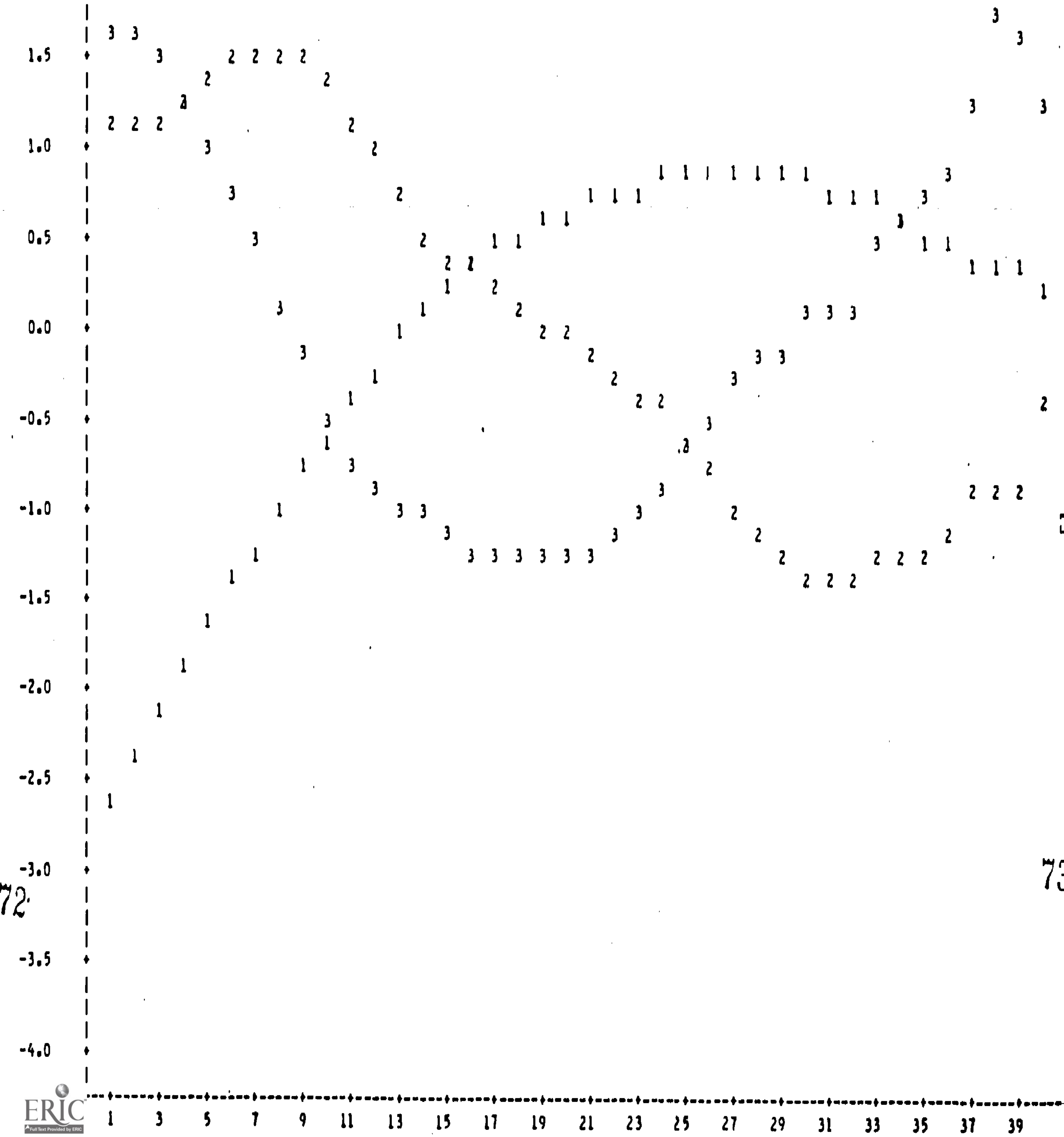

TABLE A.9

Factor Loadings (Marginal Products of Factors)

8-11 Years of Education/Weekly Wages

Years	Factor 1	Factor 2	Factor 3
1	129.601	0.35536	0.482867
2	132.303	0.461657	0.209705
3	135.15	0.686506	0.0474784
4	136.418	0.479838	0.0242773
5	135.782	0.117157	-0.323659
6	141.331	0.190127	-0.180528
7	144.906	0.375339	-0.394177
8	135.892	0.121759	-0.0599828
9	125.954	-0.154022	0.106584
10	130.845	-0.400615	-0.189567
11	133.464	-0.47526	-0.261399
12	133.095	-0.403908	0.19325
13	127.87	-0.260879	0.258396
14	122.619	-0.622773	0.0716463
15	116.865	-0.687623	0.114637

TABLE A.10

Factor Loadings (Marginal Products of Factors)

12 Years of Education/Weekly Wages

Years	Factor 1	Factor 2	Factor 3
1	155.54	0.369054	0.1927
2	160.181	0.465792	0.0457787
3	164.093	0.491042	0.0358081
4	163.707	0.327097	-0.117446
5	163.224	0.114085	-0.0436968
6	170.272	0.0607615	-0.0721708
7	173.785	-0.112057	-0.0484072
8	165.158	-0.0353485	-0.00648102
9	155.277	-0.0807565	-0.0341008
10	158.911	-0.163606	-0.021682
11	161.74	-0.115774	-0.132204
12	162.375	-0.348642	0.0608457
13	156.923	-0.0906543	0.0115206
14	150.616	-0.419644	0.140491
15	145.399	-0.539412	0.0153002

TABLE A.11

Factor Loadings (Marginal Products of Factors)

13-15 Years of Education/Weekly Wages

Years	Factor 1	Factor 2	Factor 3
1	182.706	0.572932	0.157406
2	188.039	0.789706	0.0585603
3	193.201	0.491194	-0.0293707
4	196.82	0.208957	0.0614297
5	191.246	0.147551	-0.0598179
6	201.687	-0.539776	0.262369
7	205.619	0.0217921	-0.451892
8	197.026	-0.265646	-0.323328
9	178.433	-0.129682	0.0145596
10	182.823	-0.178892	0.173939
11	181.538	-0.145817	0.0683191
12	185.776	-0.687665	0.0767118
13	173.776	0.0401345	0.153395
14	169.112	-0.110228	0.0157363
15	164.403	-0.236979	-0.130234

TABLE A.12

Factor Loadings (Marginal Products of Factors)

16 Years of Education/Weekly Wages

Years	Factor 1	Factor 2	Factor 3
1	239.956	1.05513	-0.0573112
2	244.731	1.25855	0.113626
3	259.17	0.445988	0.667852
4	258.649	0.660414	0.214732
5	259.618	0.590209	-0.224815
6	266.051	0.608908	-0.498519
7	269.326	0.115964	0.0195231
8	258.31	-0.690186	-0.172379
9	236.227	-0.111222	-0.281715
10	238.228	-0.561159	-0.393502
11	238.002	-0.867409	0.0281153
12	234.886	-0.818041	0.2015
13	229.565	-0.877571	0.107698
14	220.613	-0.748382	0.114838
15	210.43	-0.430844	0.208127

TABLE A.13

Factor Loadings (Marginal Products of Factors)

8-11 Years of Education/Annual Income

Years	Factor 1	Factor 2	Factor 3
1	6087.13	35.7866	20.084
2	6258.95	37.3097	9.99706
3	6391.73	52.5799	6.78007
4	6283.5	33.2665	0.209441
5	6291.56	5.45342	-15.665
6	6556.85	1.91171	-13.6145
7	6765.08	22.2801	-18.5531
8	6299.44	1.23304	-11.635
9	5795.37	-19.904	-1.5611
10	6017.59	-31.0973	-6.79769
11	6144.65	-28.1535	-3.16658
12	6252.09	-25.4428	2.37506
13	6053.39	-22.238	16.6305
14	5559.4	-37.9041	9.09155
15	5329.14	-41.6423	11.3532

TABLE A.14

Factor Loadings (Marginal Products of Factors)

12 Years of Education/Annual Income

Years	Factor 1	Factor 2	Factor 3
1	7633.32	29.0131	13.9513
2	7862.37	35.4852	3.07497
3	8070.36	33.0262	2.0975
4	7945.09	16.8935	-7.41939
5	7826.73	9.03734	-7.36654
6	8319.89	3.00288	-6.07076
7	8441.41	-3.3574	-1.81926
8	7978.97	-0.703989	-1.3059
9	7501.16	-13.694	-2.43485
10	7745.12	-14.6592	-1.28181
11	7907.1	-12.9542	-9.62613
12	7953.58	-12.7572	0.959216
13	7735.91	-5.90021	3.76639
14	7303.04	-32.0007	11.3013
15	7046.41	-37.3916	4.29955

TABLE A.15

Factor Loadings (Marginal Products of Factors)

13-15 Years of Education/Annual Income

Years	Factor 1	Factor 2	Factor 3
1	9052.97	45.6958	10.15
2	9302.64	54.2215	0.368995
3	9604.28	37.0382	-6.09949
4	9610.34	12.9083	0.604393
5	9387.41	7.09435	-3.27638
6	9916.63	-38.8271	12.1159
7	10024.2	-16.3369	-11.4625
8	9637.68	-16.571	-10.142
9	8857.07	-12.8041	5.02098
10	9032.2	-25.5474	7.23896
11	9013.07	-13.9227	0.13116
12	8947.08	13.8976	-5.19091
13	8695.31	2.00657	7.89226
14	8424.89	-21.9946	-1.28453
15	8167.57	-29.7279	-5.10434

TABLE A.16

Factor Loadings (Marginal Products of Factors)

16 Years of Education/Annual Income

Years	Factor 1	Factor 2	Factor 3
1	12014	56.3361	6.23682
2	12220	64.0604	14.2946
3	13042.6	19.357	38.7483
4	12826.3	35.8191	13.51
5	12947.7	28.6625	-16.9688
6	13276.3	38.1595	-33.9256
7	13478.1	2.55007	-7.48866
8	12943.5	-35.7132	-10.0258
9	11988	-9.59484	-19.8015
10	11833.3	-9.71028	-18.4575
11	12075.7	-47.2661	-1.00558
12	11915.5	-40.7449	8.90509
13	11689.3	-48.4731	9.54032
14	11204.1	-43.8088	6.51799
15	10677.9	-26.0102	14.0315

Figure A.9: Predicted Wage Profiles 8-11 Years of Schooling
(Weekly Wages -- Measured in Standard Deviations About the Mean)

(N) Minimum factor 2 load
(X) Maximum factor 2 load
(R) Reference profile

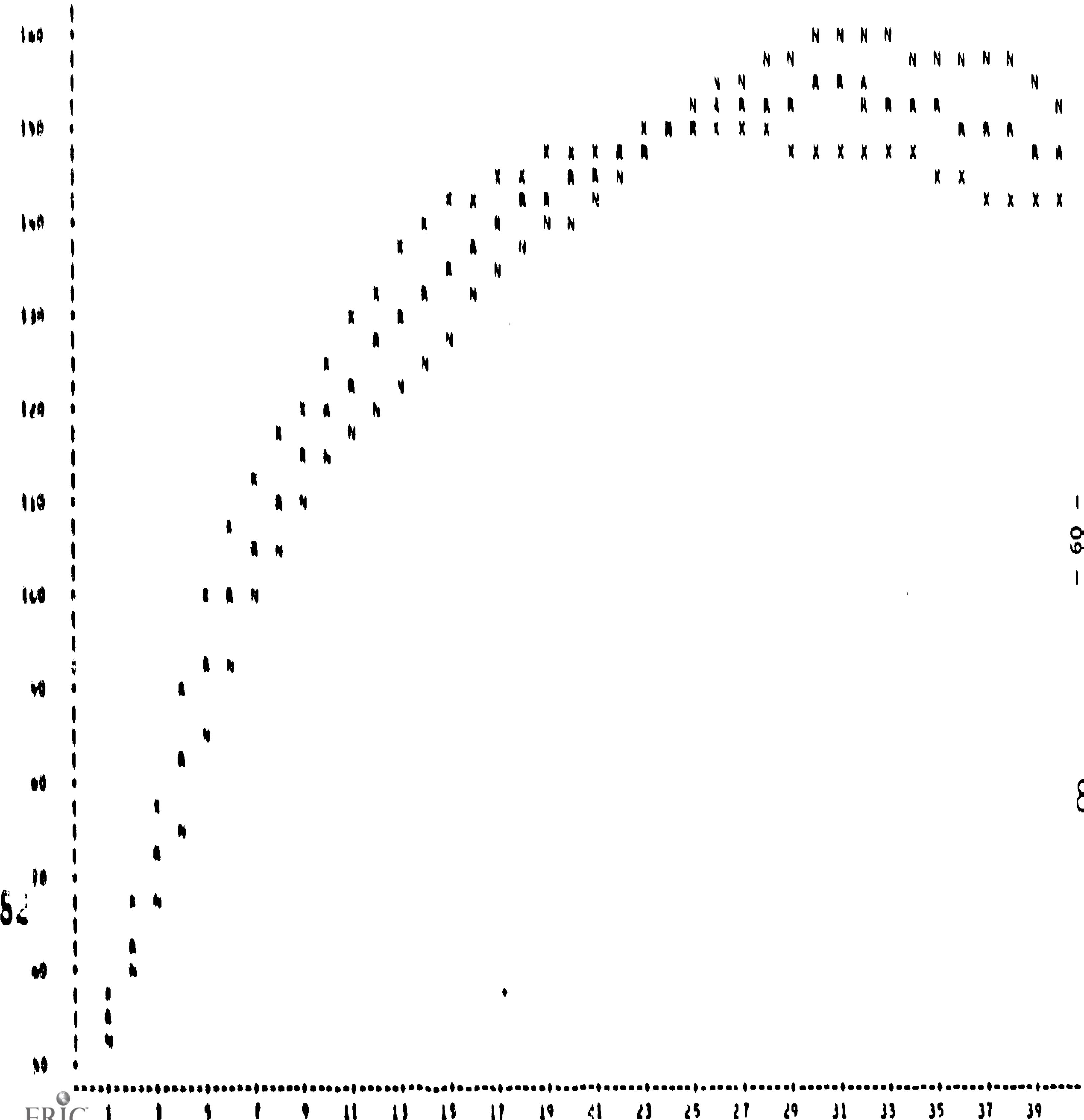

Figure A.10: Predicted Wage Profiles 12 Years of Schooling
(Weekly Wages -- Measured in Standard Deviations About the Mean)

(N) Minimum factor 2 load
(X) Maximum factor 2 load
(R) Reference Profile

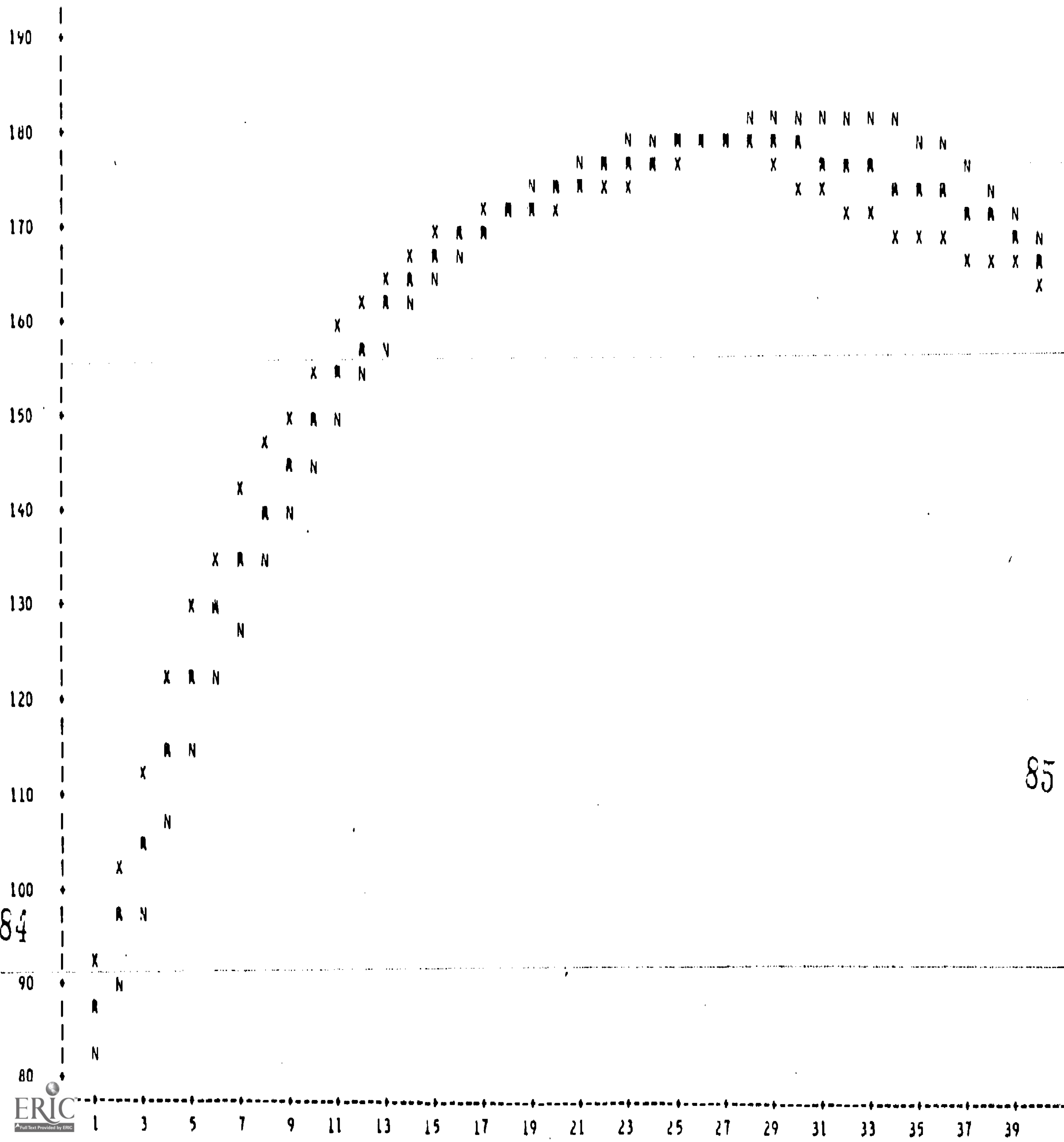

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Figure A.11: Predicted Wage Profiles 13-15 Years of Schooling
(Weekly Wages -- Measured in Standard Deviations About the Mean)

(N) Minimum factor 2 load
(X) Maximum factor 2 load
(R) Reference profile

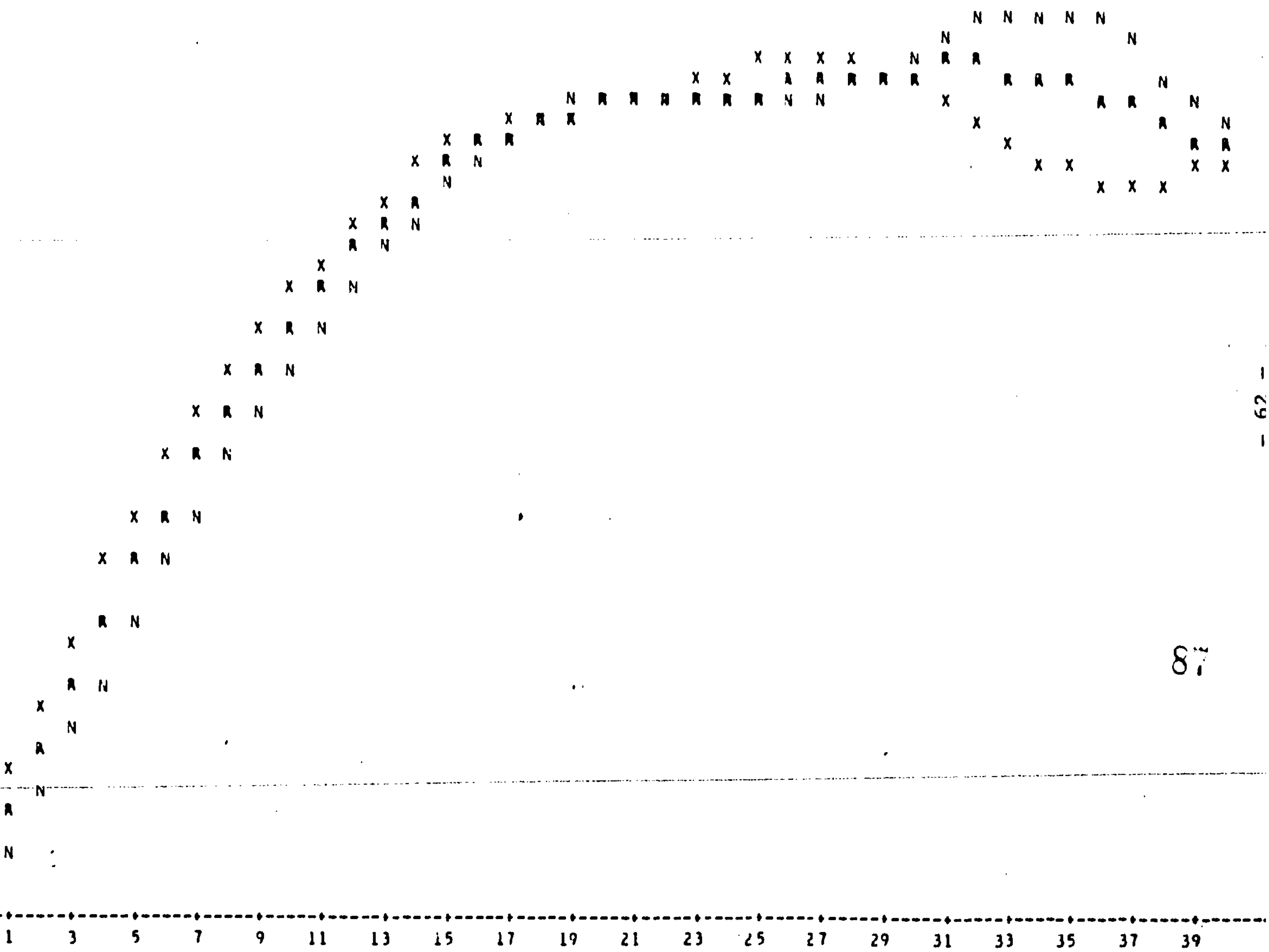


Figure A.12: Predicted Wage Profiles 16 Years of Schooling
(Weekly Wages -- Measured in Standard Deviations About the Mean)

(N) Minimum factor 2 load
(X) Maximum factor 2 load
(R) Reference profile

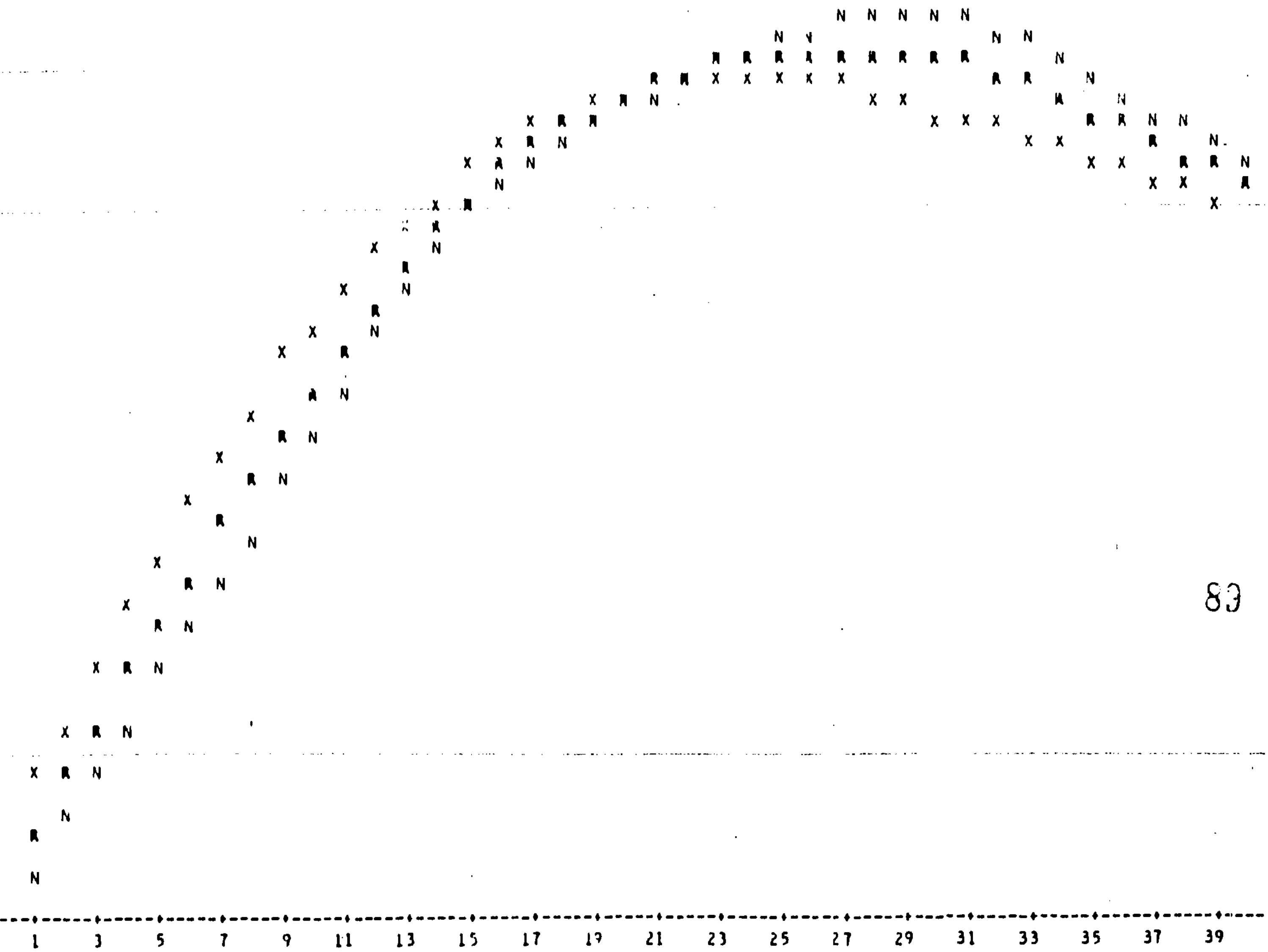


Figure A.13: Predicted Wage Profiles 8-11 Years of Schooling
(Annual Income -- Measured in Standard Deviations About the Mean)

(N) Minimum factor 2 load
(X) Maximum factor 2 load
(R) Reference profile

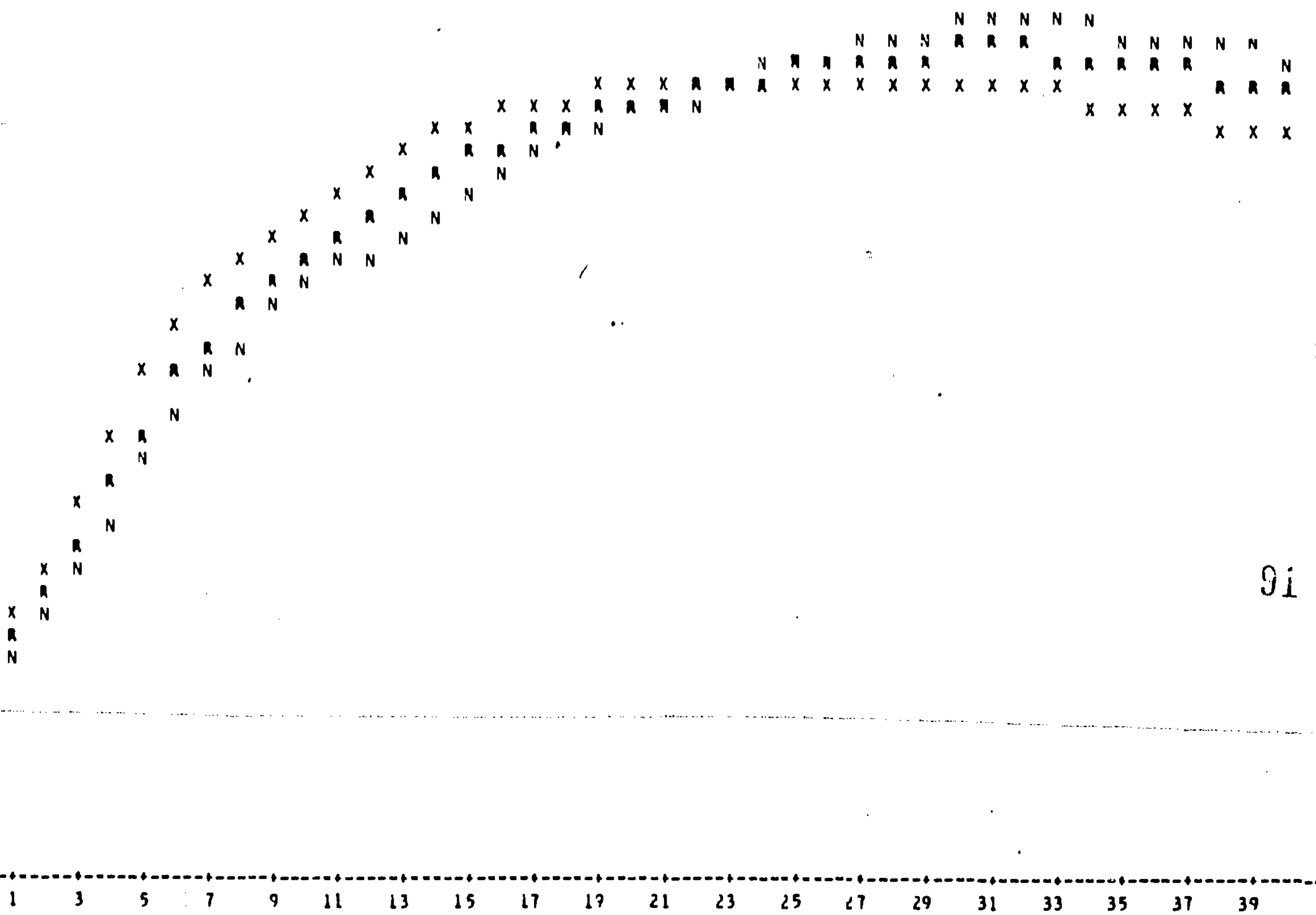
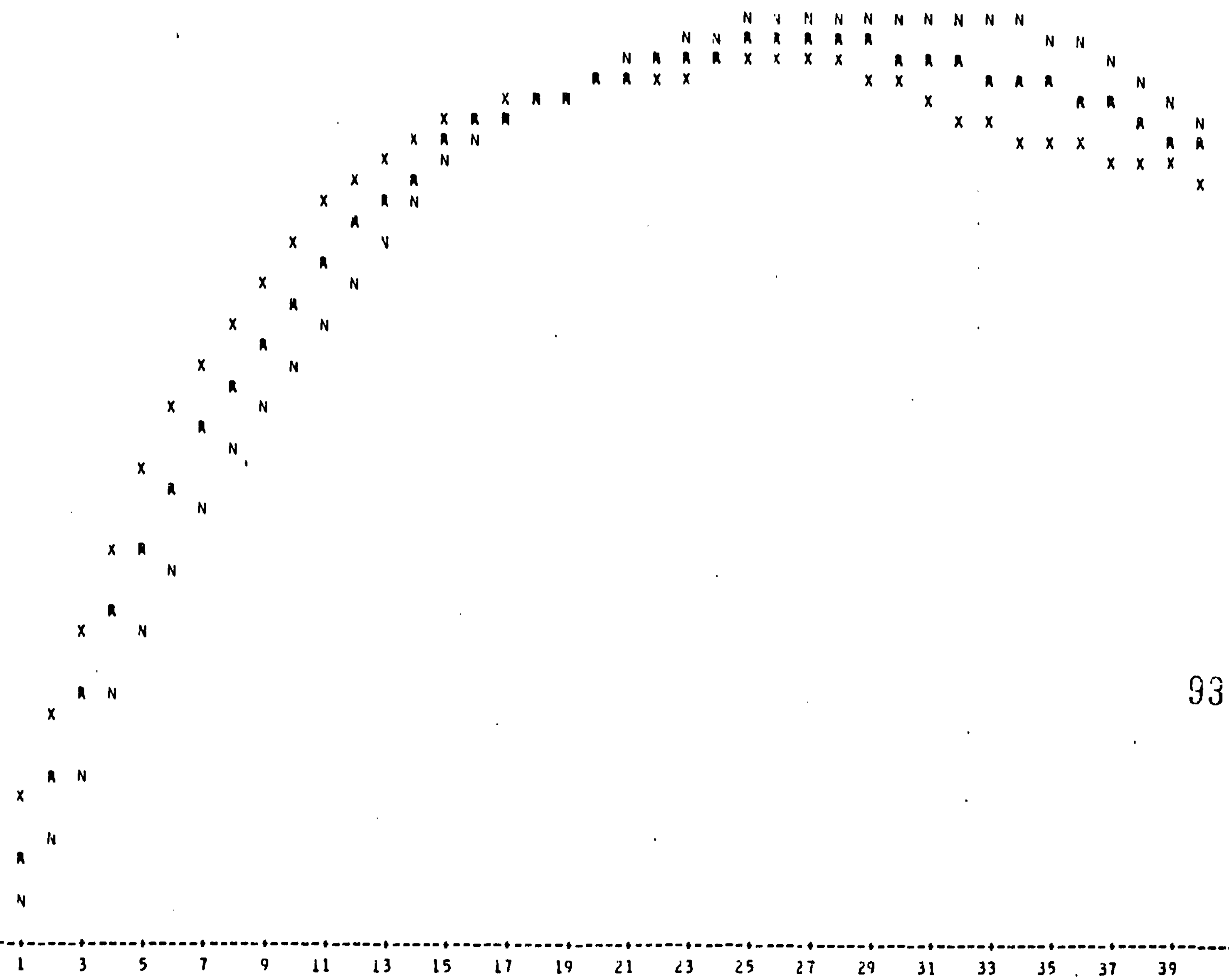


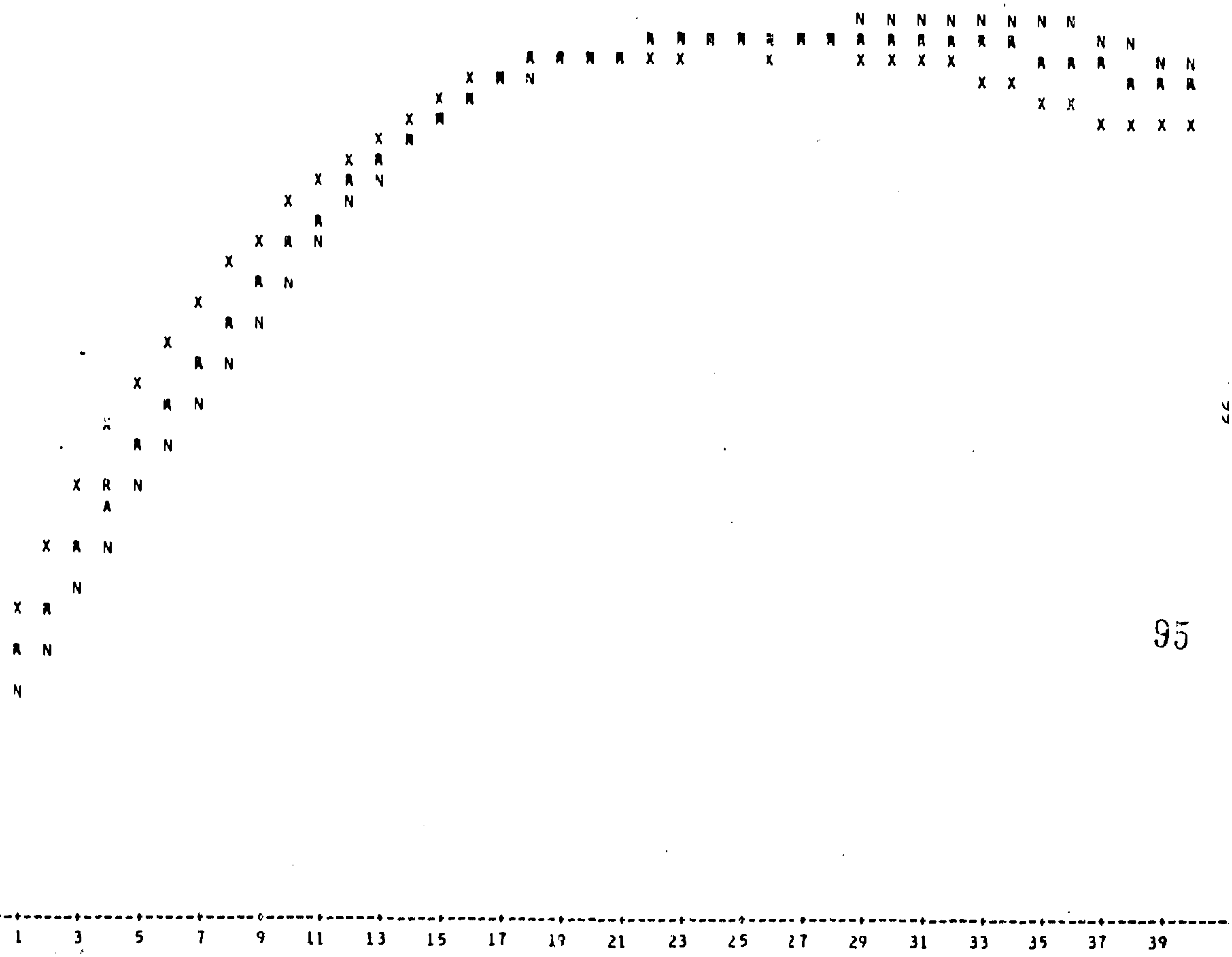
Figure A.14: Predicted Wage Profiles 12 Years of Schooling
(Annual Income -- Measured in Standard Deviations About the Mean)

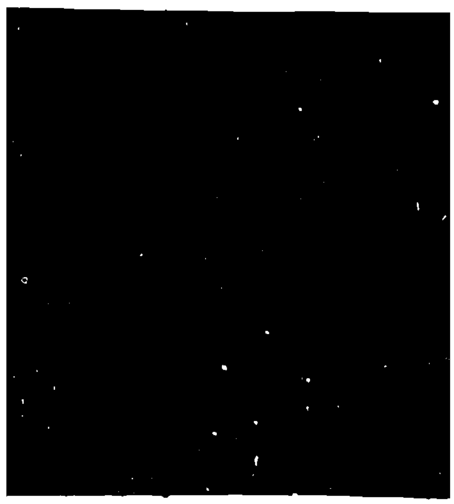
(N) Minimum factor 2 load
(X) Maximum factor 2 load
(R) Reference profile

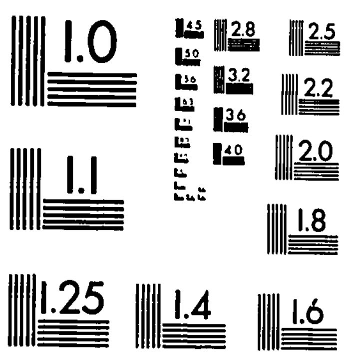


(Annual Income -- Measured in Standard Deviations About the Mean)

(N) Minimum factor 2 load
(X) Maximum factor 2 load
(R) Reference profile







MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS
STANDARD REFERENCE MATERIAL 1010a
(ANSI and ISO TEST CHART No. 2)

(Annual Income -- Measured in Standard Deviations About the Mean)

(N) Minimum factor 2 load
(X) Maximum factor 2 load
(R) Reference profile

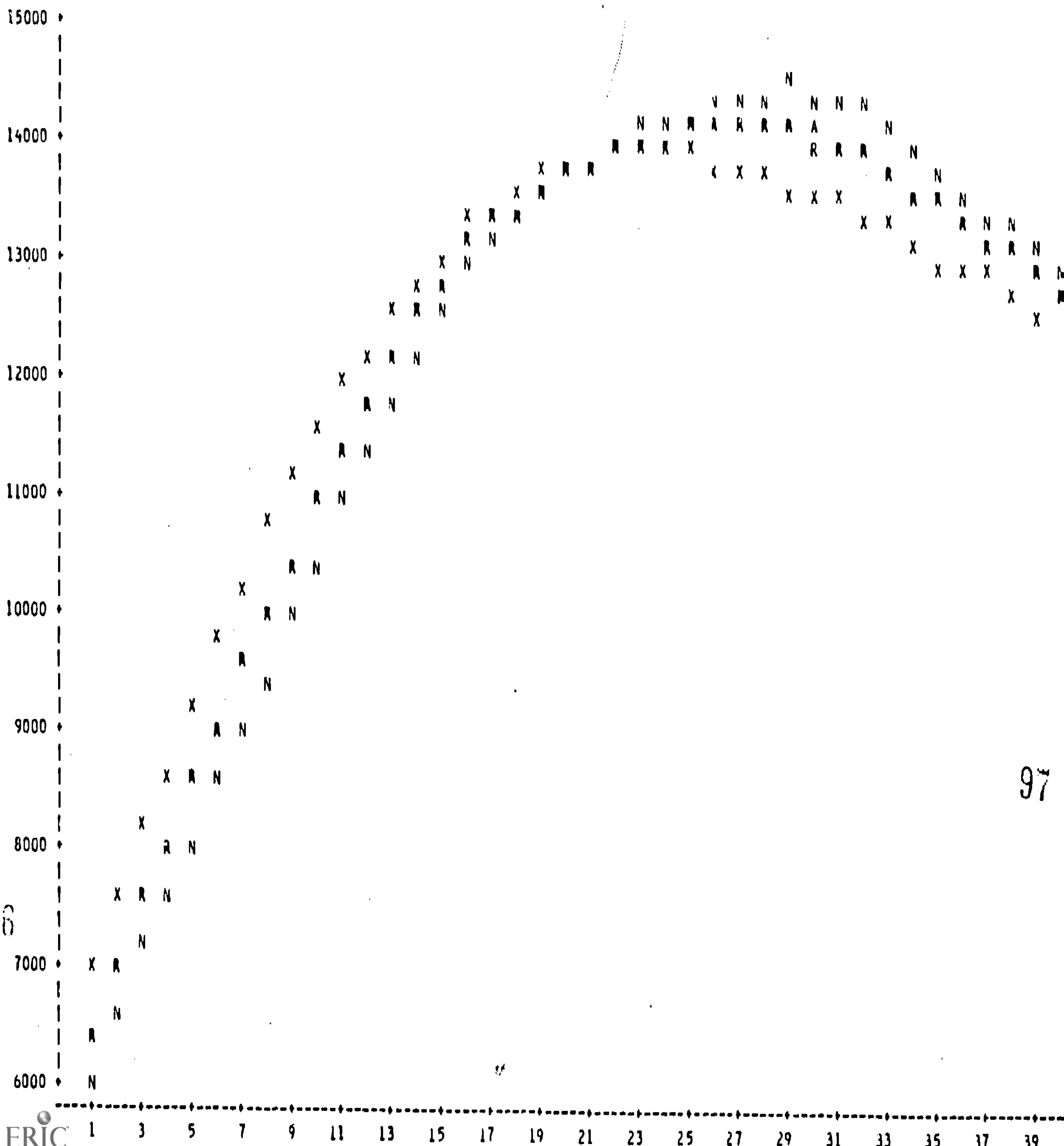


TABLE A.17

Fraction of Variance Explained by Factor Decomposition

Numbers of Factors	8-11 Years (a)	8-11 Years (b)	High School Graduates (a)	High School Graduates (b)	13-15 Years (a)	13-15 Years (b)	College Graduates (a)	College Graduates (b)
1	0.998		0.999		0.999		0.999	
2	0.999	0.714	0.999	0.721	0.999	0.604	0.999	0.536
3	0.999	0.880	0.999	0.862	0.999	0.788	0.999	0.816
4	0.999	0.918	0.999	0.909	0.999	0.873	0.999	0.927
5	0.999	0.949	0.999	0.941	0.999	0.927	0.999	0.970
6	0.999	0.967	0.999	0.965	0.999	0.962	0.999	0.981
7	0.999	0.980	0.999	0.984	0.999	0.982	0.999	0.990
8	0.999	0.987	1.000	0.993	1.000	0.994	1.000	0.993
9	0.999	0.992	1.000	0.997	1.000	0.997	1.000	0.996
10	0.999	0.994	1.000	0.998	1.000	0.998	1.000	0.997
11	1.000	0.997	1.000	0.999	1.000	0.999	1.000	0.998
12	1.000	0.998	1.000	0.999	1.000	0.999	1.000	0.999
13	1.000	0.999	1.000	0.999	1.000	0.999	1.000	0.999
14	1.000	0.999	1.000	0.999	1.000	0.999	1.000	0.999

(a) Fractions of variance explained.

(b) Fractions of residual variance explained after 1 factor included.

TABLE A.18

Regressions of Relative Factor Marginal Products On Relative Cohort Size

	Educational Level			
	8-11	12	13-15	16 +
W2/W1 on				
Constant	0.00814	0.00126	0.0121	0.0434
	(0.00220)	(0.00245)	(0.00119)	(0.0128)
N2/N1	-0.00347	-0.00333	-0.00226	-0.00944
	(0.00262)	(0.000921)	(0.00332)	(0.00286)
N3/N1	-0.00425	-0.000412	-0.00104	0.00246
	(0.00255)	(0.000729)	(0.000225)	(0.00175)
R Squared	0.884	0.838	0.541	0.607
W3/W1 on				
Constant	0.00458	0.00338	0.000831	-0.00613
	(0.00181)	(0.00132)	(0.00437)	(0.00662)
N2/N1	0.00666	0.00151	-0.000198	0.00155
	(0.00215)	(0.000494)	(0.00122)	(0.00147)
N3/N1	-0.00607	-0.00129	-0.0000609	0.00226
	(0.00209)	(0.000391)	(0.000826)	(0.000904)
R Squared	0.443	0.480	0.0083	0.474

Note: n = 15 for all regressions, Based on decomposition of annual income. Standard errors in parentheses.

TABLE A.19

Regressions of Relat ctor Marginal Products On Relative Cohort Size

Incl Business Cycle Measures

Educa onal Level: 8-11 Years

W2/W1 on			
Constant	0.00814 (0.00220)	0.00108 (0.00161)	0.00800 (0.00235)
N2/N1	-0.00347 (0.00262)	-0.00323 (0.000176)	-0.00342 (0.00274)
N3/N1	-0.00425 (0.00255)	-0.00248 (0.00176)	-0.00429 (0.00226)
Unemployment Rate		-0.00187 (0.000470)	
Δ GNP			0.0000564 (0.000211)
R Squared	0.884	0.952	0.885
W3/W1 on			
Constant	0.00458 (0.00181)	0.00543 (0.00197)	0.00497 (0.00187)
N2/N1	0.00666 (0.00215)	0.00673 (0.00214)	0.00652 (0.00217)
N3/N1	-0.00607 (0.00209)	-0.00549 (0.00216)	-0.00597 (0.00211)
Unemployment Rate		-0.000602 (0.000573)	
Δ GNP			-0.0000157 (0.000168)
R Squared	0.443	0.494	0.484

Note: n = 15 for all regressions, Based on decomposition of annual income. Standard errors in parentheses.

TABLE A.20

Regressions of Relative Factor Marginal Products On Relative Cohort Size

Including Business Cycle Measures*

Educational Level: High School Graduates

W2/W1 on			
Constant	0.0126 (0.00245)	0.0128 (0.00207)	0.0117 (0.00257)
N2/N1	−0.00333 (0.000921)	−0.00281 (0.00081)	−0.00311 (0.000934)
N3/N1	−0.00412 (0.00029)	−0.0000599 (0.000633)	−0.000585 (0.000741)
Unemployment Rate		−0.000945 (0.000392)	
Δ GNP			−0.000149 (0.000136)
R Squared	0.838	0.894	0.854
W3/W1 on			
Constant	−0.00338 (0.00132)	−0.00330 (0.00131)	−0.00318 (0.00145)
N2/N1	0.000151 (0.000494)	0.00165 (0.000511)	0.00146 (0.000524)
N3/N1	−0.00129 (0.000391)	−0.00119 (0.000401)	−0.00125 (0.000416)
Unemployment Rate		−0.000255 (0.000248)	
Δ GNP			−0.0000304 (0.0000768)
R Squared	0.480	0.526	0.487

Note: n = 15 for all regressions, Based on decomposition of annual income. Standard errors in parentheses.

TABLE A.21

Regressions of Relative Factor Marginal Products On Relative Cohort Size

Including Business Cycle Measures*

Educational Level: 13-15 Years

W2/W1 on			
Constant	0.0121 (0.0119)	0.0105 (0.0110)	0.0121 (0.0123)
N2/N1	−0.00226 (0.00332)	−0.00118 (0.00312)	−0.00239 (0.00342)
N3/N1	−0.00104 (0.00225)	−0.000942 (0.00208)	−0.000999 (0.00232)
Unemployment Rate		−0.00123 (0.000694)	
Δ GNP			0.00151 (0.000249)
R Squared	0.541	0.642	0.557
W3/W1 on			
Constant	0.00831 (0.00437)	0.00118 (0.00440)	0.00847 (0.00453)
N2/N1	−0.000198 (0.00122)	−0.000430 (0.00125)	−0.000227 (0.00126)
N3/N1	0.0000609 (0.000826)	0.0000395 (0.00830)	0.0000712 (0.000857)
Unemployment Rate		0.000263 (0.000277)	
Δ GNP			−0.0000361 (0.0000920)
R Squared	0.0083	0.083	0.0220

Note: n = 15 for all regressions, Based on decomposition of annual income. Standard errors in parentheses.

TABLE A.22

Regressions of Relative Factor Marginal Products On Relative Cohort Size

Including Business Cycle Measures*

Educational Level: College Graduates

W2/W1 on			
Constant	0.0434 (0.0128)	0.0416 (0.0136)	0.0449 (0.0123)
N2/N1	-0.00944 (0.00286)	-0.00881 (0.00316)	-0.00997 (0.00274)
N3/N1	0.00246 (0.00175)	0.00253 (0.00181)	0.00269 (0.00167)
Unemployment Rate		-0.000447 (0.000797	
Δ GNP			0.000336 (0.000225)
R Squared	0.607	0.618	0.673
W3/W1 on			
Constant	-0.00613 (0.00662)	-0.00752 (0.00689)	-0.00650 (0.00678)
N2/N1	0.00155 (0.00147)	0.00206 (0.00160)	0.00170 (0.00152)
N3/N1	-0.00226 (0.000904)	-0.00221 (0.000916)	-0.000232 (0.000927)
Unemployment Rate		-0.000349 (0.000404)	
Δ GNP			0.0000891 (0.000124)
R Squared	0.474	0.508	0.497

Note: n = 15 for all regressions, Based on decomposition of annual income. Standard errors in parentheses.

Figure A.17: Residual Variances in Weekly Wage Profiles for 8-11 Years of Schooling After

(1) Zero factor (4) Third factor
(2) First factor (5) Fourth factor
(3) Second factor (6) Fifth factor

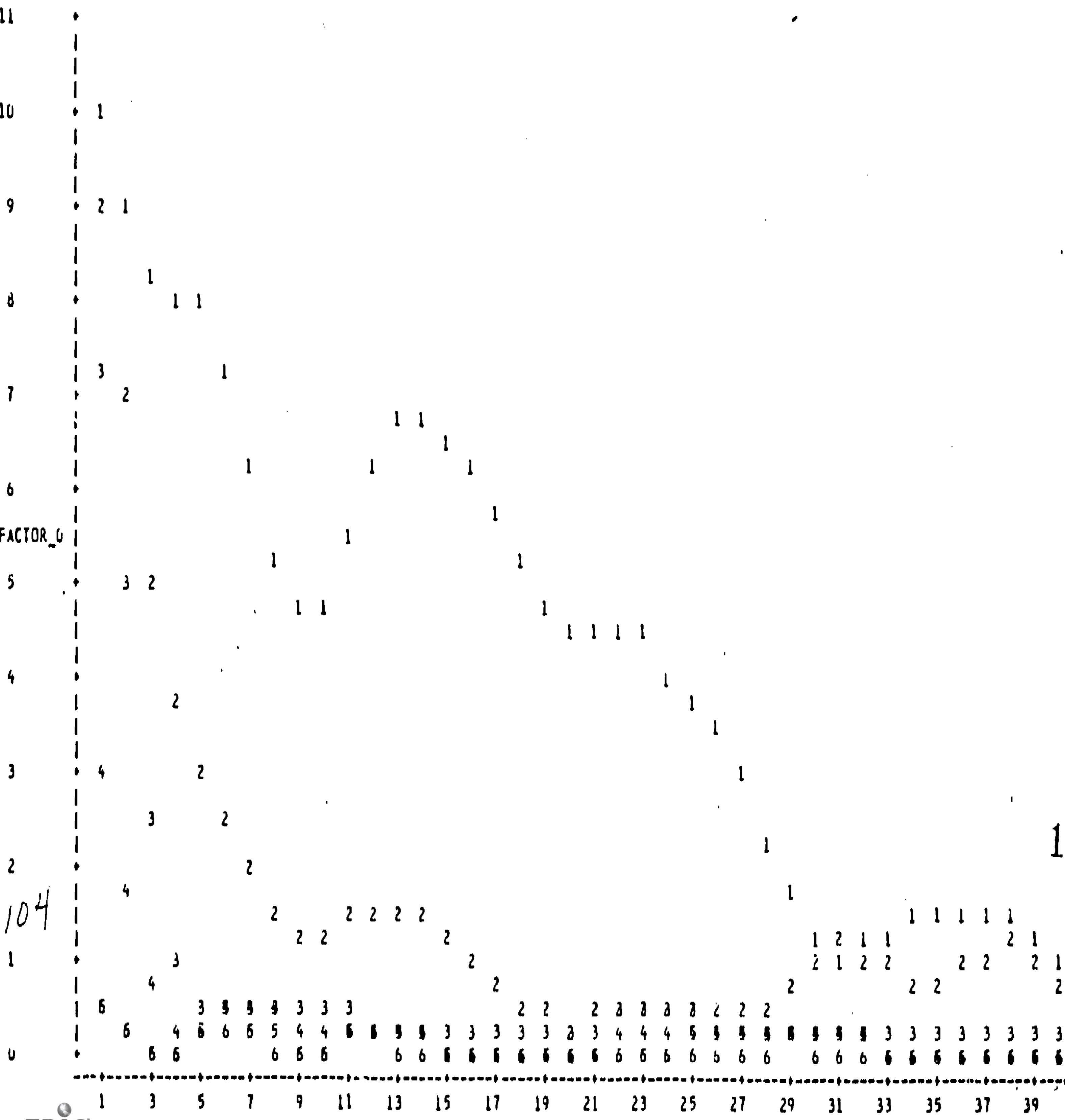


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Figure A.10. Residual Variances in Weekly Wage Profiles for 12 Years of Schooling After

(1) Zero factor (4) Third factor
(2) First factor (5) Fourth factor
(3) Second factor (6) Fifth factor

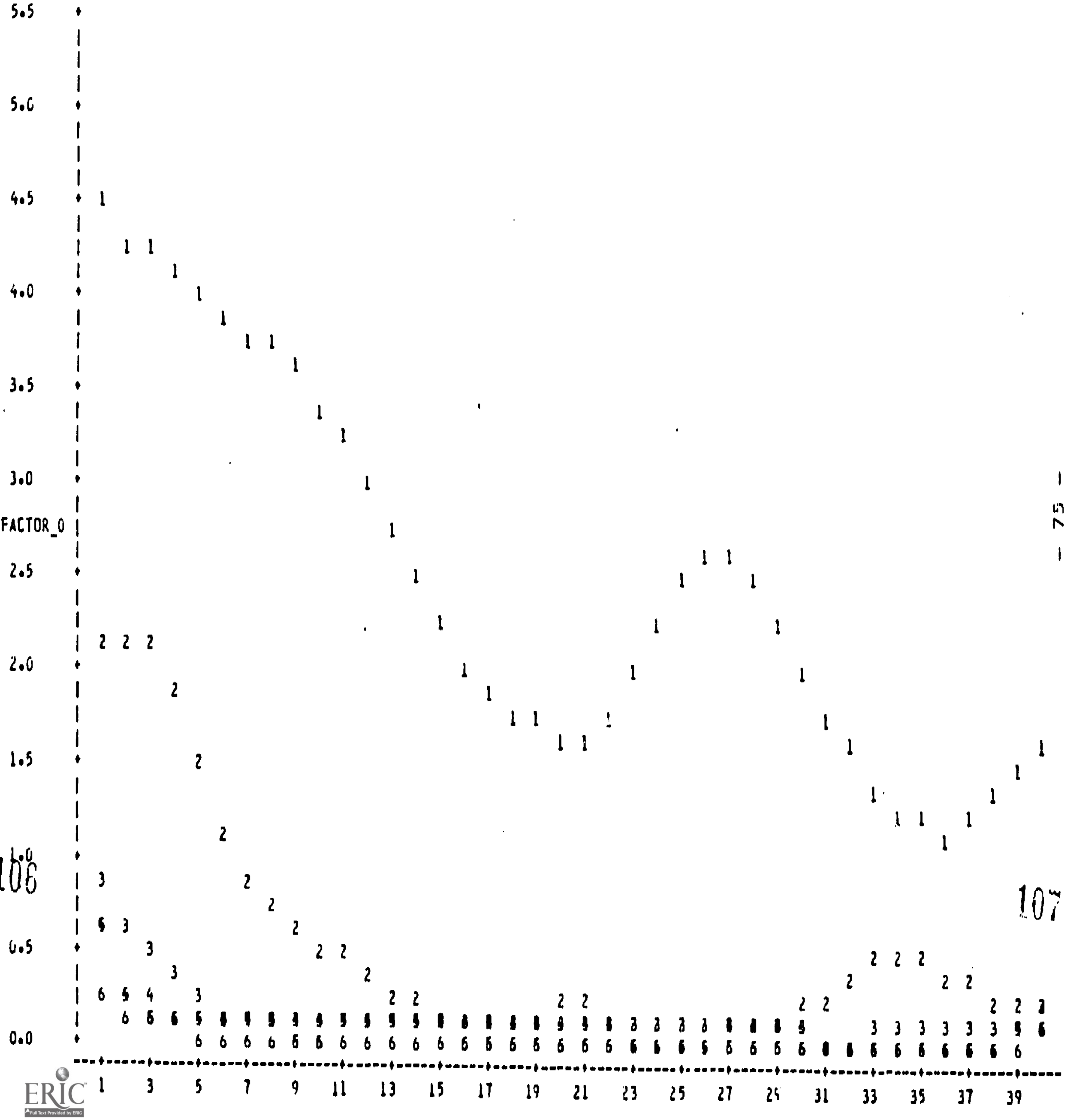

Figure A.19: Residual Variances in Weekly Wage Profiles for 13-15 Years of Schooling After

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(2) First factor (5) Fourth factor
(3) Second factor (6) Fifth factor

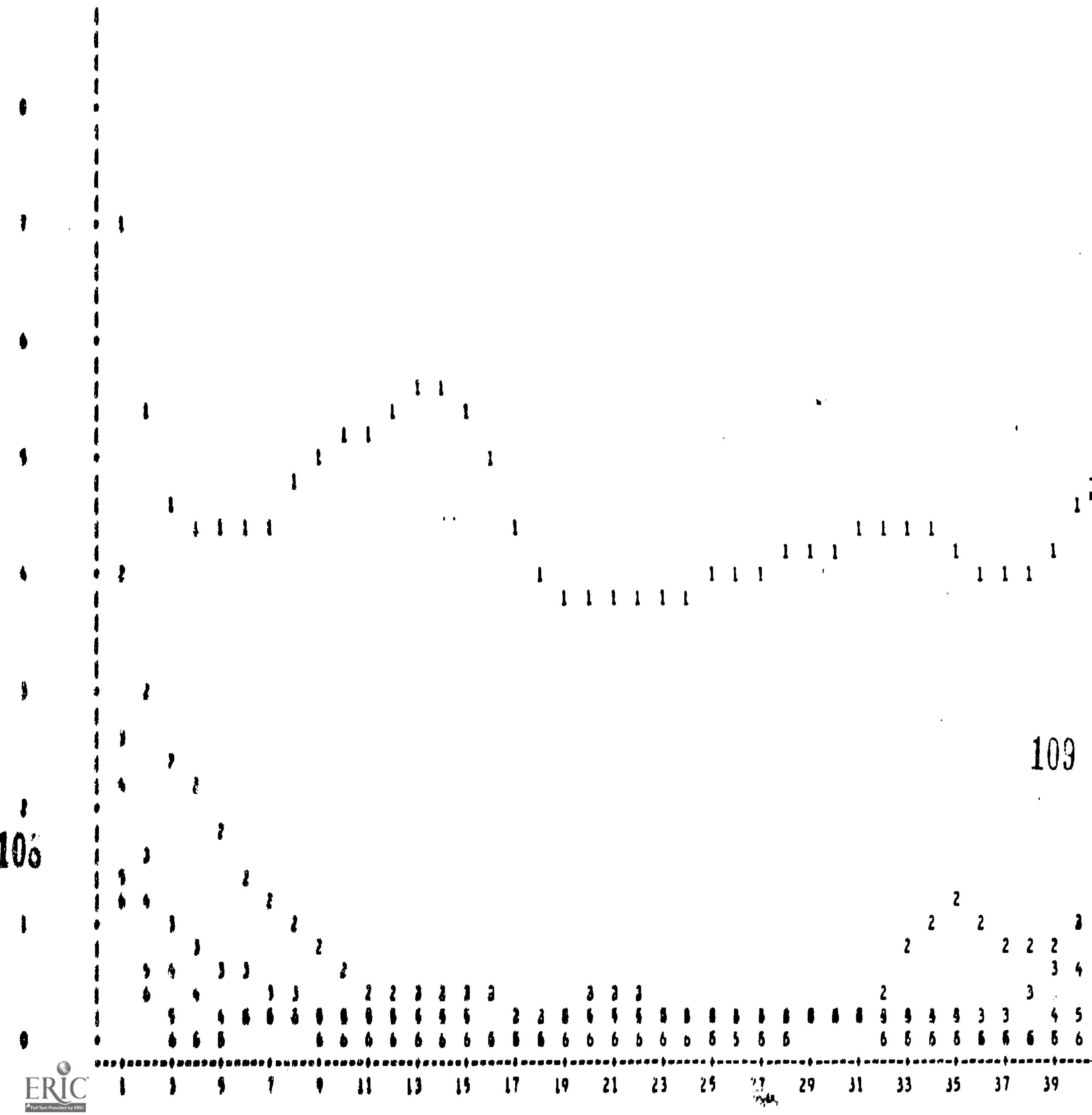

Figure A.20: Residual Variances in Weekly Wage Profiles for 16 Years of Schooling After

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(2) First factor (5) Fourth factor
(3) Second factor (6) Fifth factor

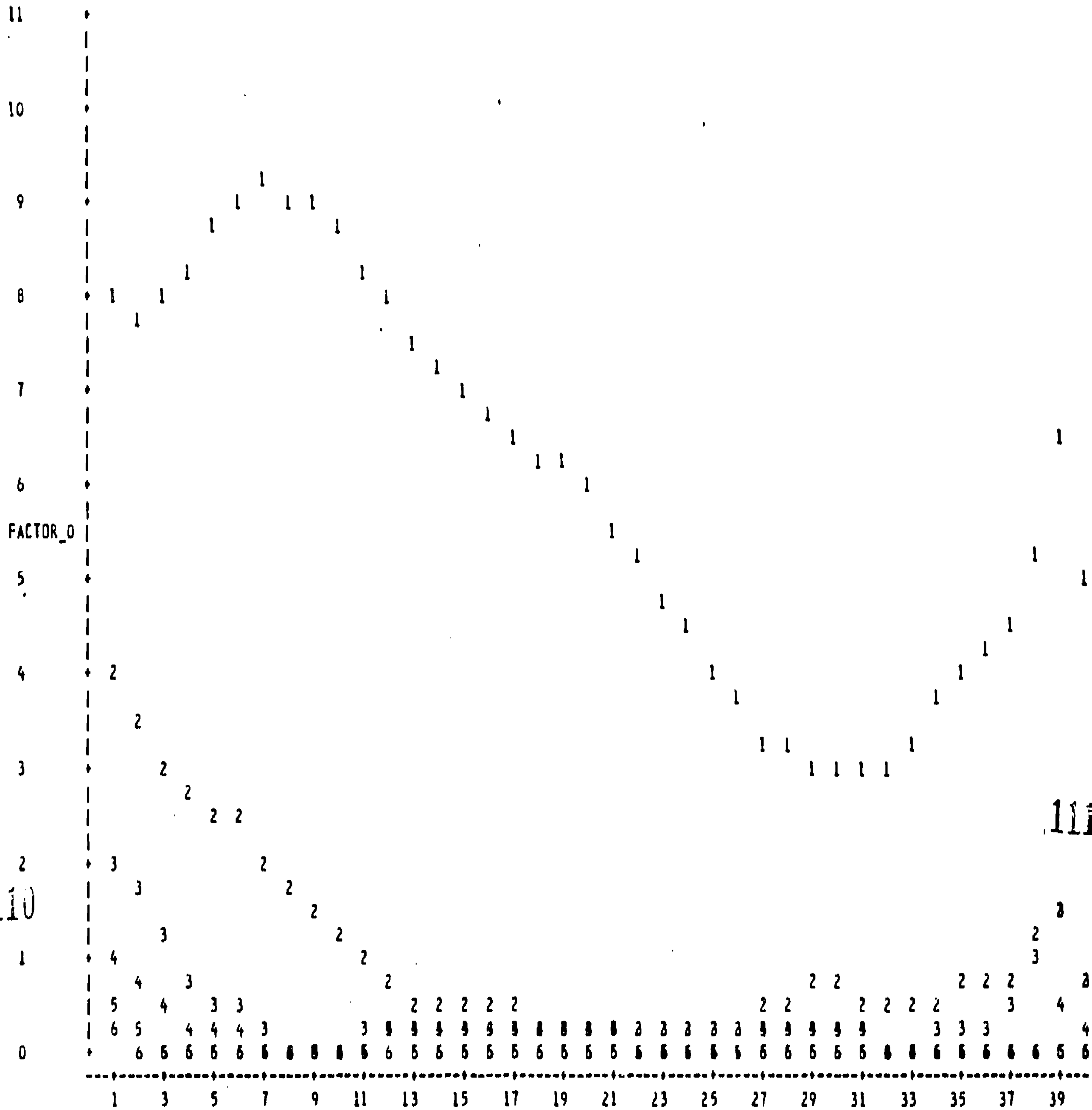

Figure A.21: Residual Variances in Annual Income Profiles for 8-11 Years of Schooling After

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(2) First factor (5) Fourth factor
(3) Second factor (6) Fifth factor

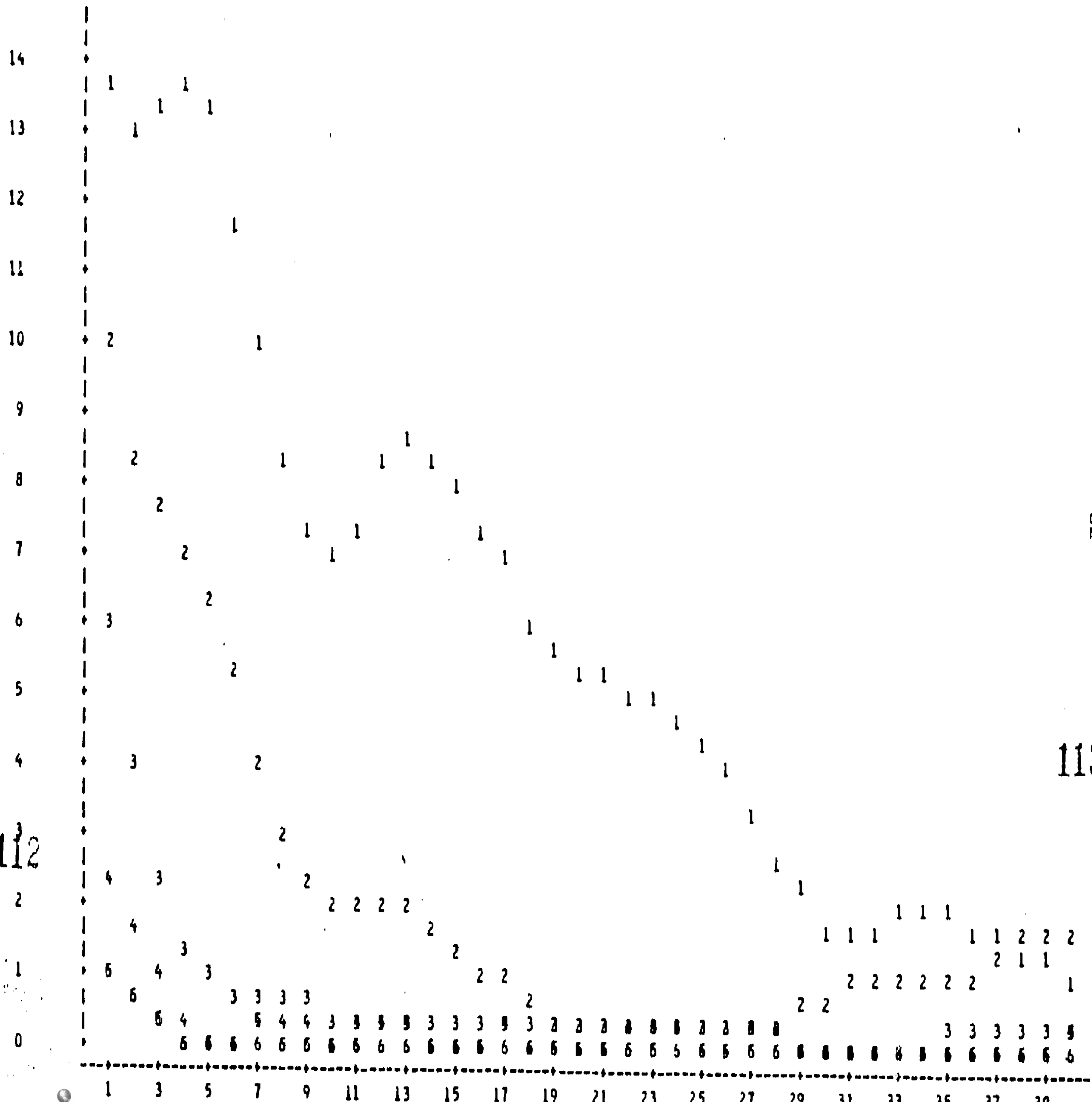

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Figure A.22: Residual Variances in Annual Income Profiles for 12 Years of Schooling After

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(2) First factor (5) Fourth factor
(3) Second factor (6) Fifth factor

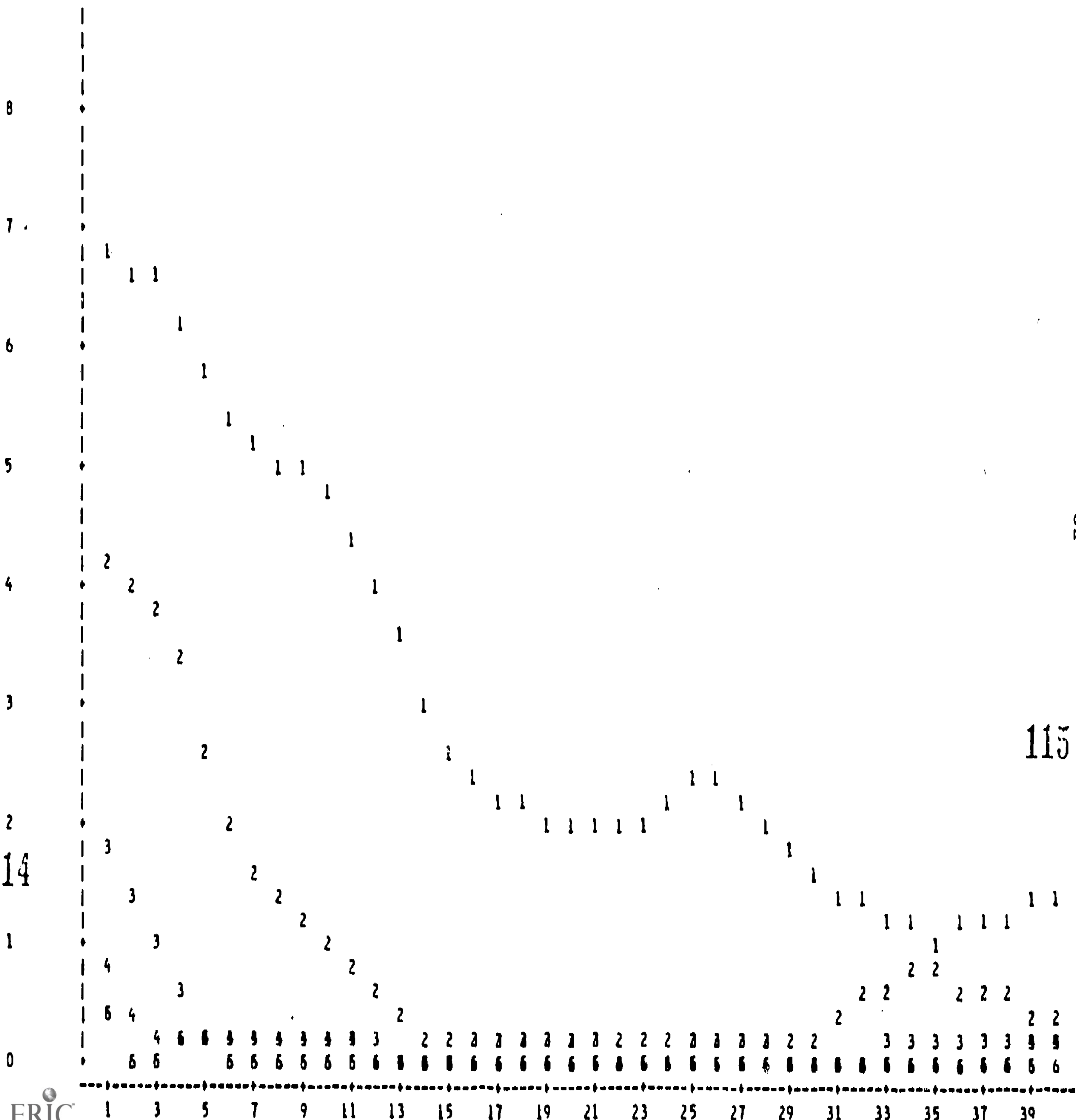

Figure A.23: Residual Variances in Annual Income Profiles for 13-15 Years of Schooling After

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(2) First factor (5) Fourth factor
(3) Second factor (6) Fifth factor

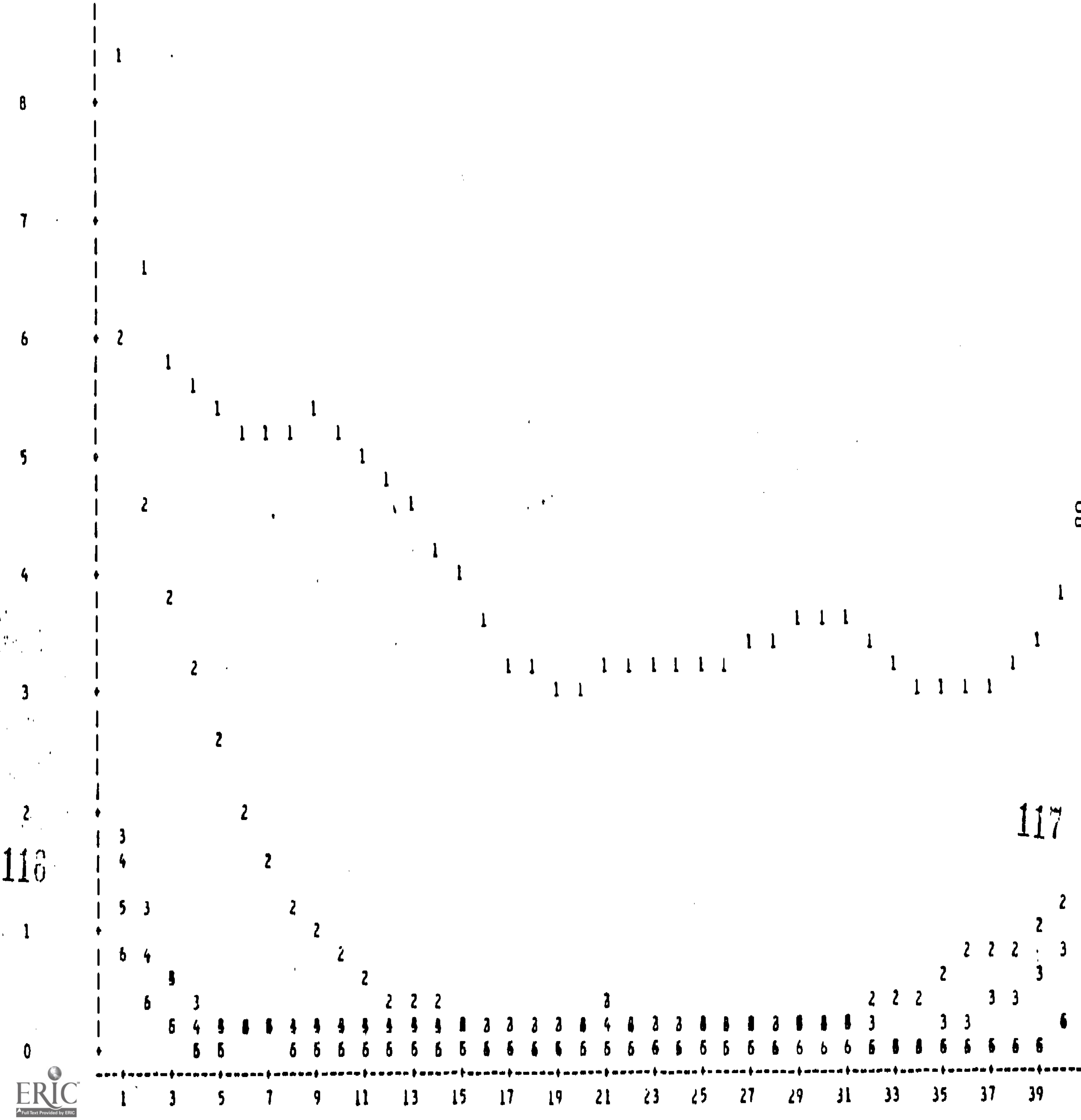

Figure A.24: Residual Variances in Annual Income Profiles for 16 Years of Schooling After

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(2) First factor (5) Fourth factor
(3) Second factor (6) Fifth factor

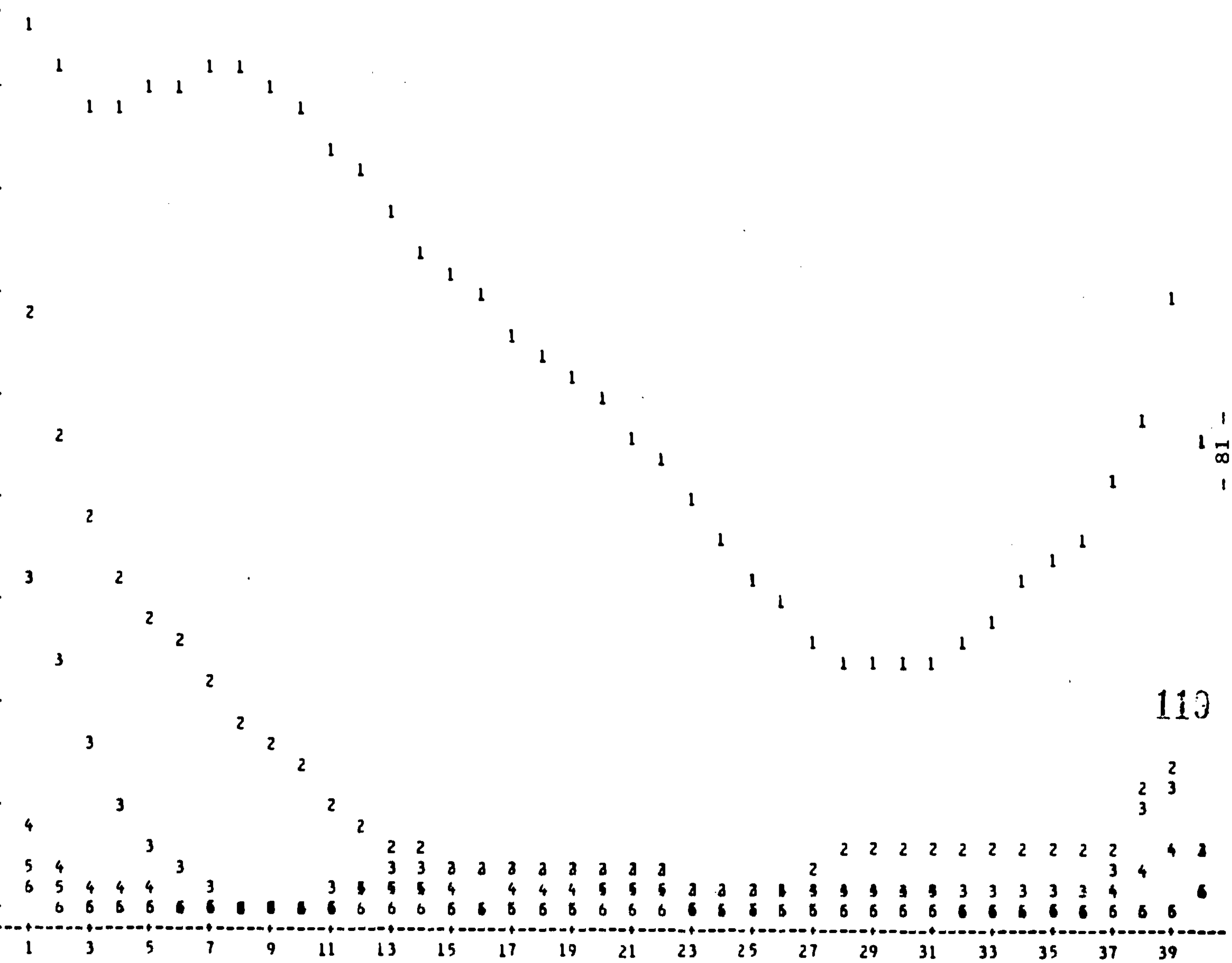
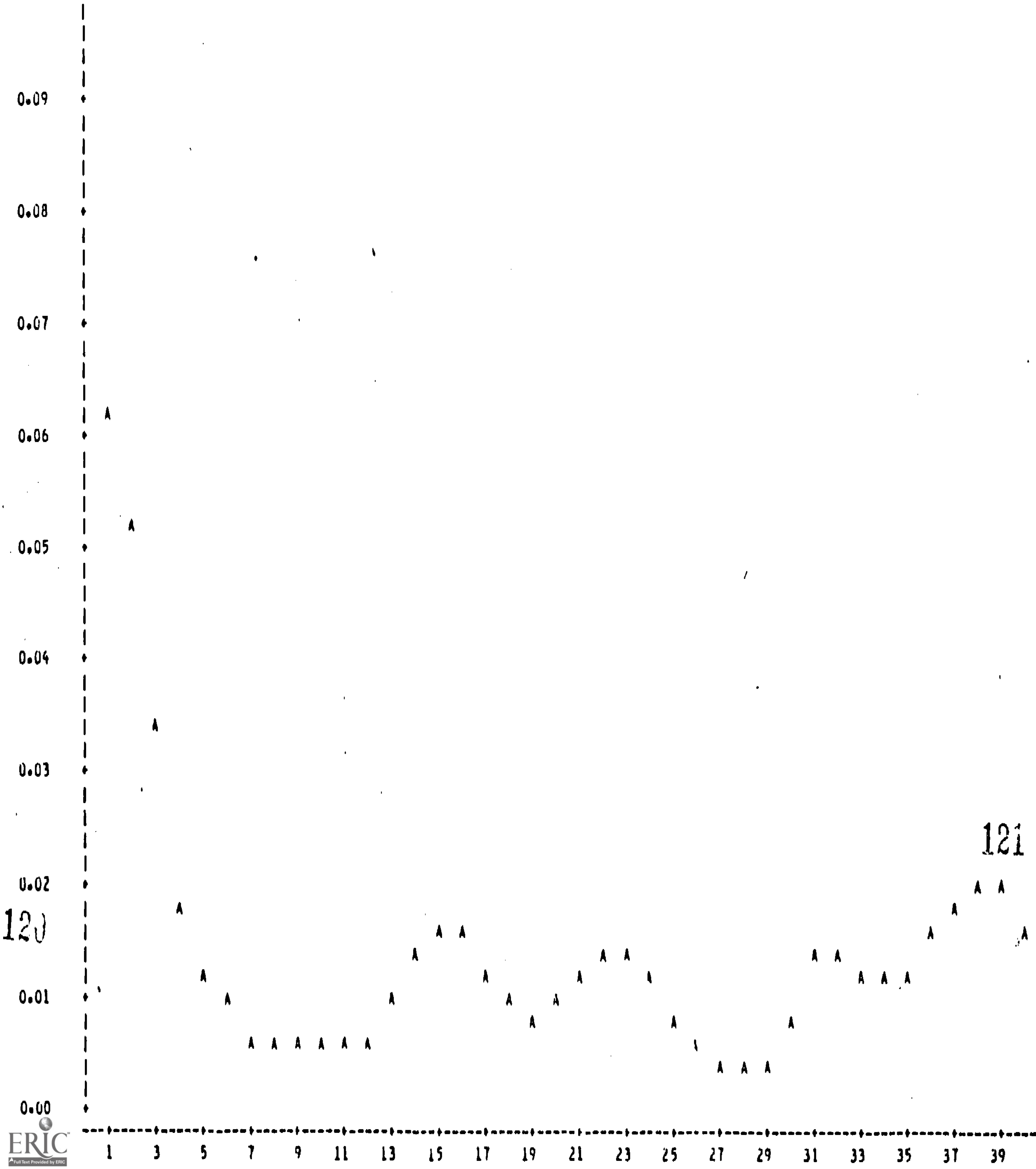


Figure A.25: Own Wage Elasticity: 8-11 Years of Schooling, Weekly Wages



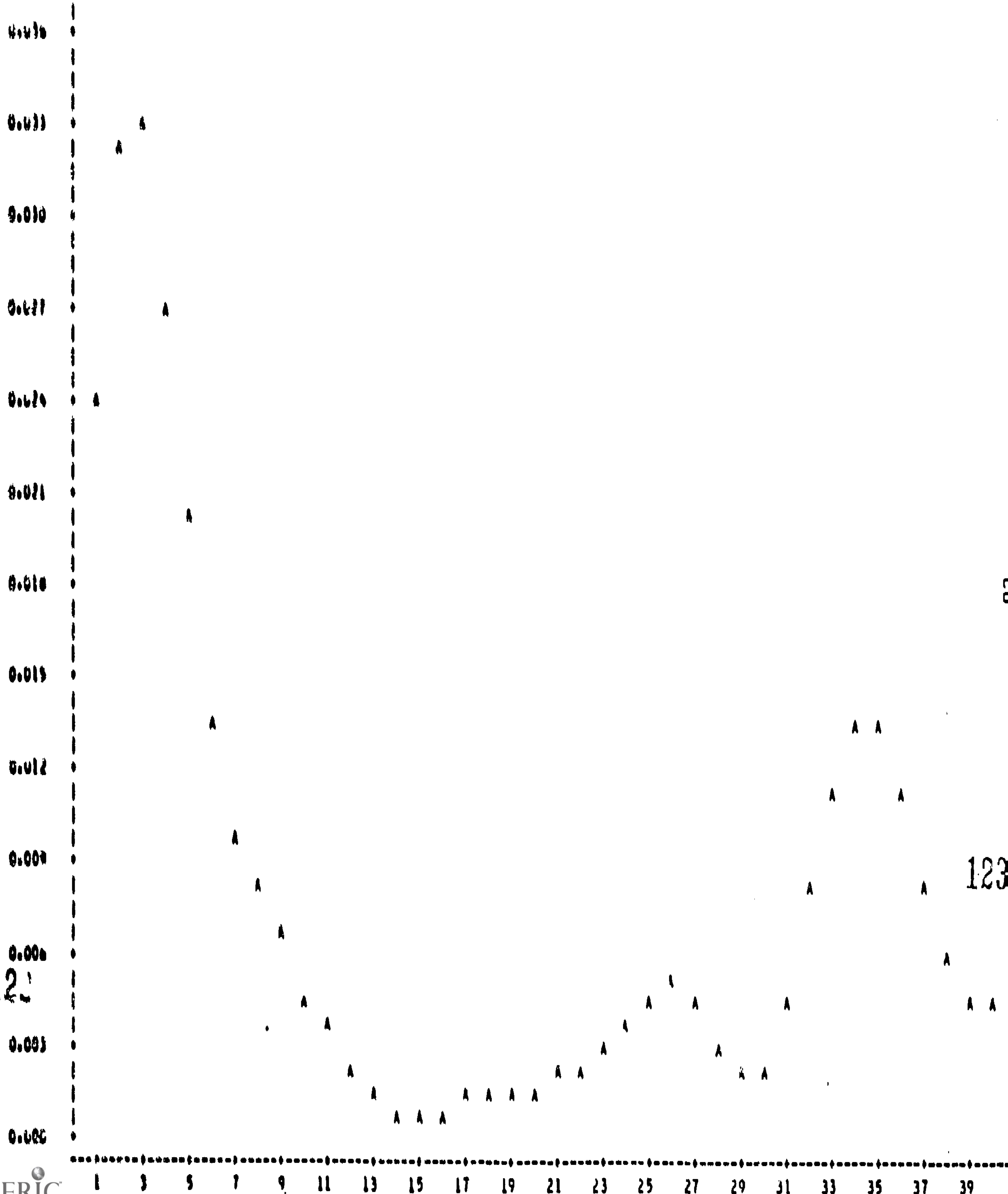

0.036
0.033
0.030
0.027
0.024
0.021
0.018
0.015
0.012
0.009
0.006
0.003
0.000
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39

Figure A.27: Own Wage Elasticity: 13-15 Years of Schooling, Weekly Wages

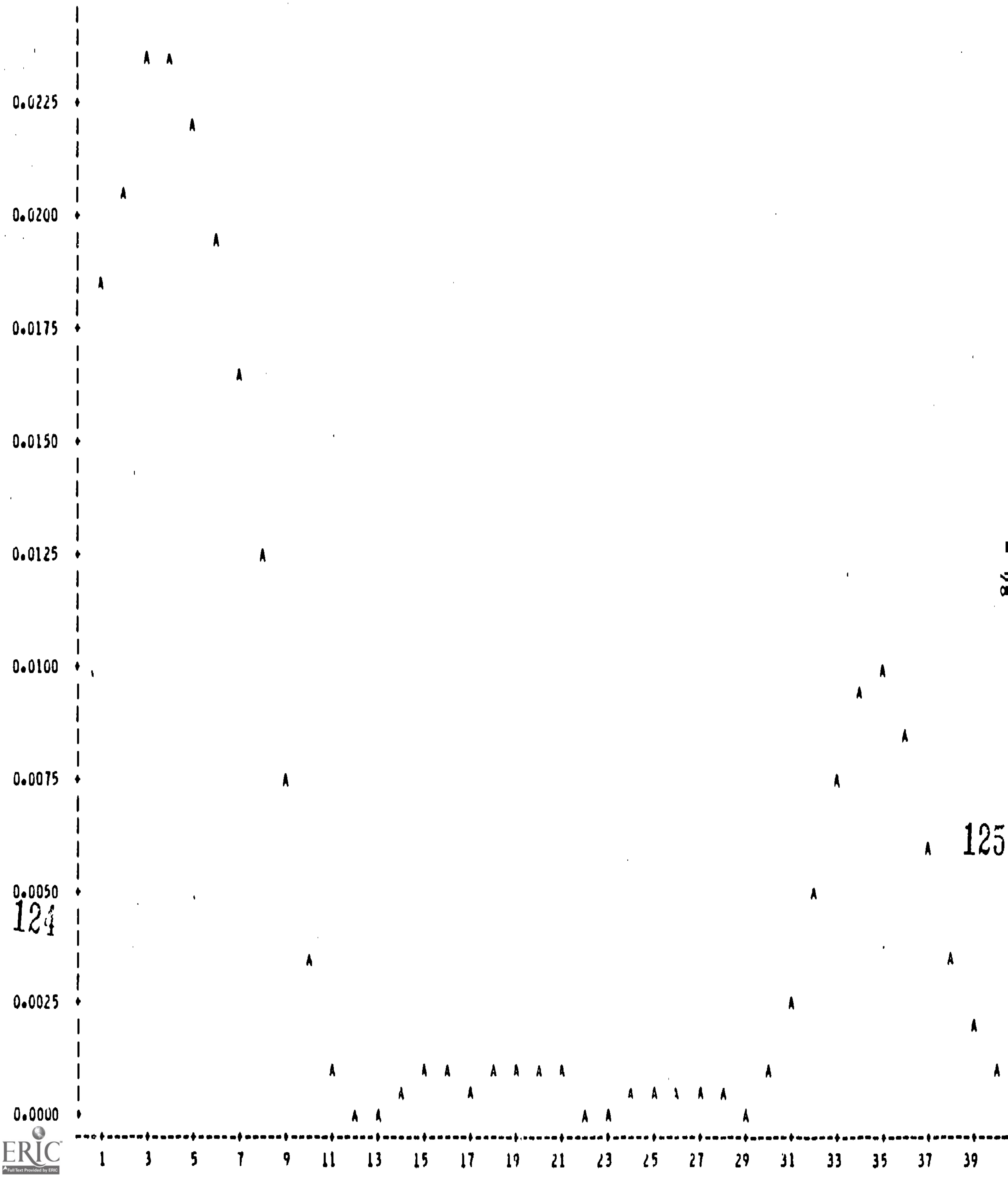


Figure A.28: Own Wage Elasticity: 16 Years of Schooling, Weekly Wages

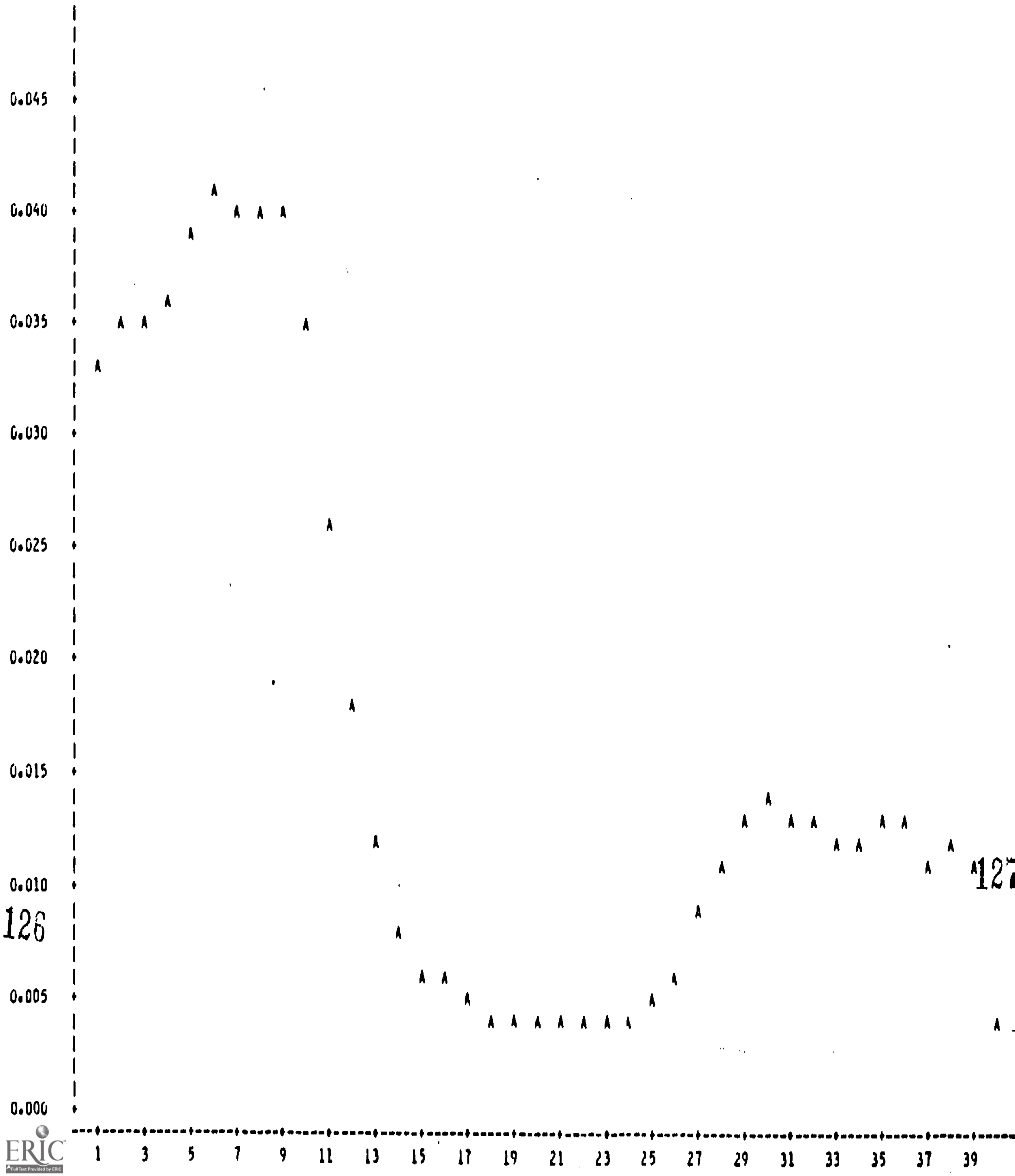


Figure A.29: Own Wage Elasticity: 8-11 Years of Schooling, Annual Income

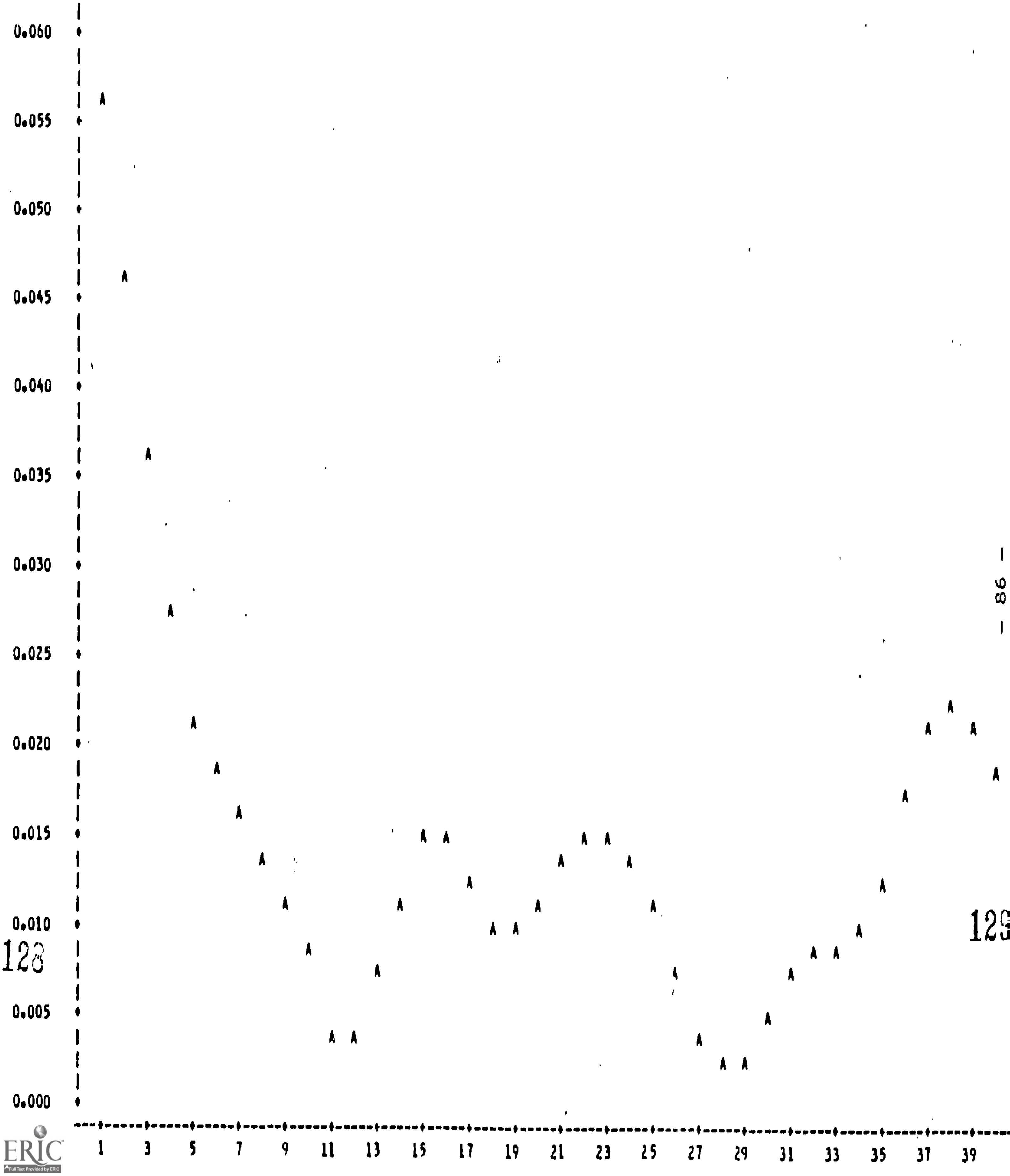


Figure A.30: Own Wage Elasticity: 12 Years of Schooling, Annual Income

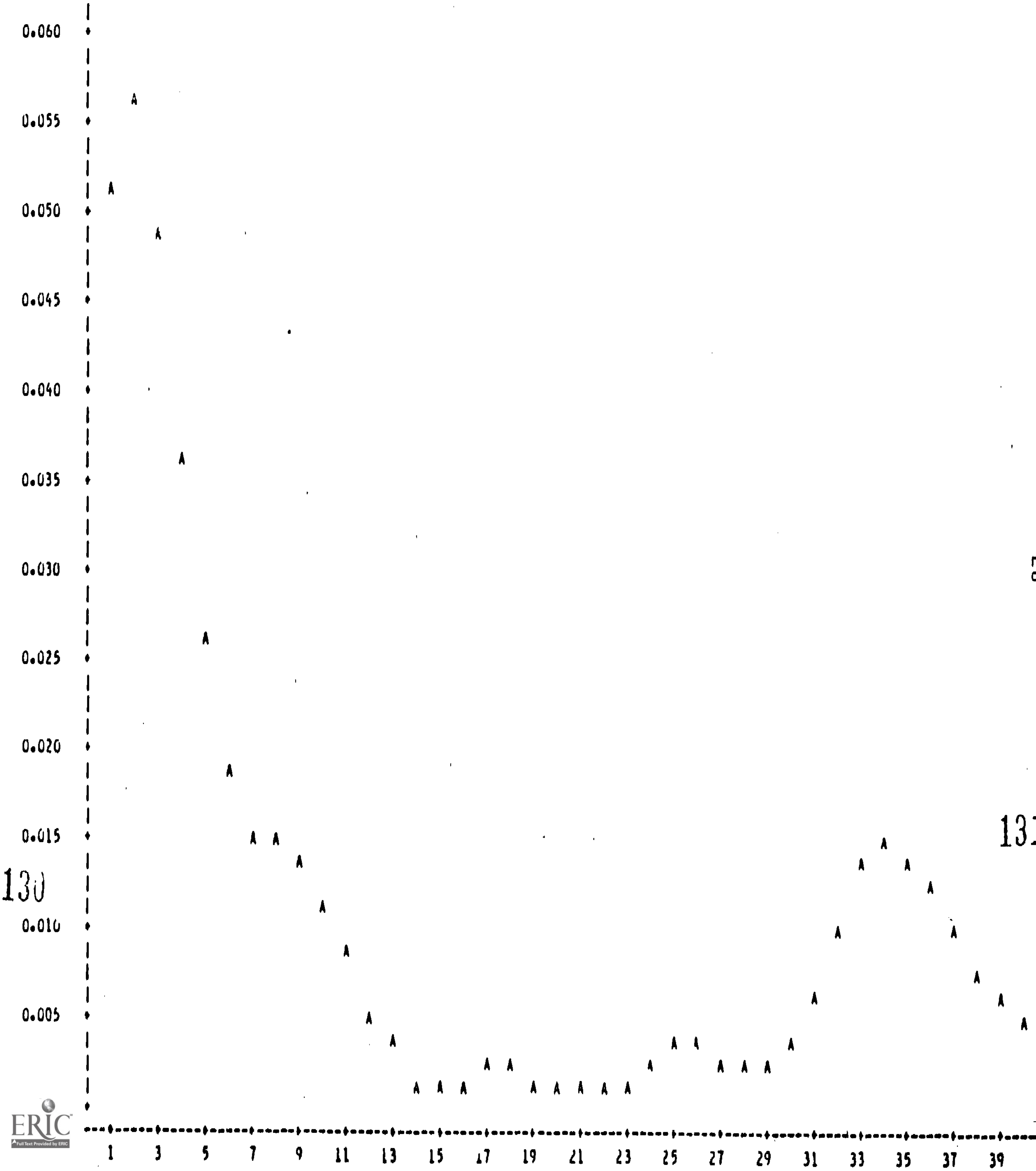


Figure A.31: Own Wage Elasticity: 13-15 Years of Schooling, Annual Income

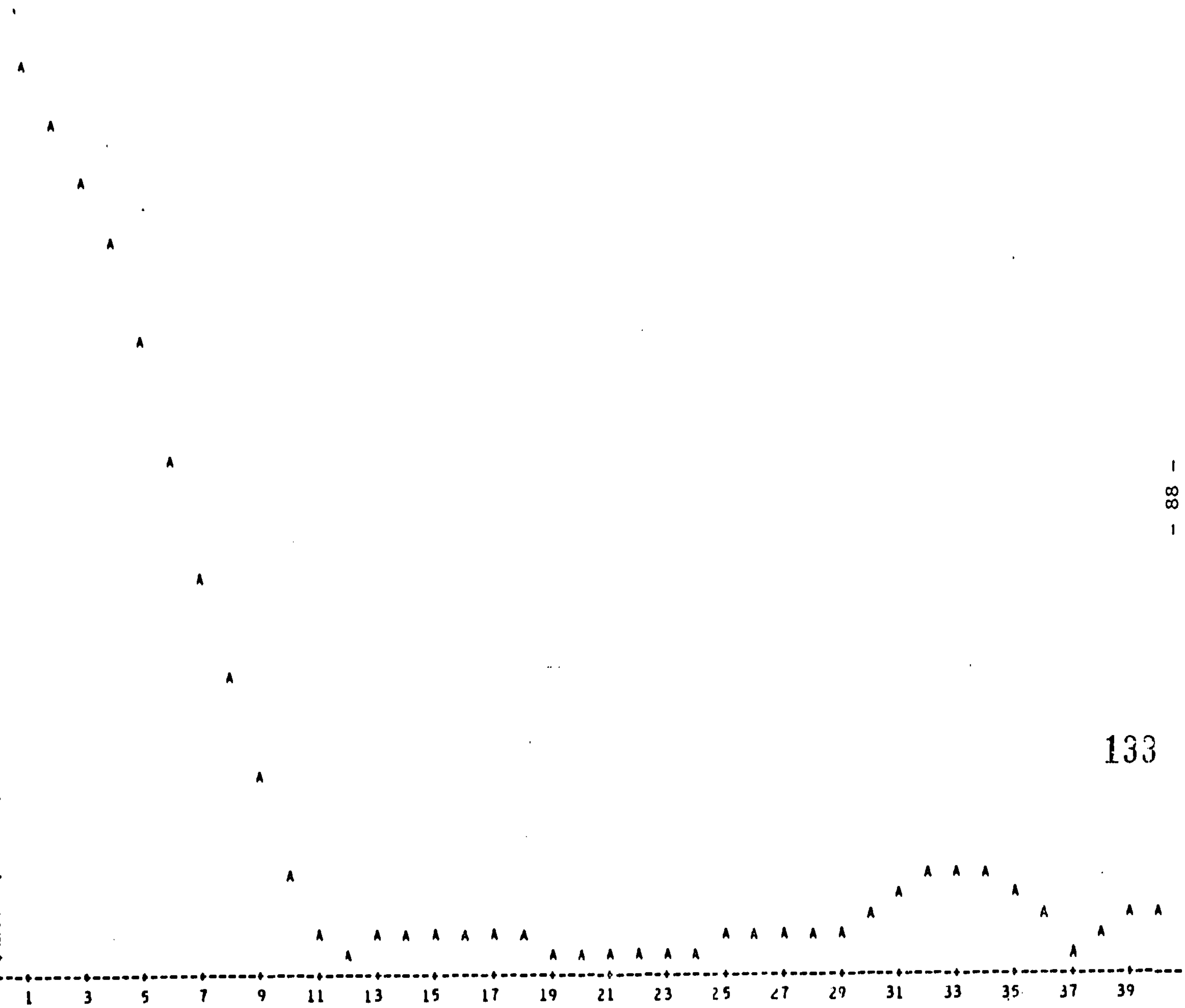


Figure A.32: Own Wage Elasticity: 16 Years of Schooling, Annual Income

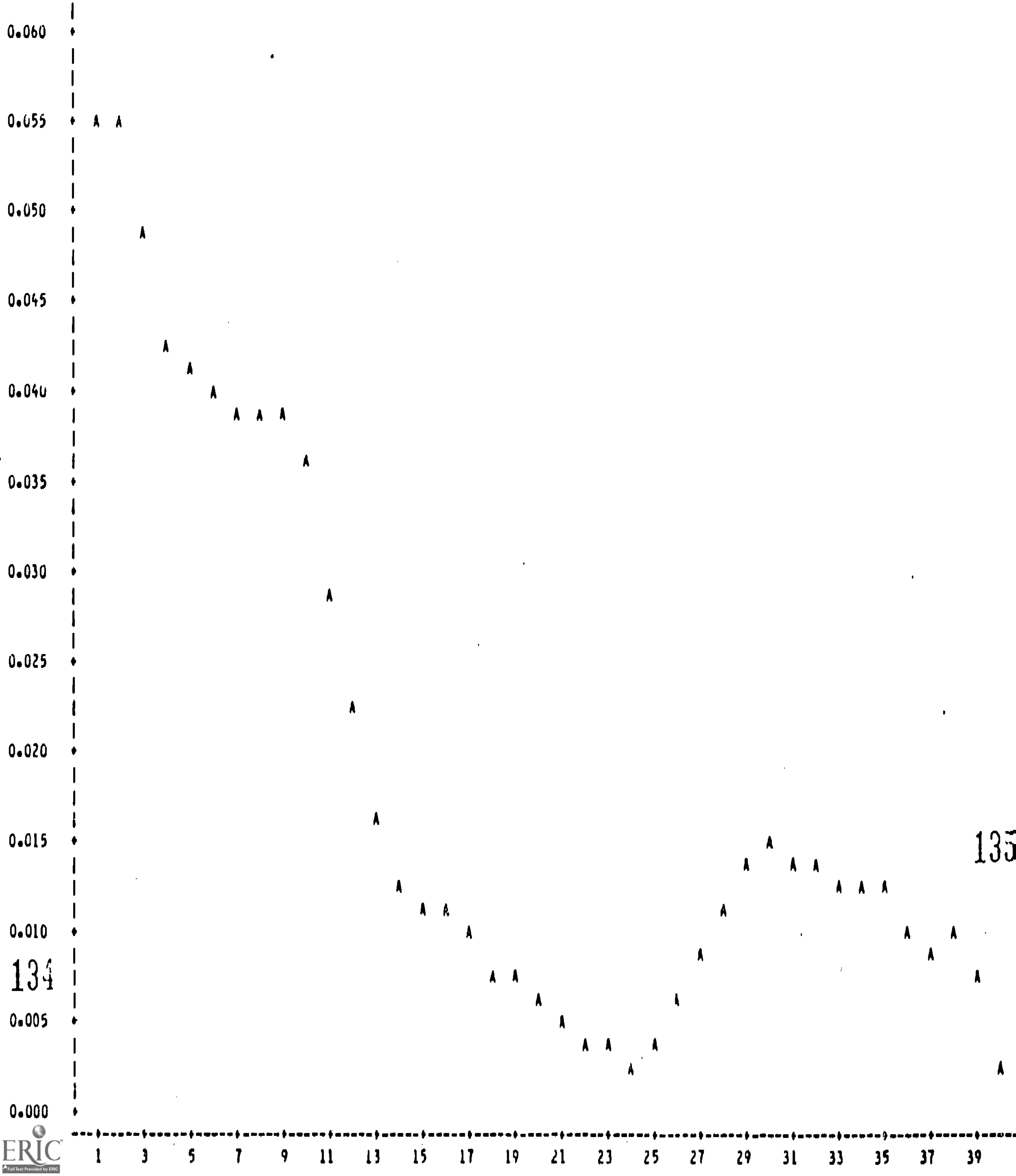


Figure A.33: Crosselasticity of Wages with Respect to Change in 1st Year Cohort Size

8-11 Years of Education/Weekly Wages

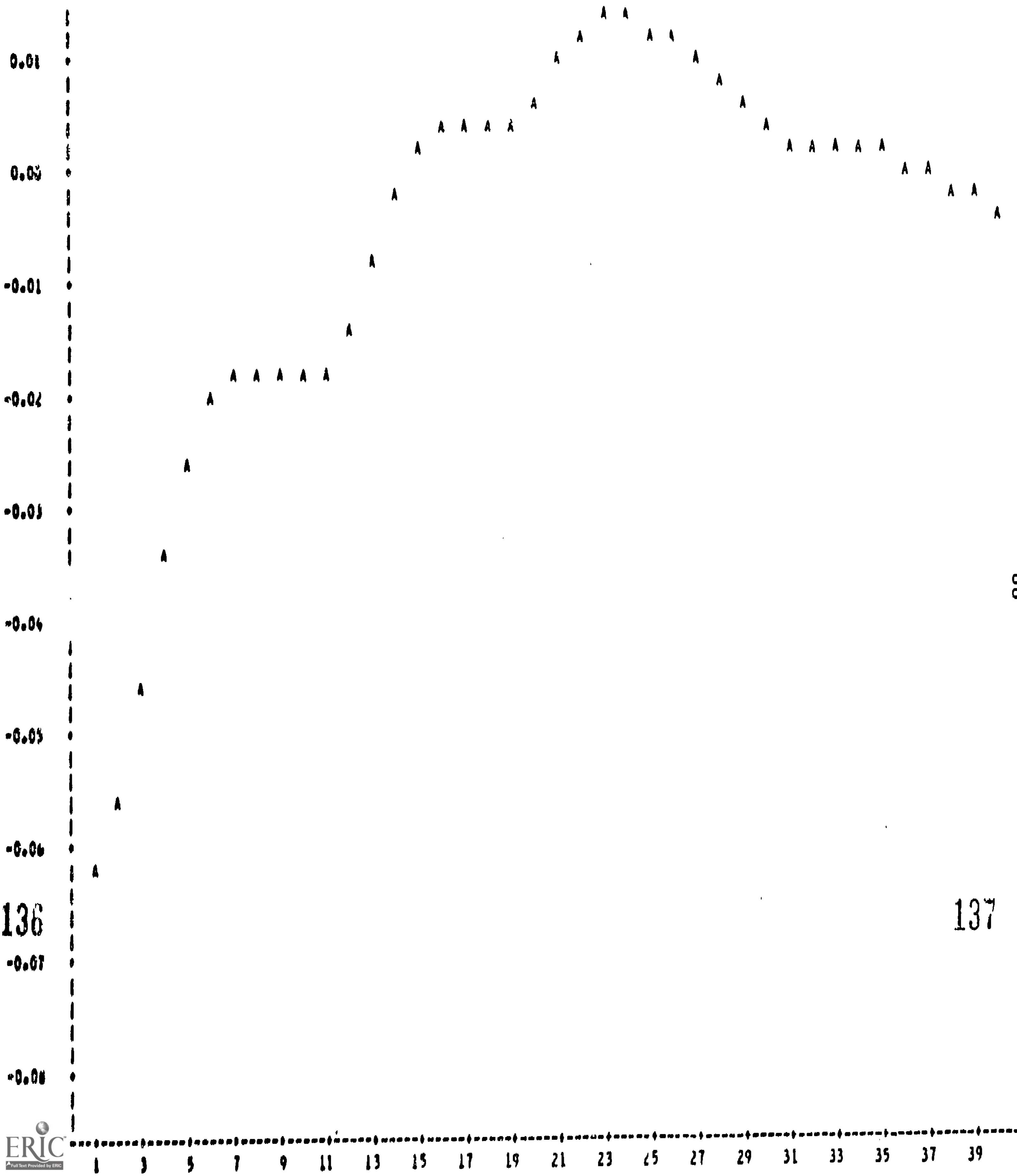


Figure A.34: Crosselasticity of Wages with Respect to Change in 1st Year Cohort Size

12 Years of Education/Weekly Wages

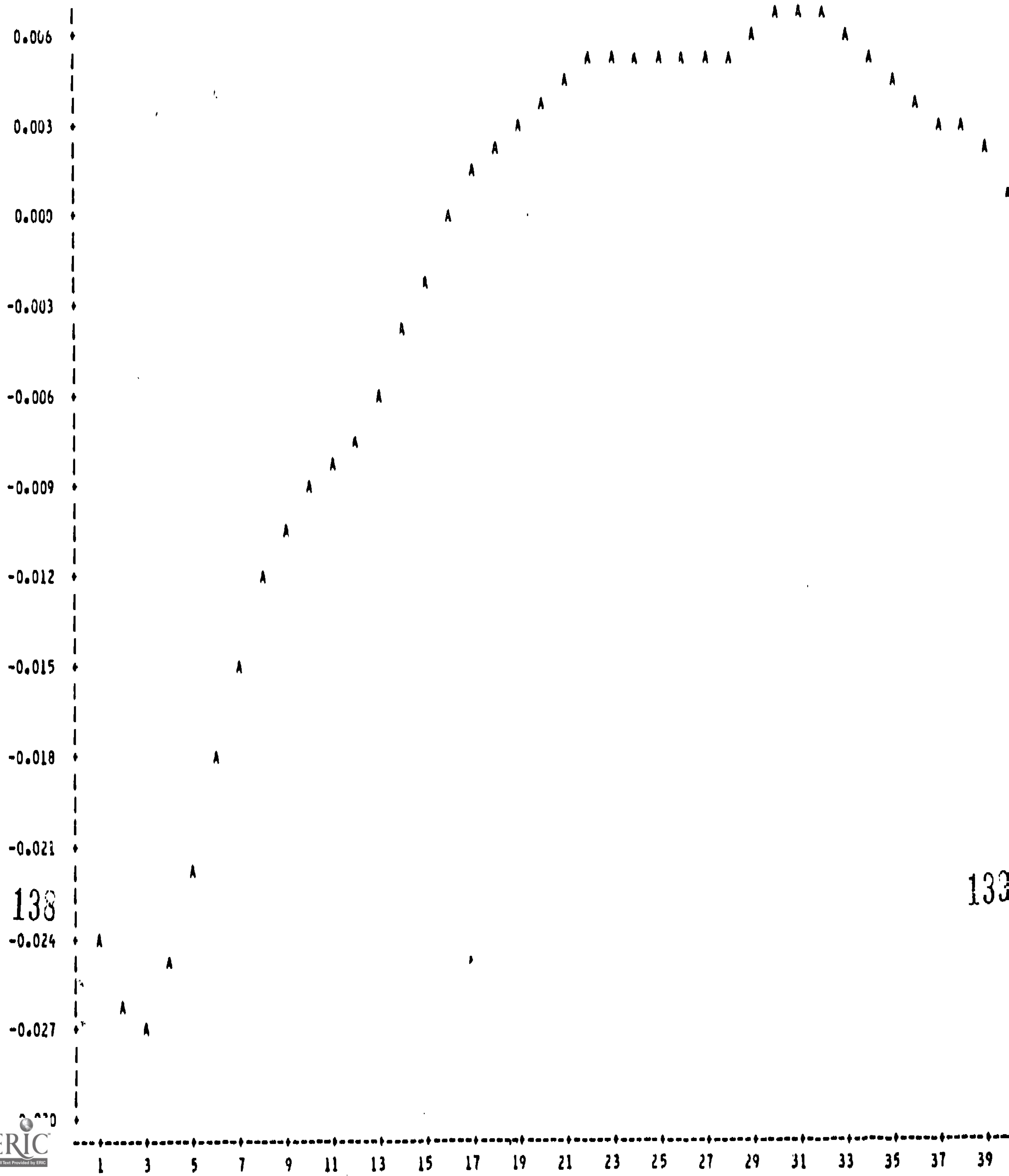


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Figure A.35: Crosselasticity of Wages with Respect to Change in 1st Year Cohort Size

13-15 Years of Education/Weekly Wages

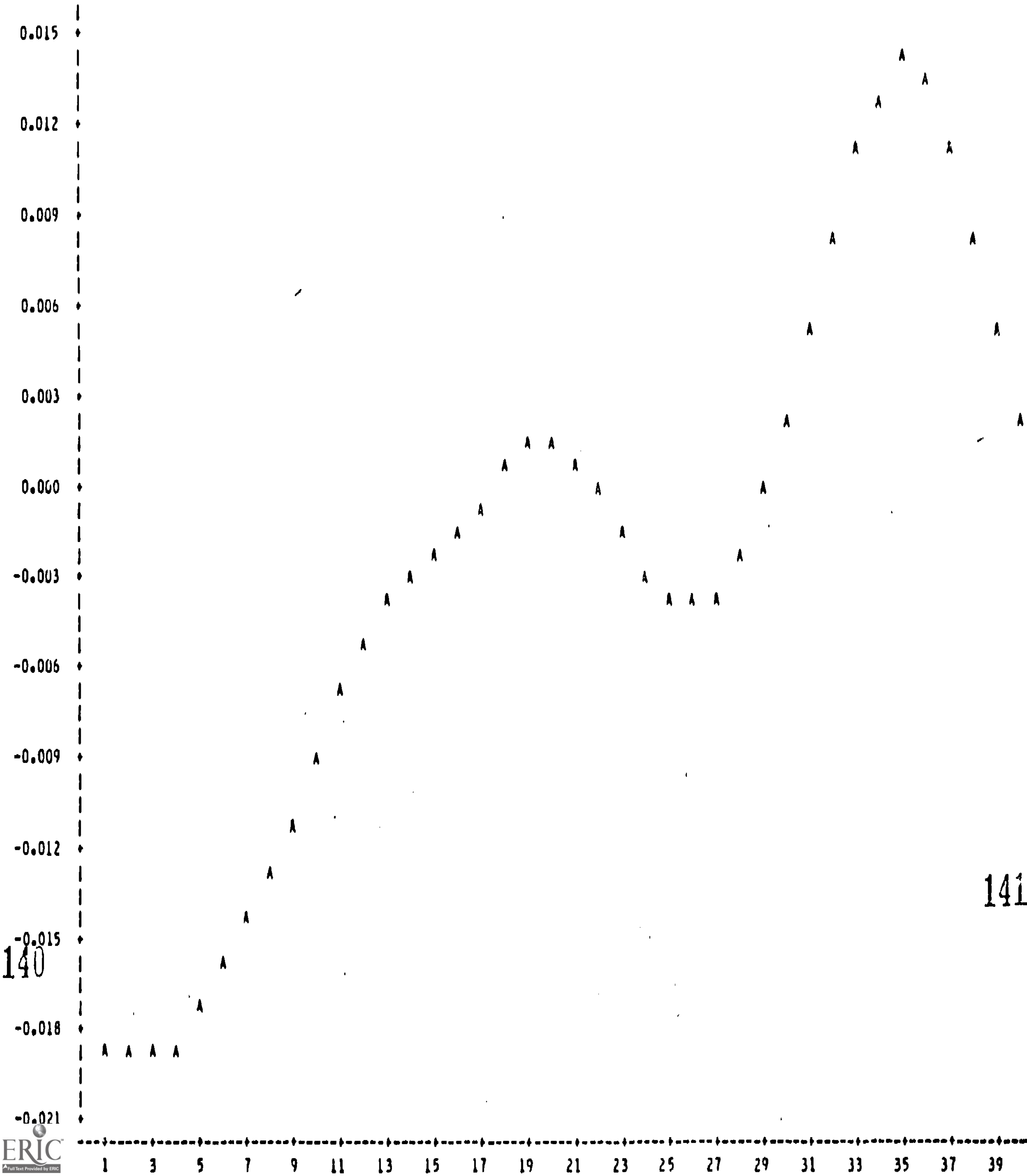

Figure A.36: Crosselasticity of Wages with Respect to Change in 1st Year Cohort Size

16 Years of Education/Weekly Wages

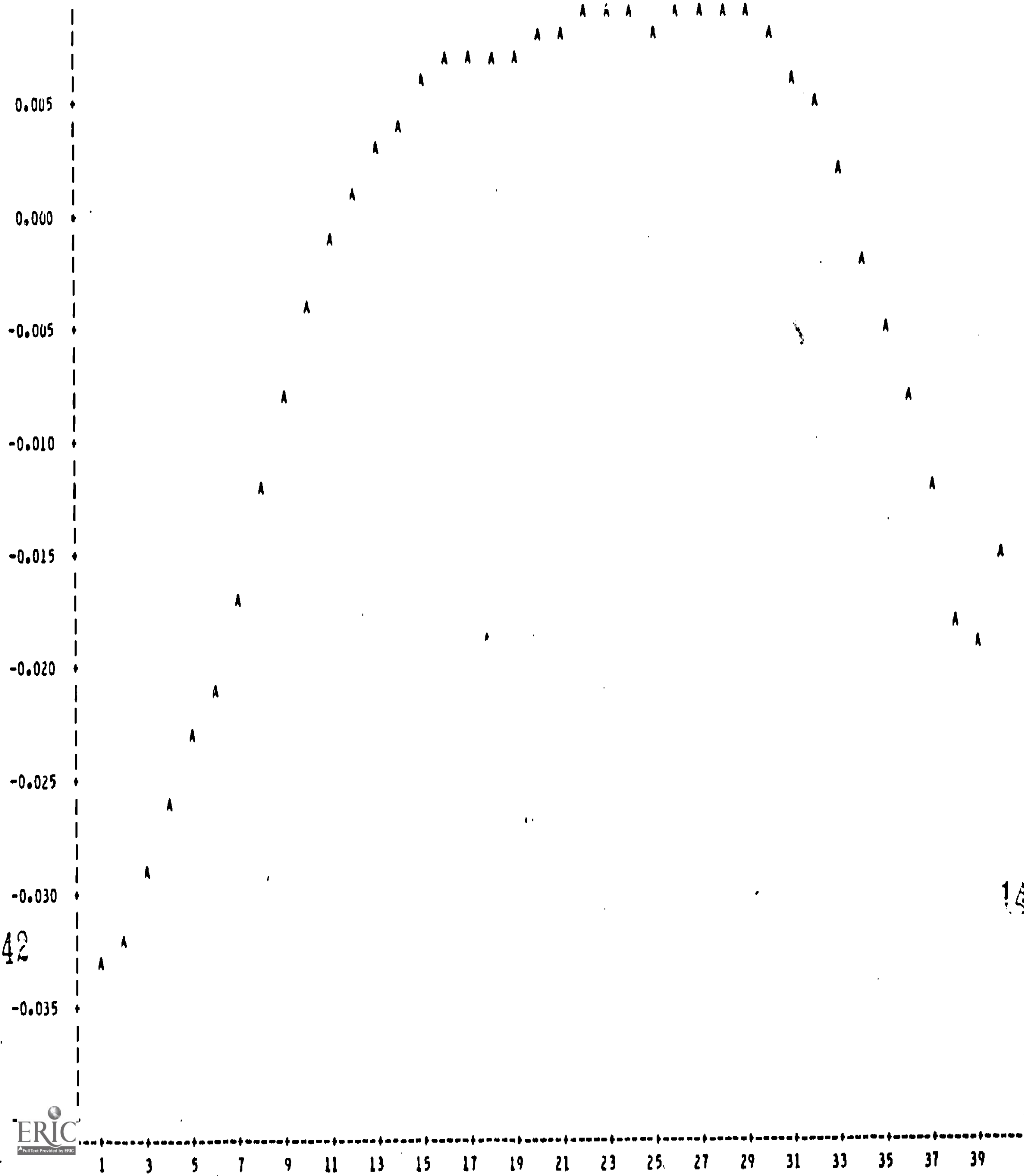

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Figure A.37: Crosselasticity of Wages with Respect to Change in 1st Year Cohort Size

8-11 Years of Education/Annual Income

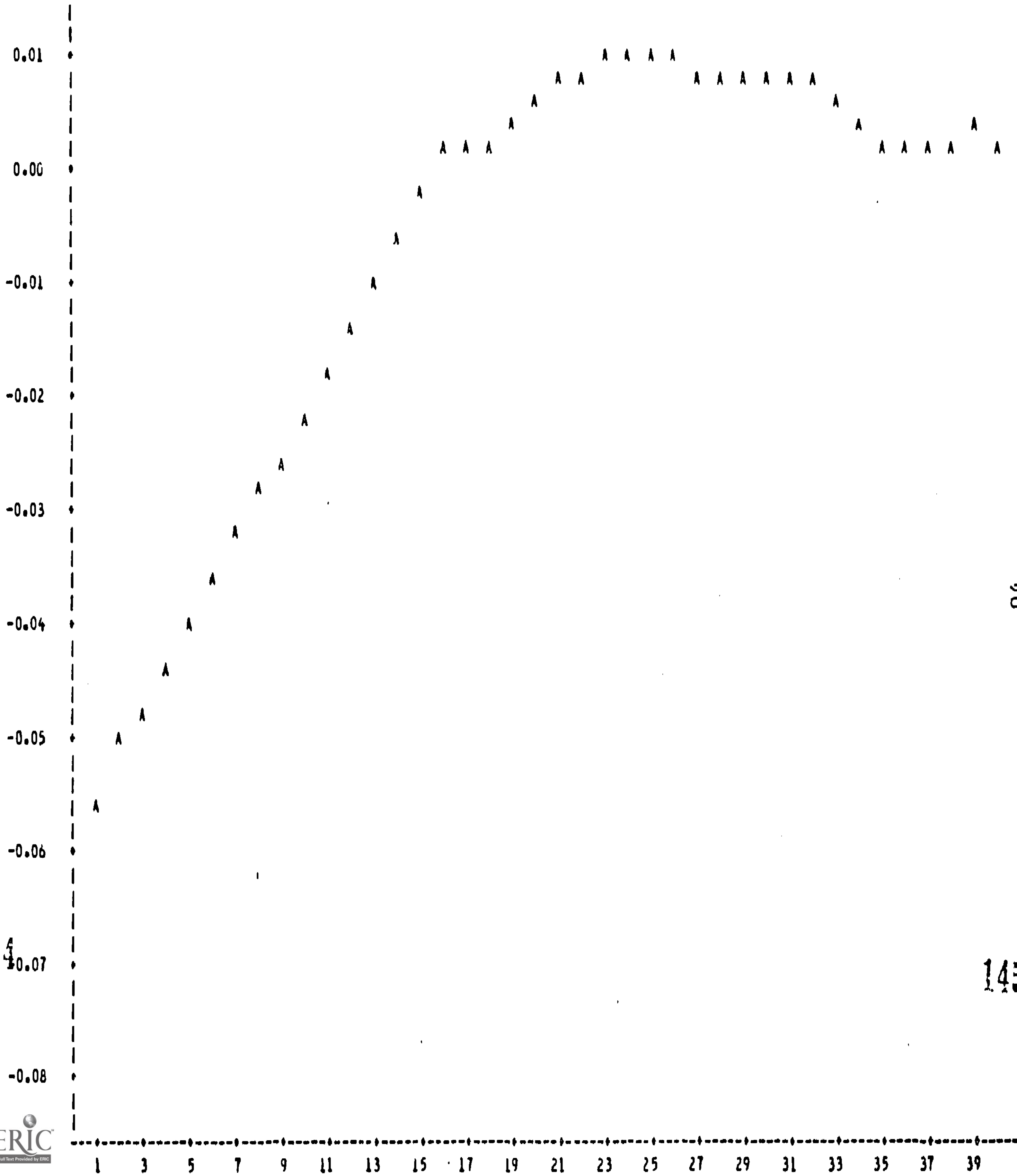

Figure A.38: Crosselasticity of Wages with Respect to Change in 1st Year Cohort Size

12 Years of Education/Annual Income

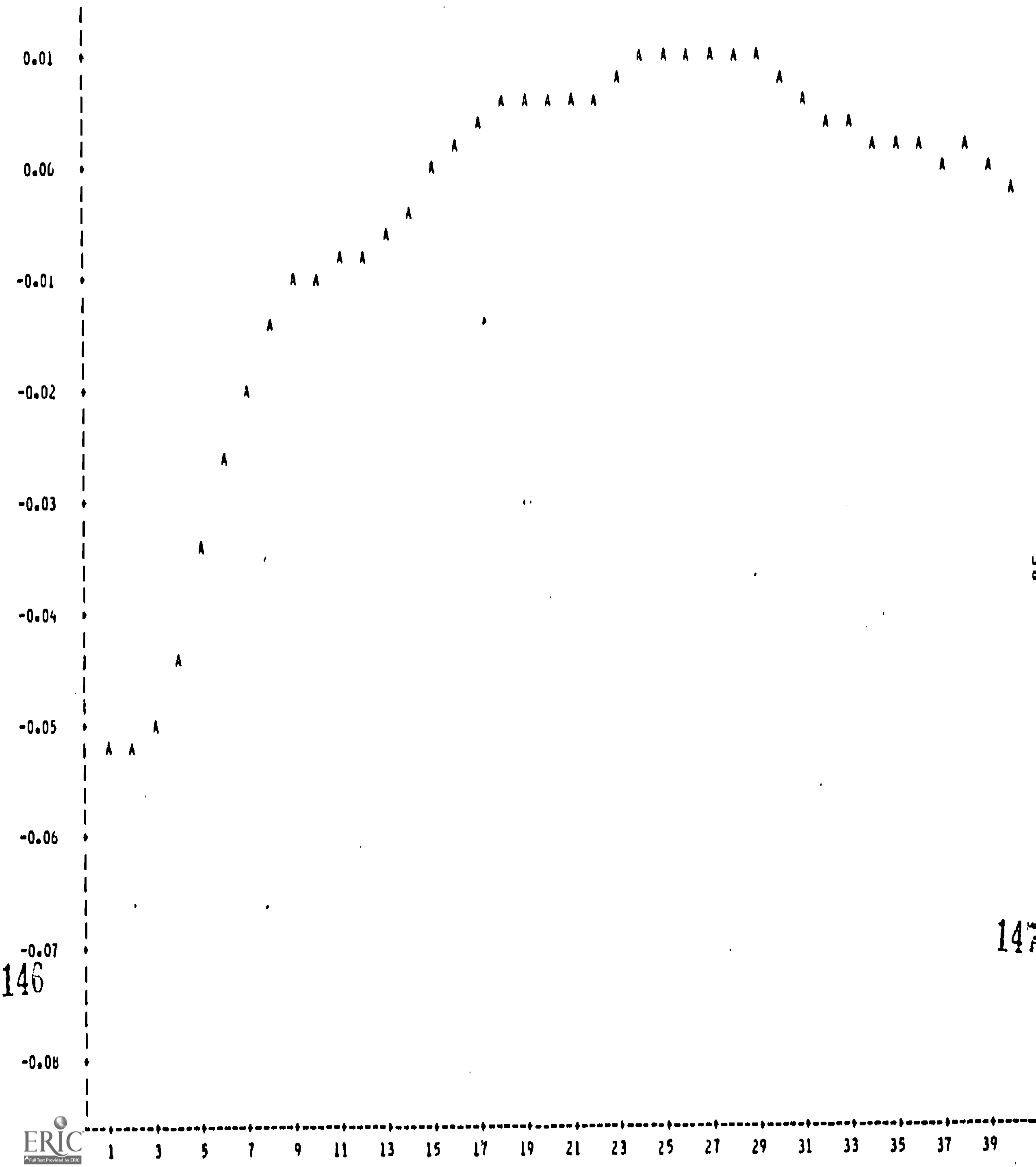

Figure A.39: Crosselasticity of Wages with Respect to Change to 1st Year Cohort Size

13-15 Years of Education/Annual Income

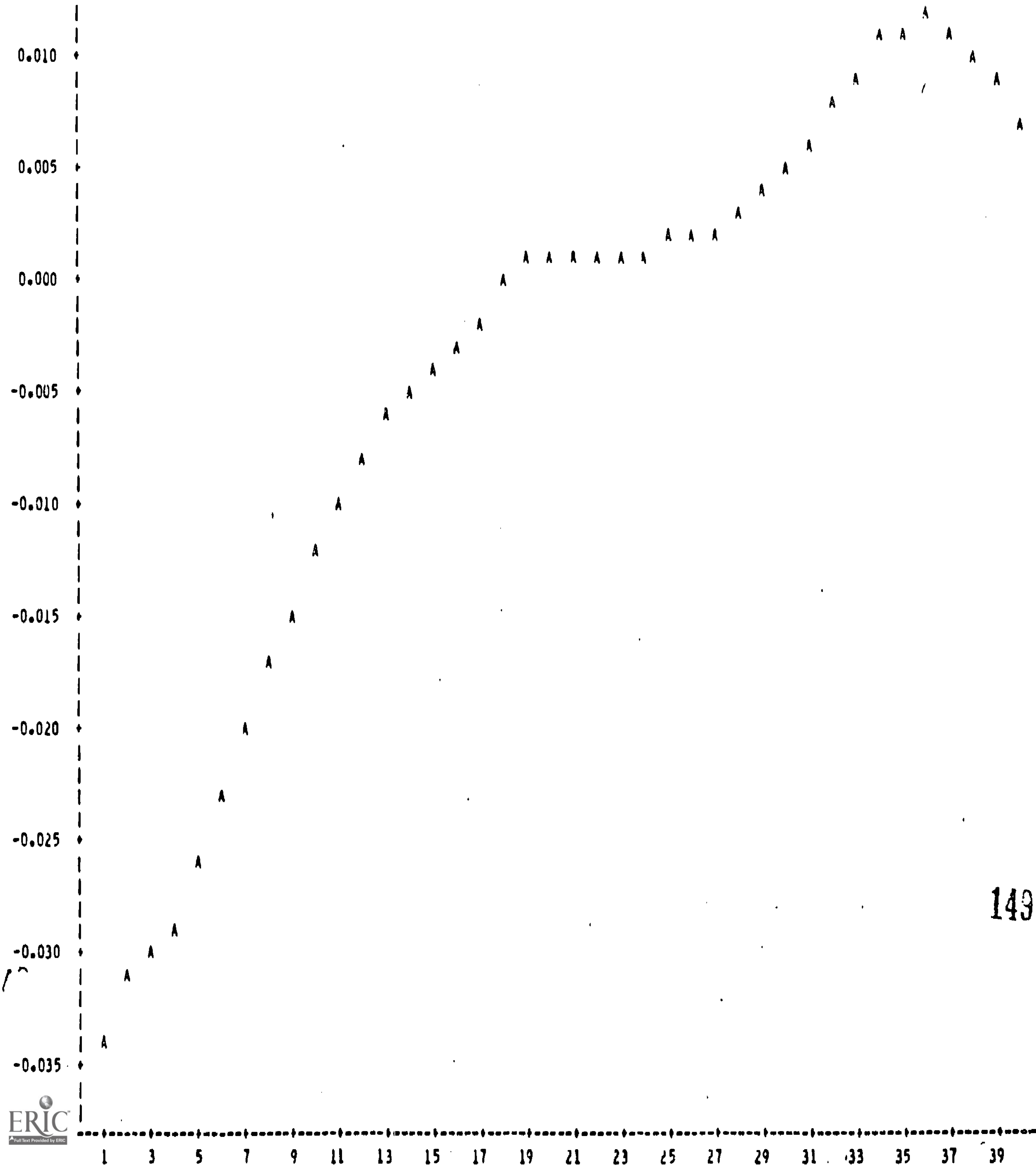

Figure A.40: Crosselasticity of Wages with Respect to Change to 1st Year Cohort Size

16 Years of Education/Annual Income

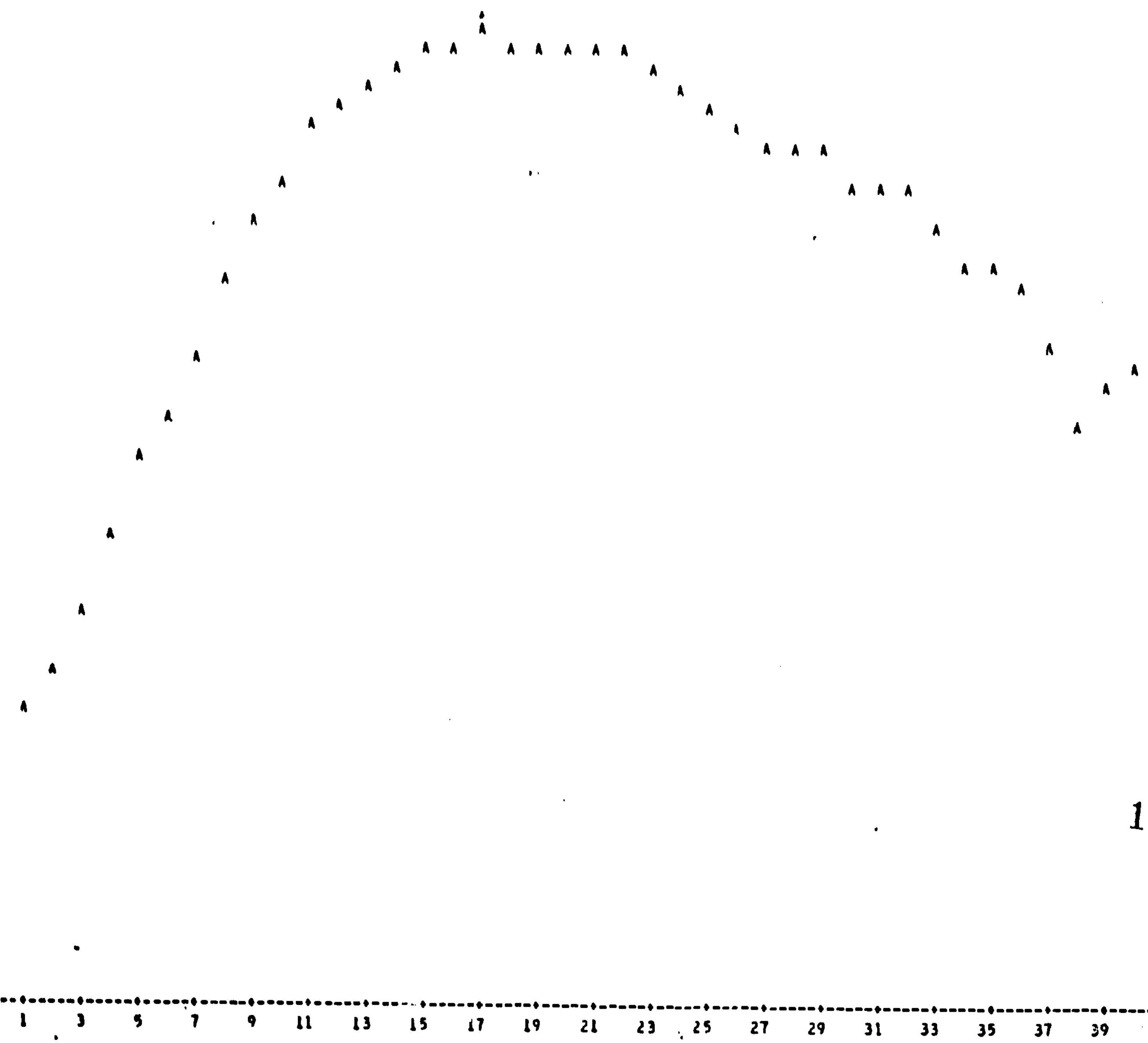

Figure A.41: Simulated Relative Present Value of Earnings - 9 Year Baby Boom

8-11 Years of Education/Weekly Wage

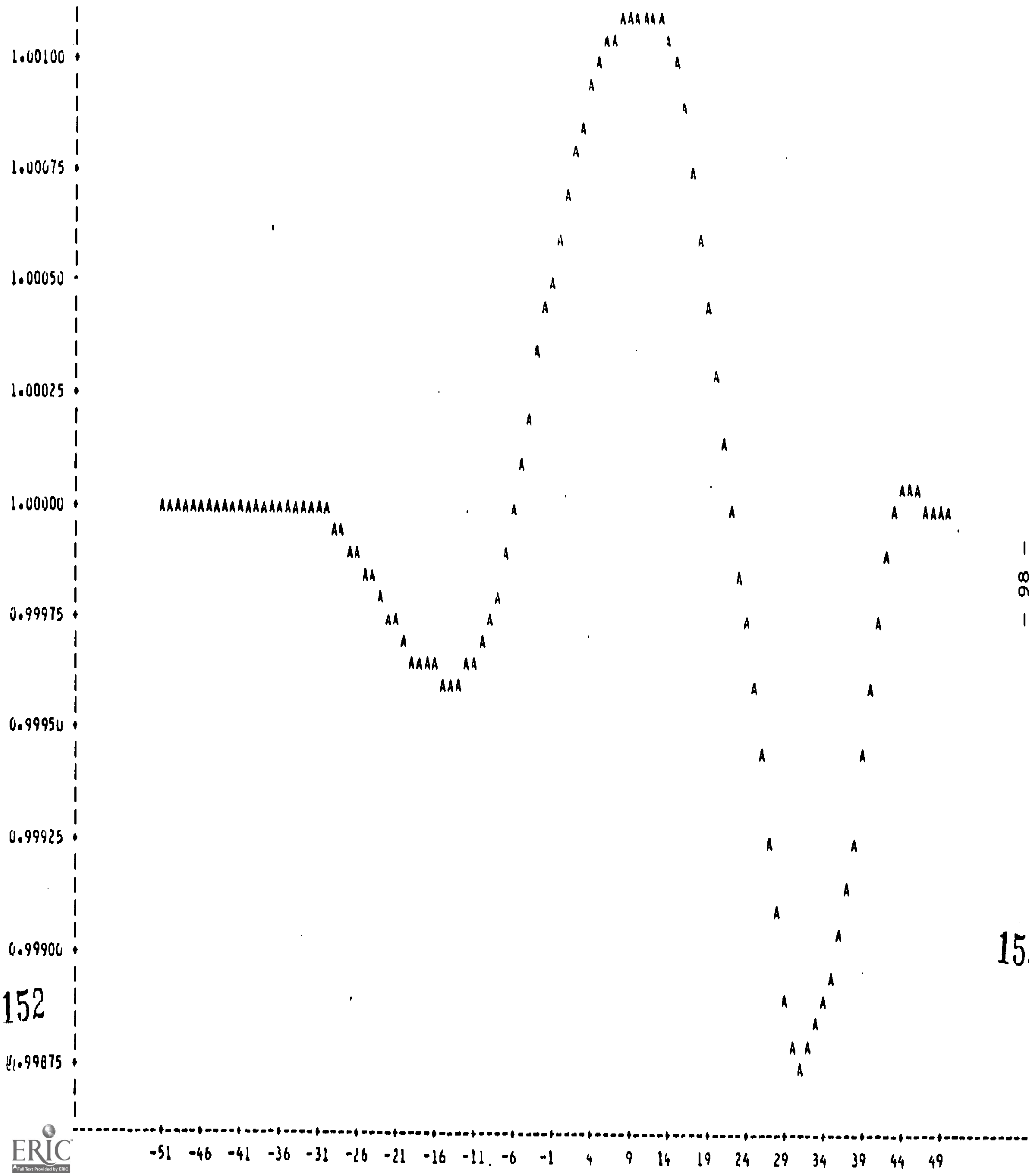

Figure A.42: Simulated Relative Present Value of Earnings - 9 Year Baby Boom

12 Years of Education/Weekly Wage

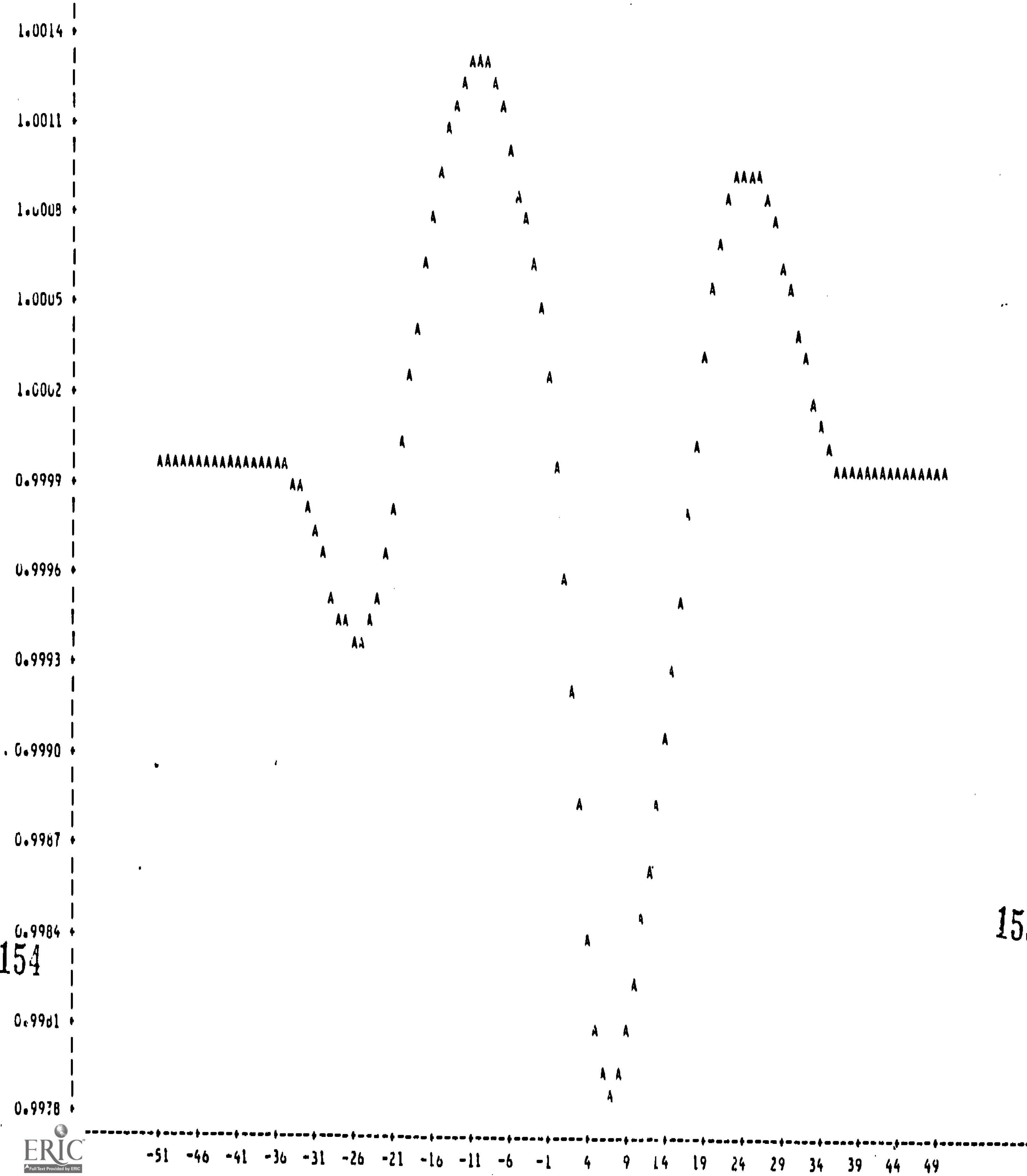

Figure A.43: Simulated Relative Present Value of Earnings - 9 Year Baby Boom

13-15 Years of Education/Weekly Wage

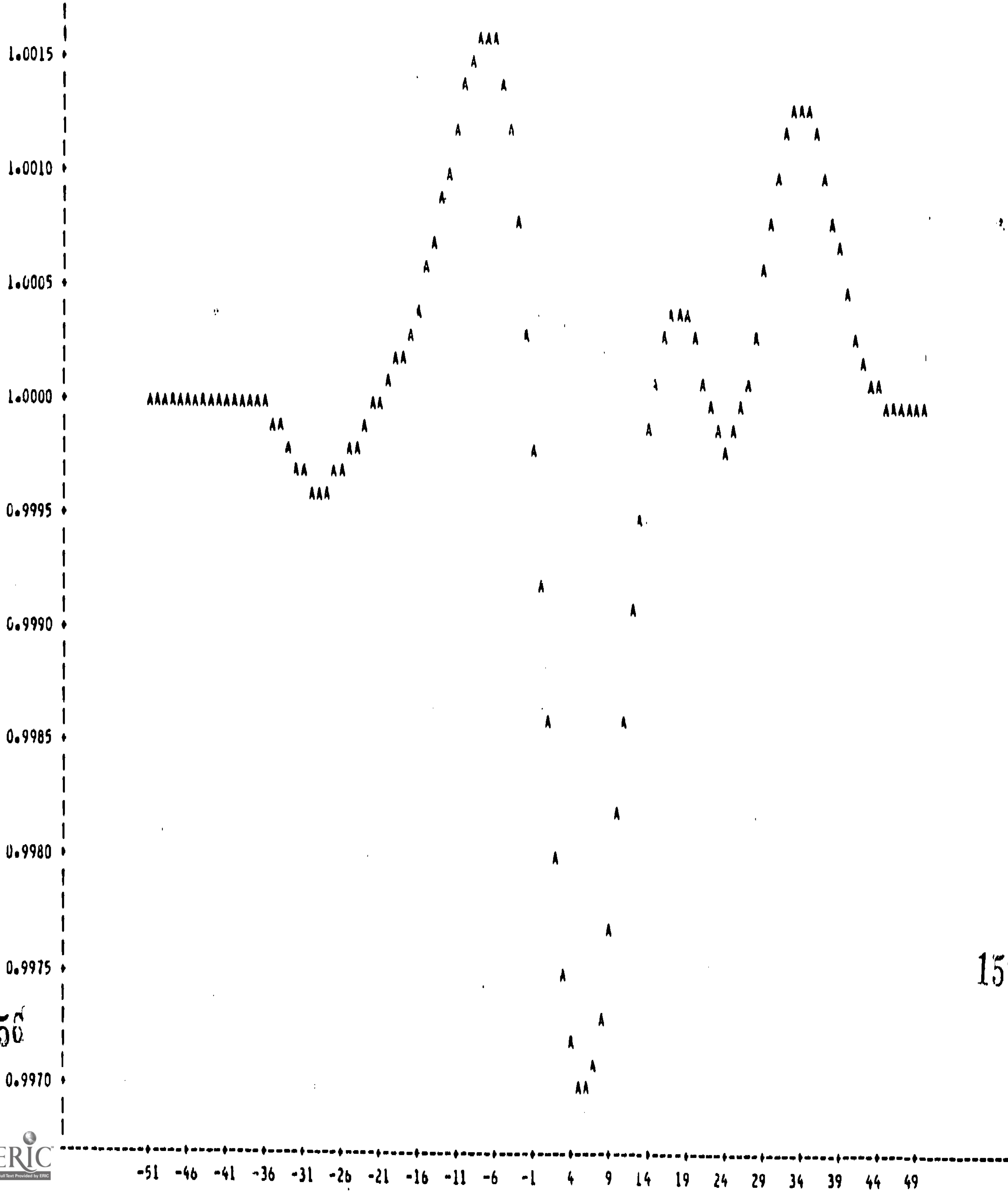

Figure A.44: Simulated Relative Present Value of Earnings - 9 Year Baby Boom

16 Years of Education/Weekly Wage

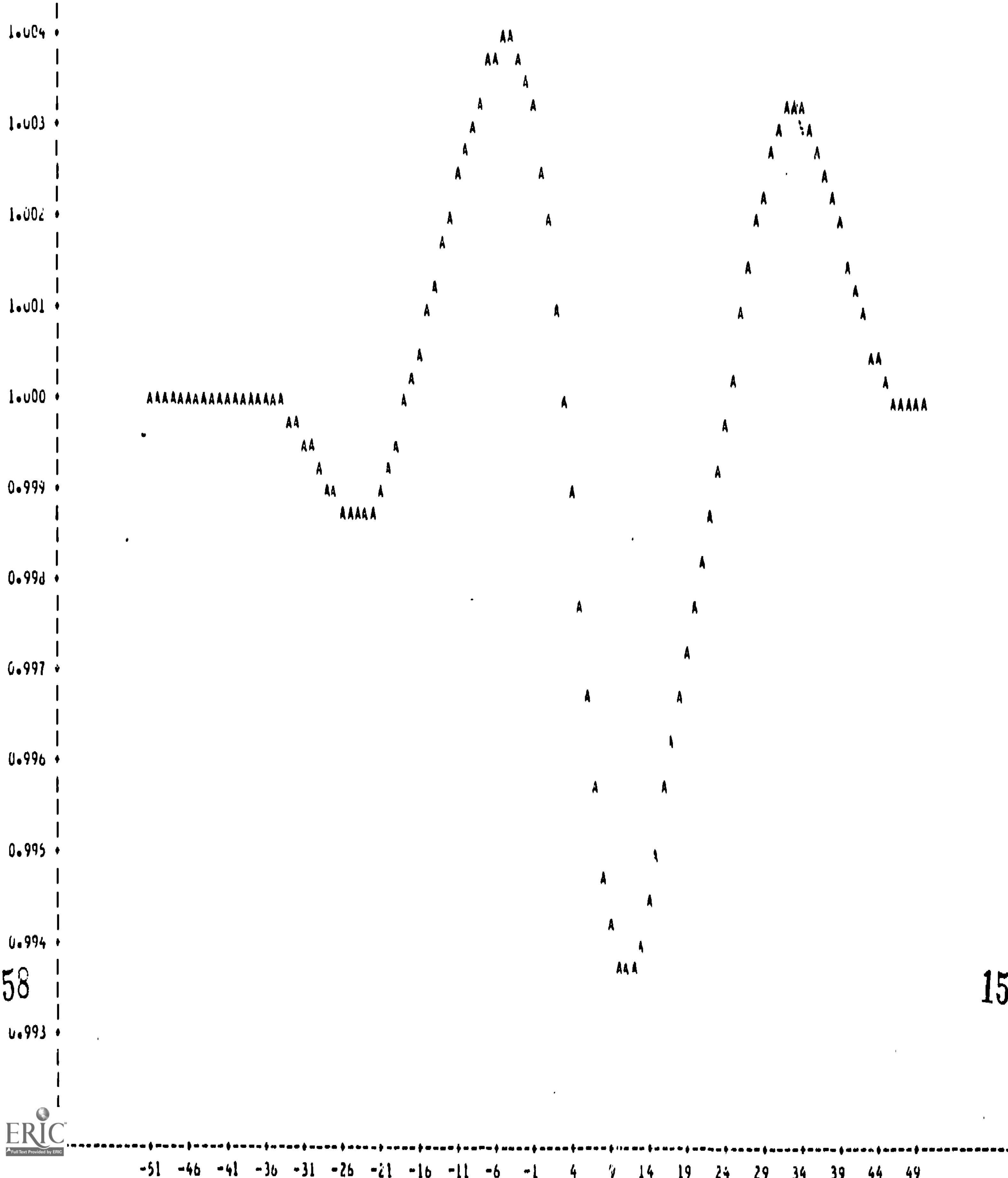

Figure A.45: Simulated Relative Present Value of Earnings - 9 Year Baby Boom

8-11 Years of Education/Annual Income

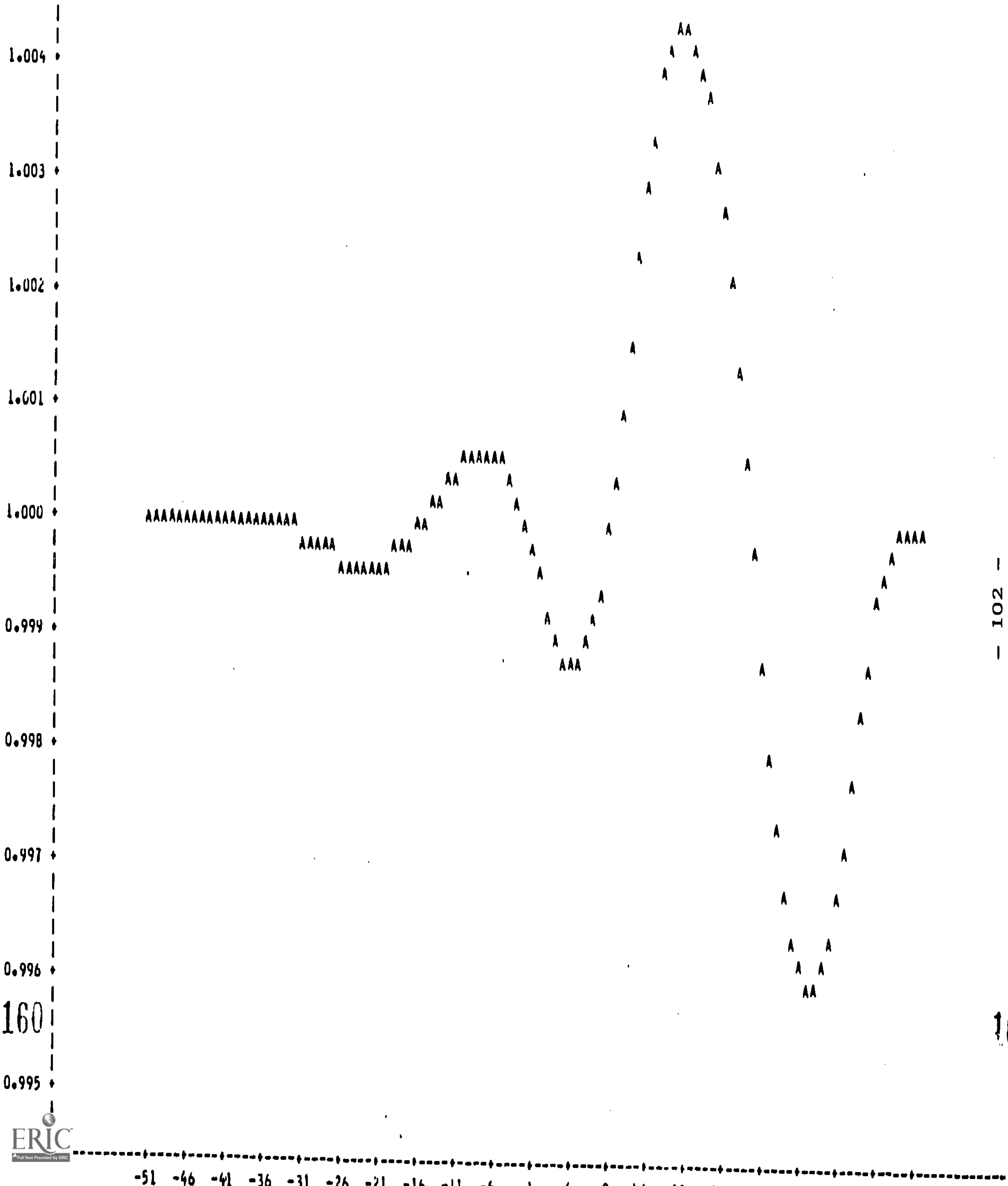

Figure A.46: Simulated Relative Present Value of Earnings - 9 Year Baby Boom

12 Years of Education/Annual Income

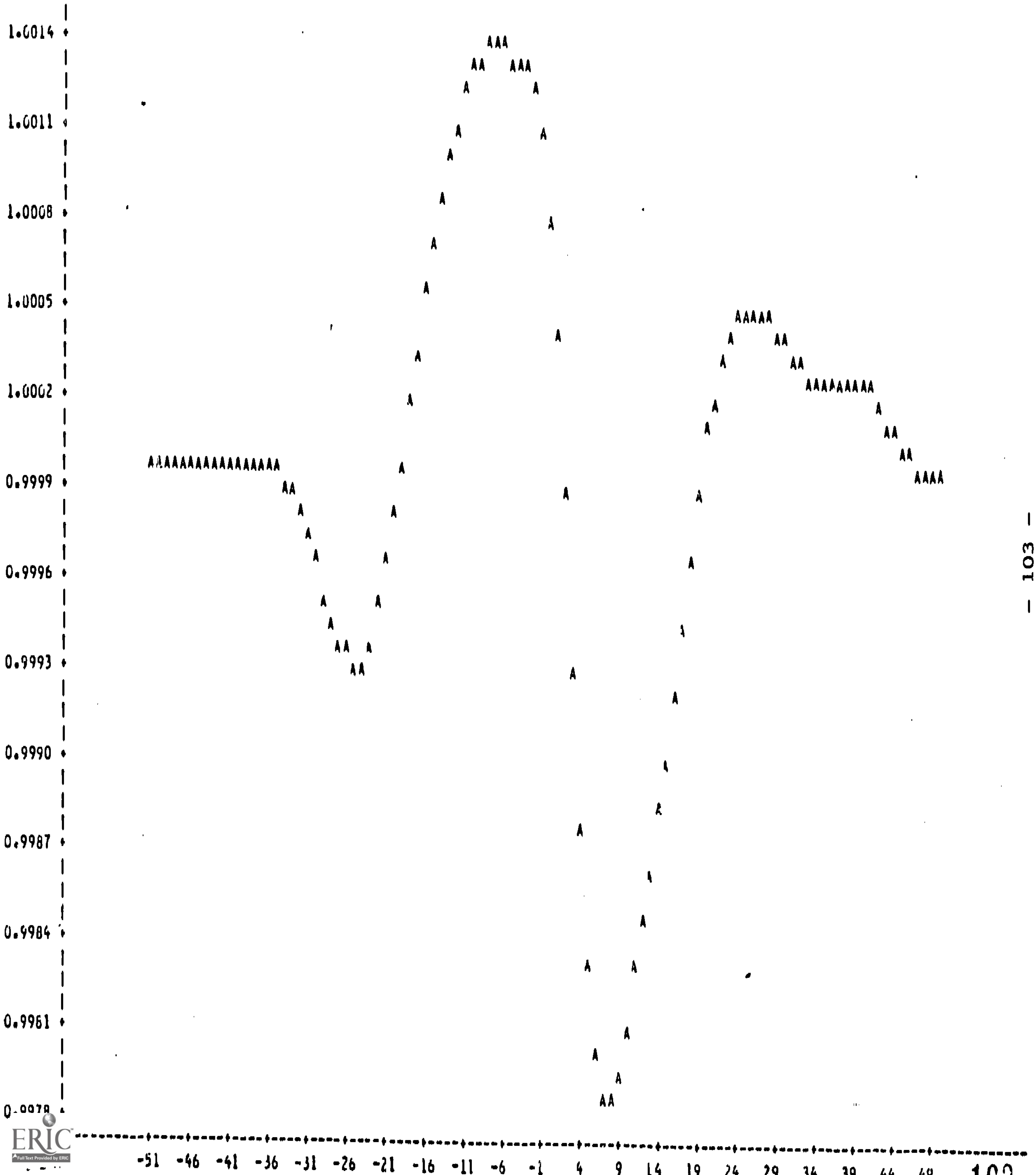

Figure A.47: Simulated Relative Present Value of Earnings - 9 Year Baby Boom

13-15 Years of Education/Annual Income

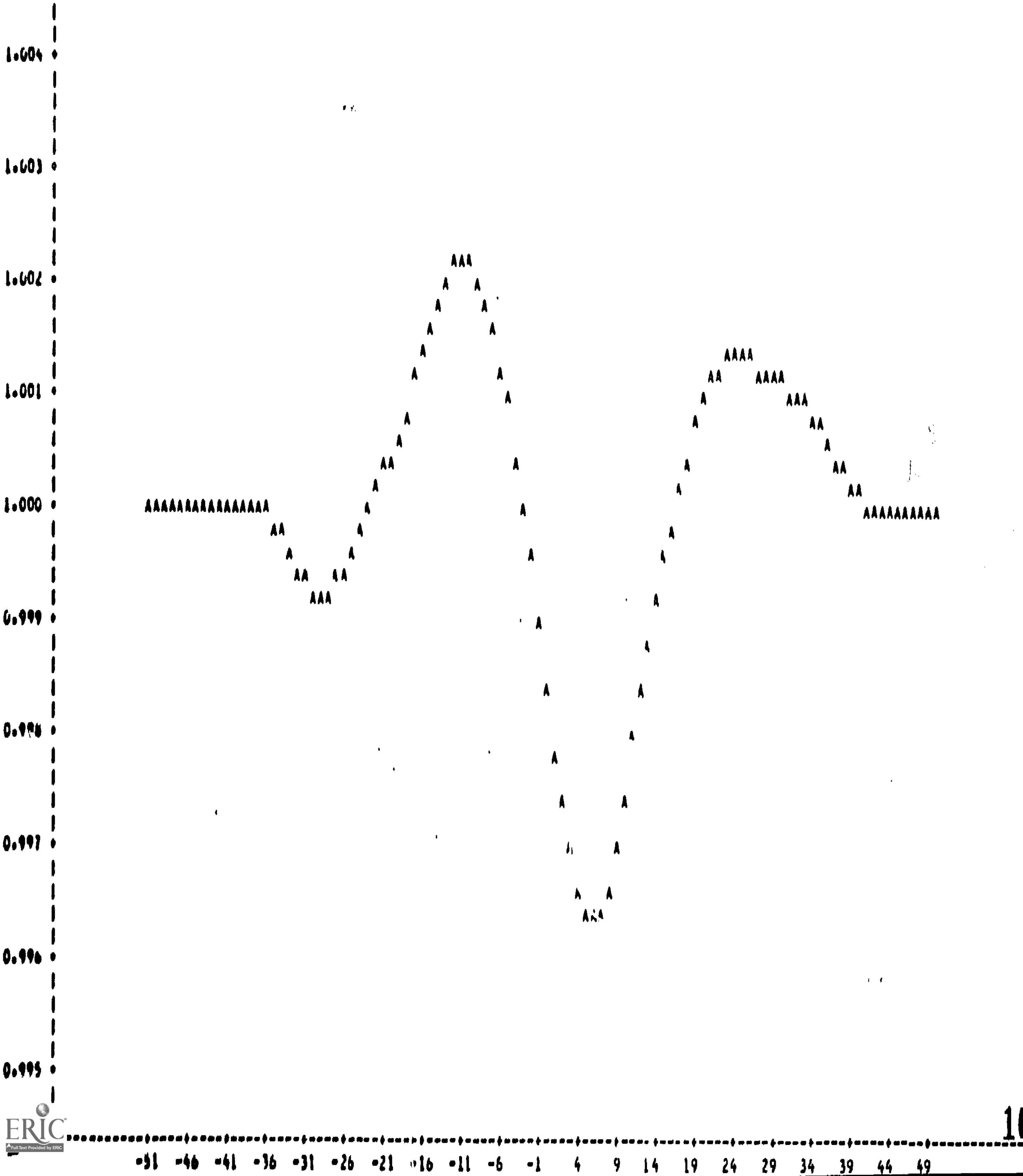

Figure A.48: Simulated Relative Present Value of Earnings - 9 Year Baby Boom

16 Years of Education/Annual Income

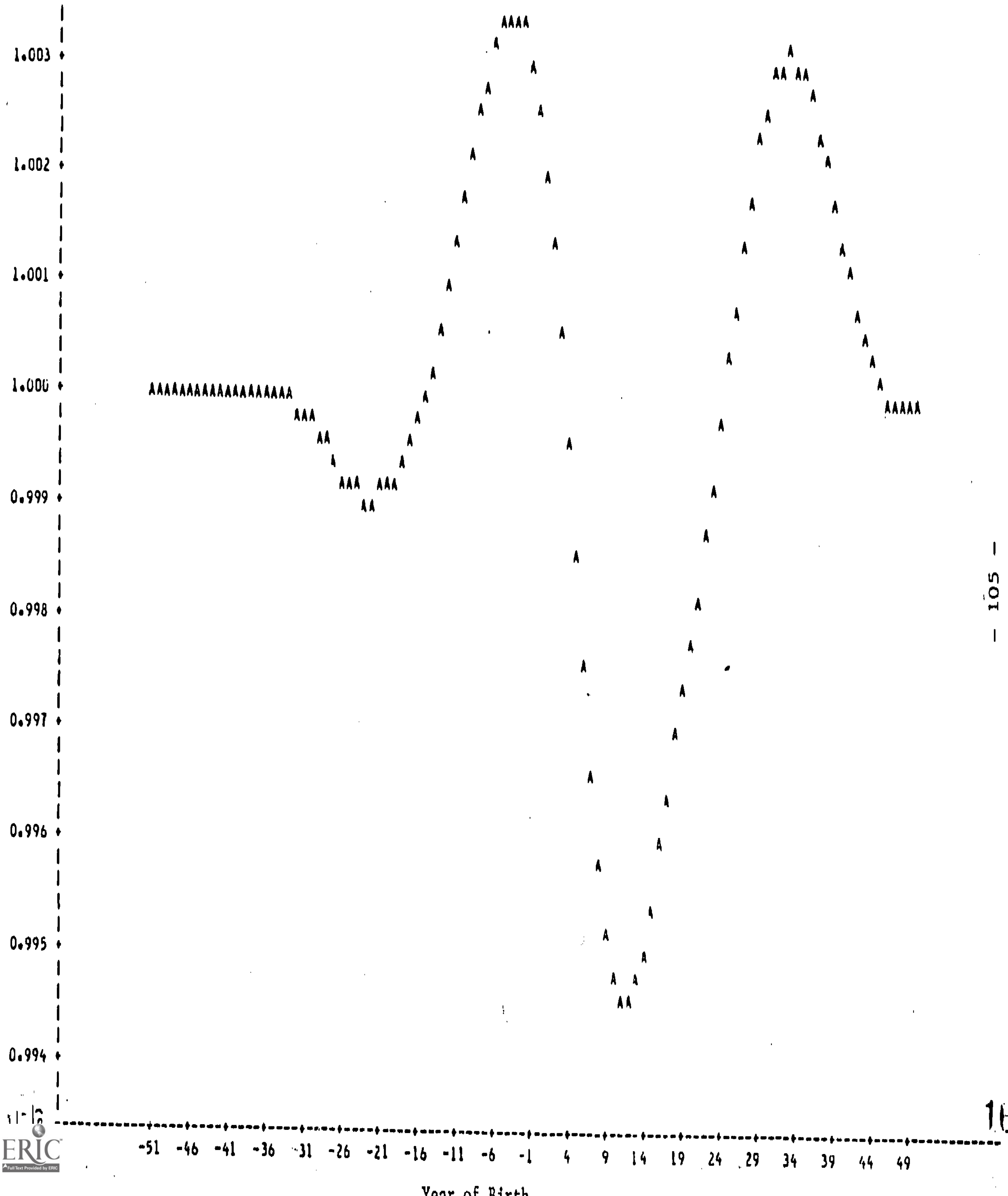

Figure A.49: Simulated Relative Present Value of Earnings - 31 Year Baby Boom

8-11 Years of Schooling/Weekly Wages

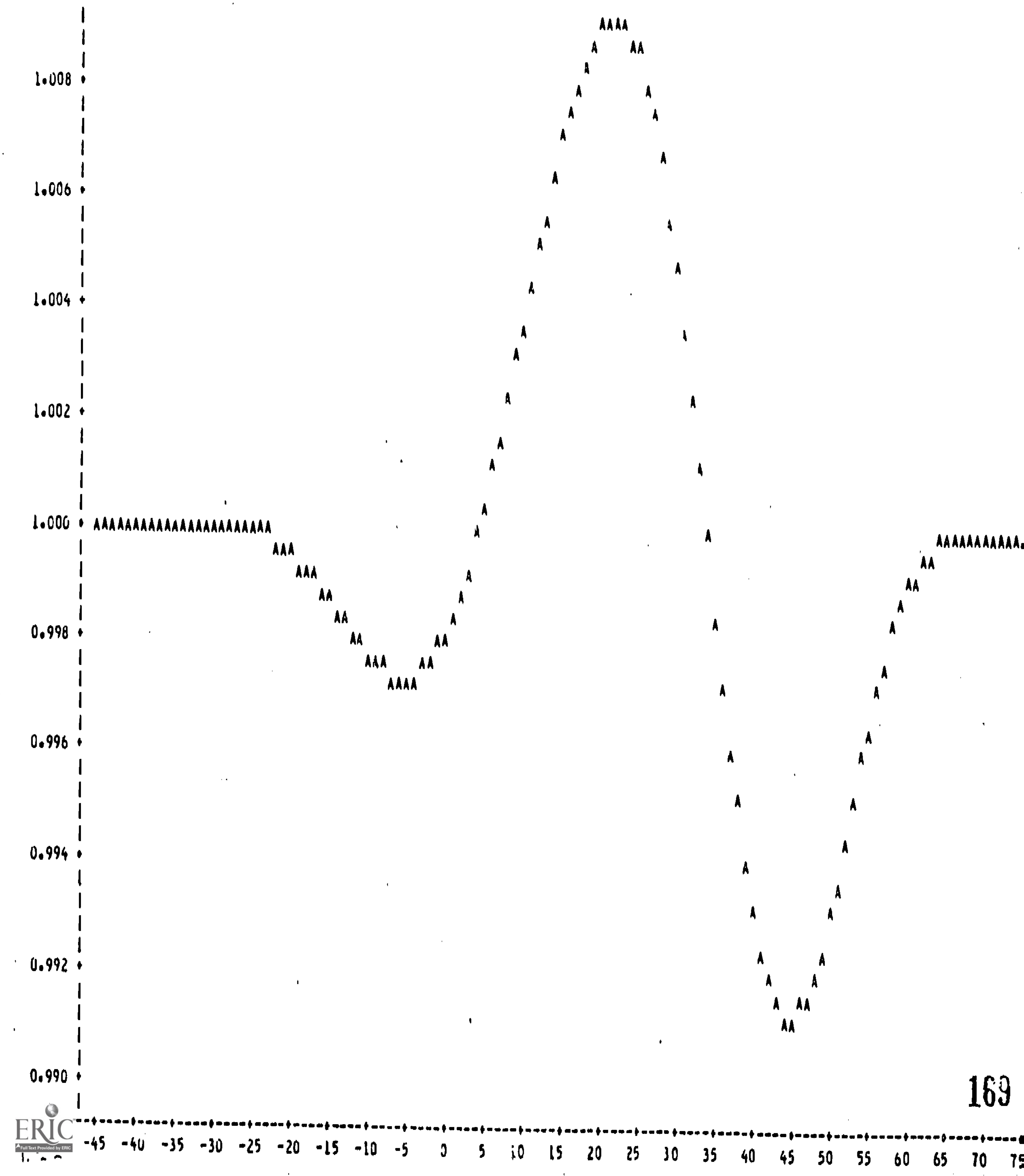

Figure A.50: Simulated Relative Present Value of Earnings - 31 Year Baby Boom

12 Years of Schooling/Weekly Wages

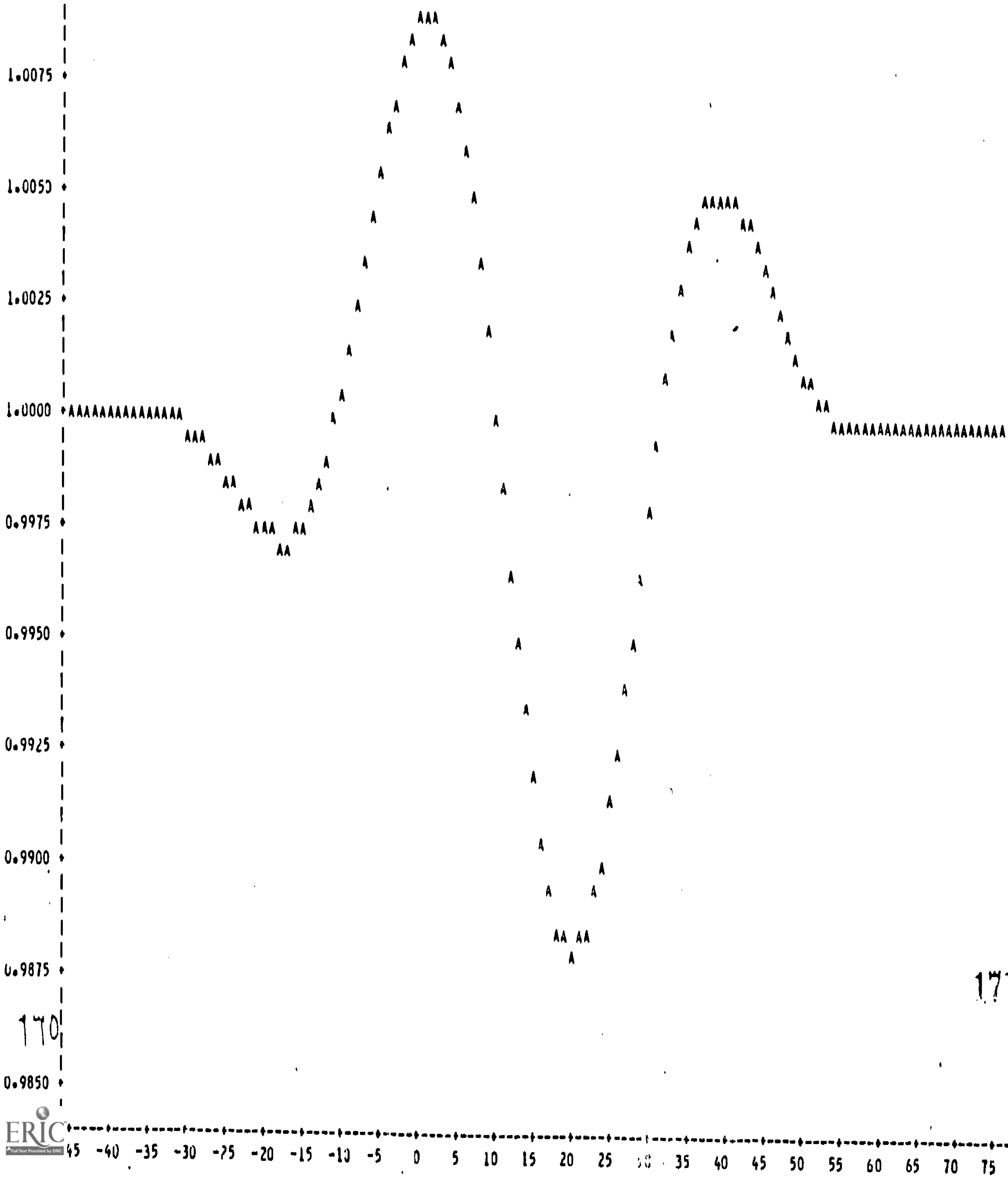

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Figure A.31: Simulated Present Value of Earnings - 31 Year Baby Boom

13-15 Years of Schooling/Weekly Wages

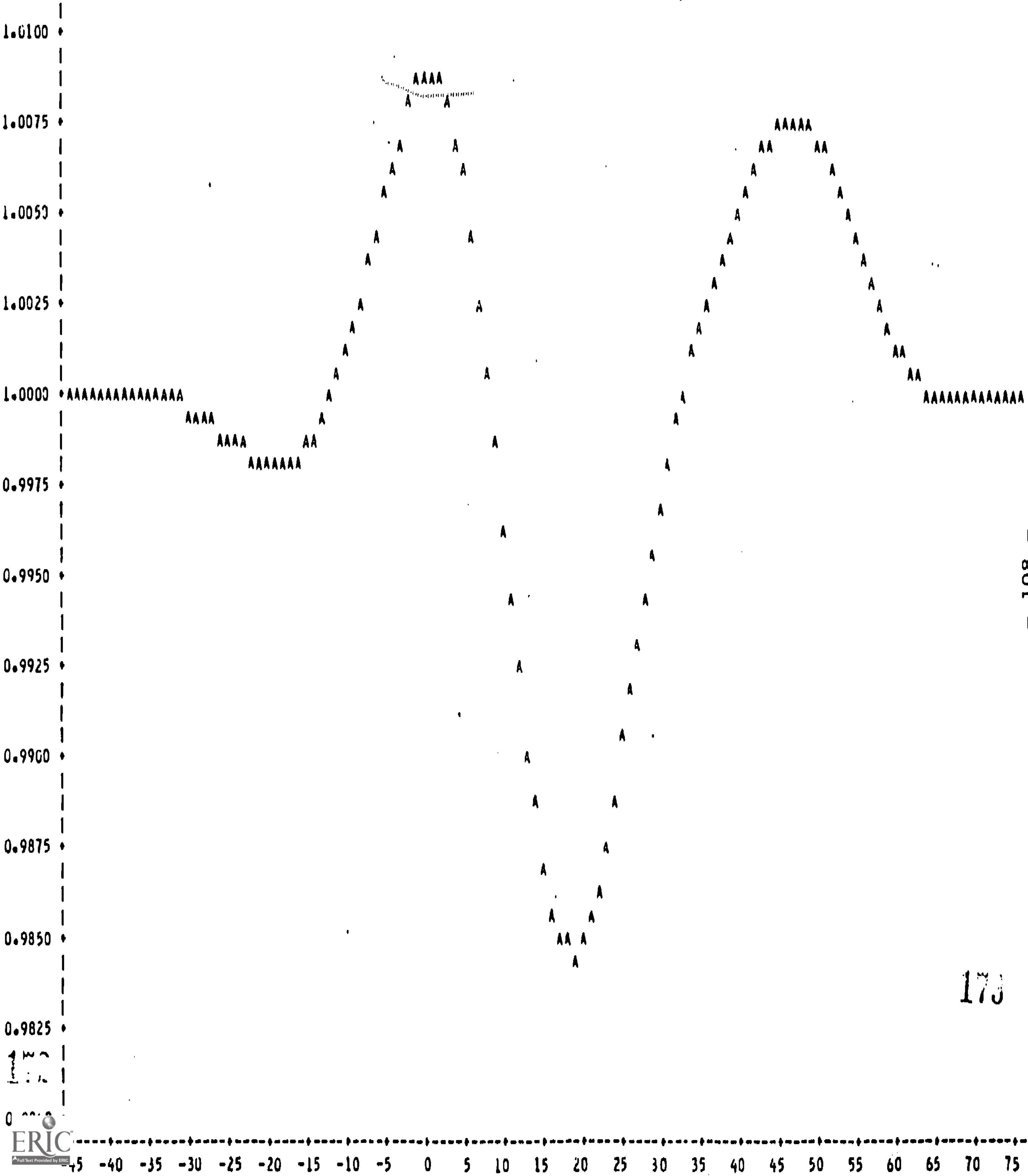

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Figure A.52: Simulated Present Value of Earnings - 31 Year [illegible] Boom

16 Years of Schooling/Weekly Wages

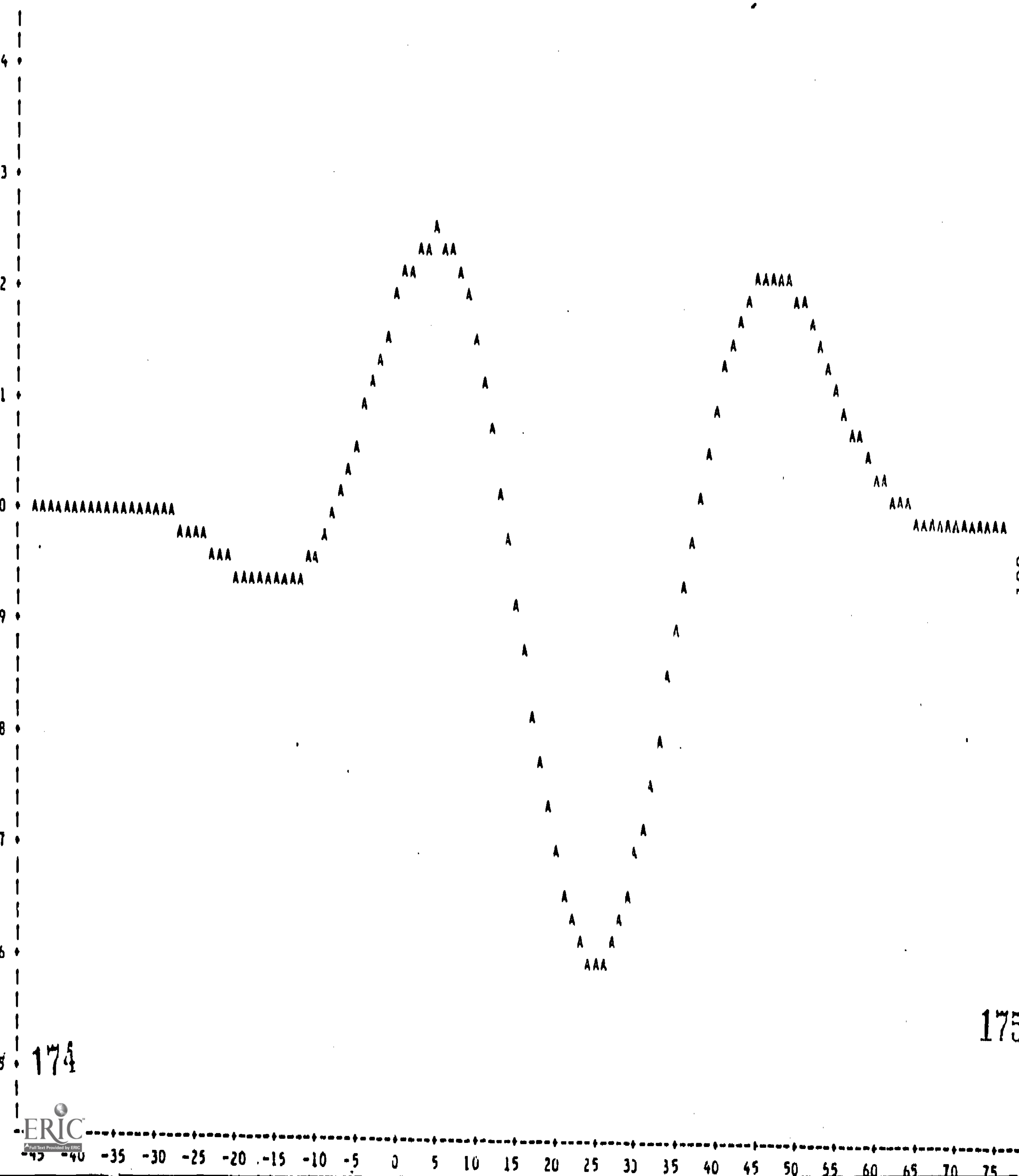


Figure A.53: Simulated Present Value of Earnings - 31 Year Baby Boom

8-11 Years of Schooling/Annual Income

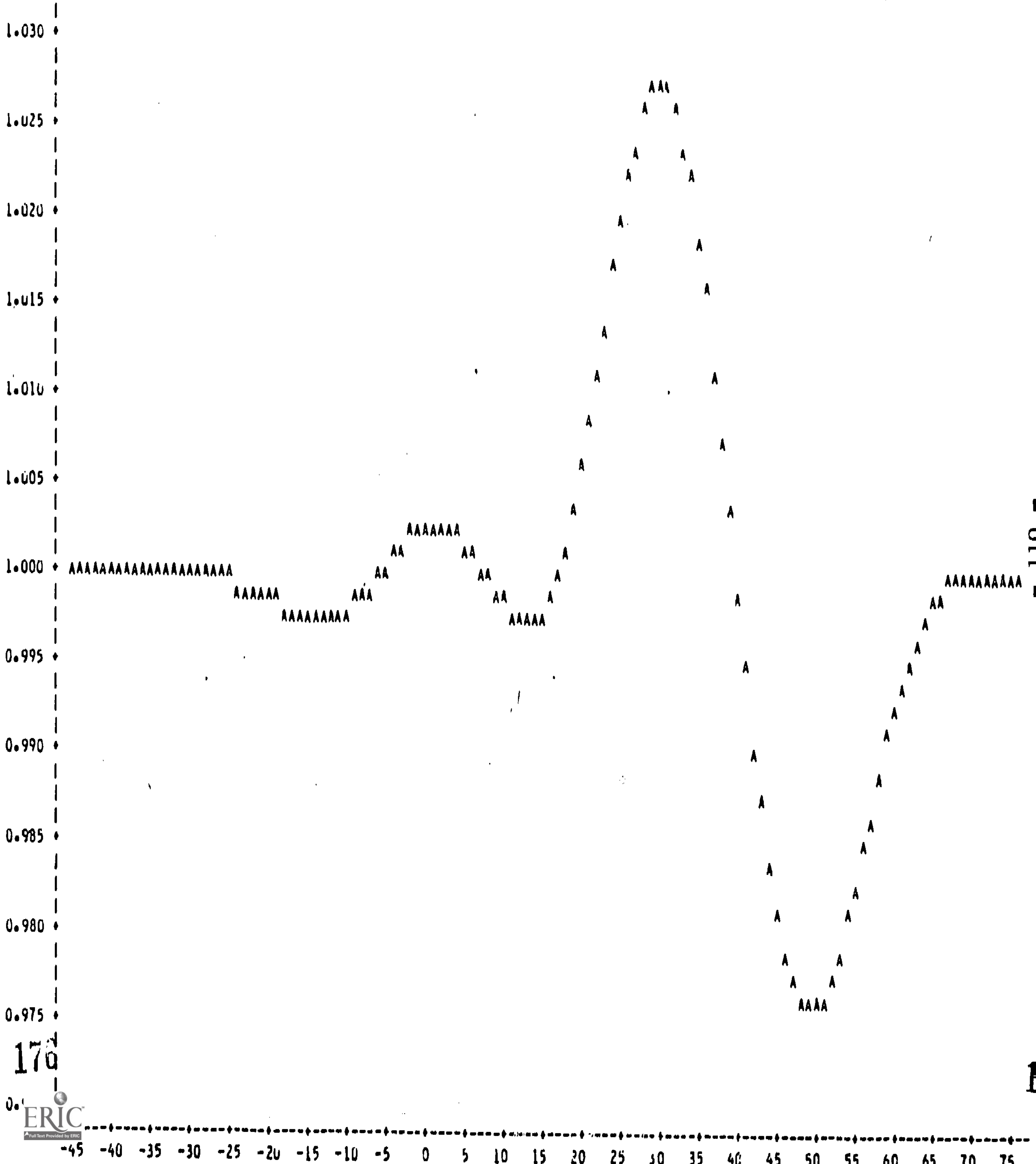


Figure A.54: Simulated Present Value of Earnings - 31 Year Baby Boom

12 Years of Schooling/Annual Income

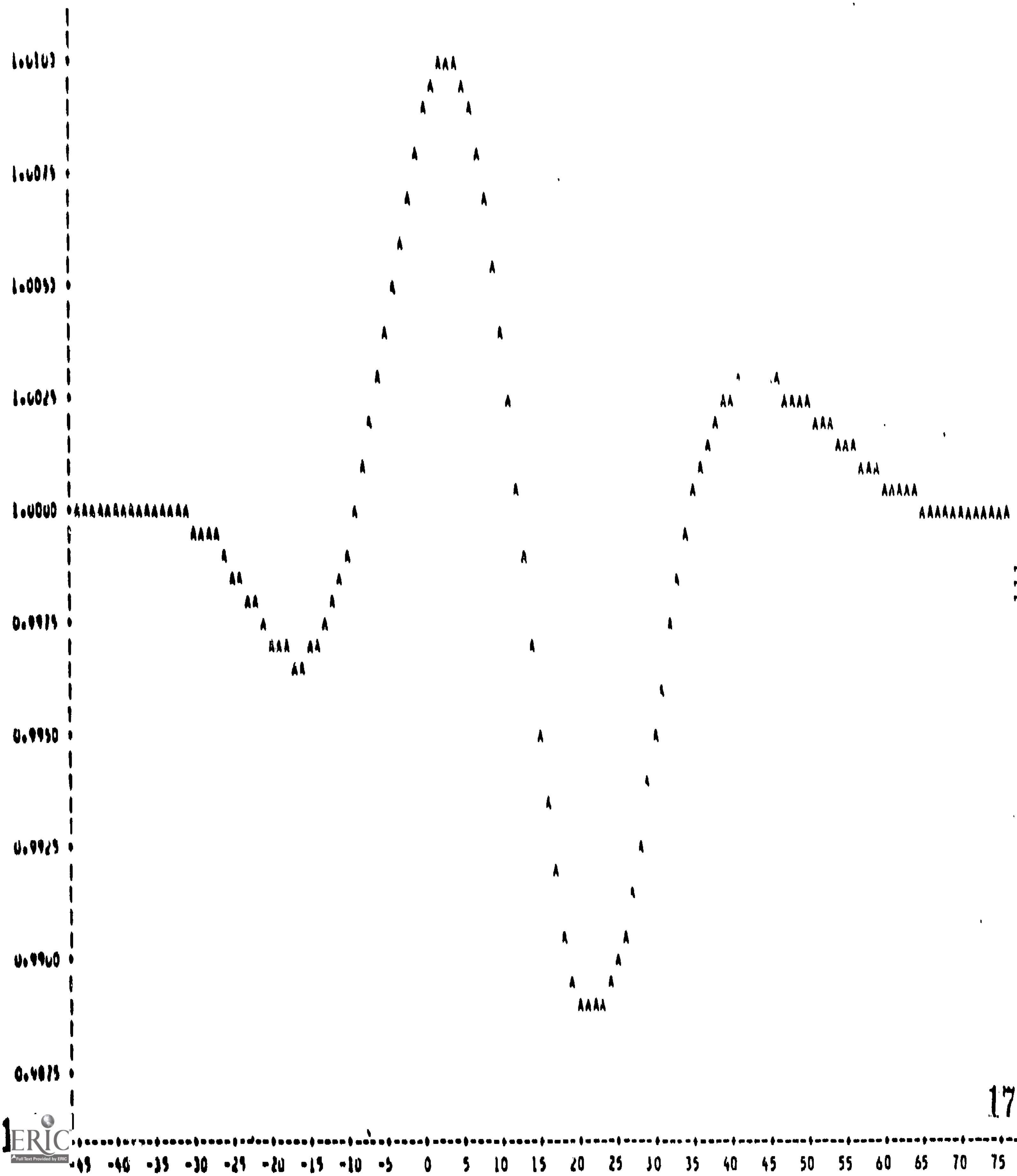


Figure A.55: Simulated Present Value of Earnings - 31 Year Baby Boom

13-15 Years of Schooling/Annual Income

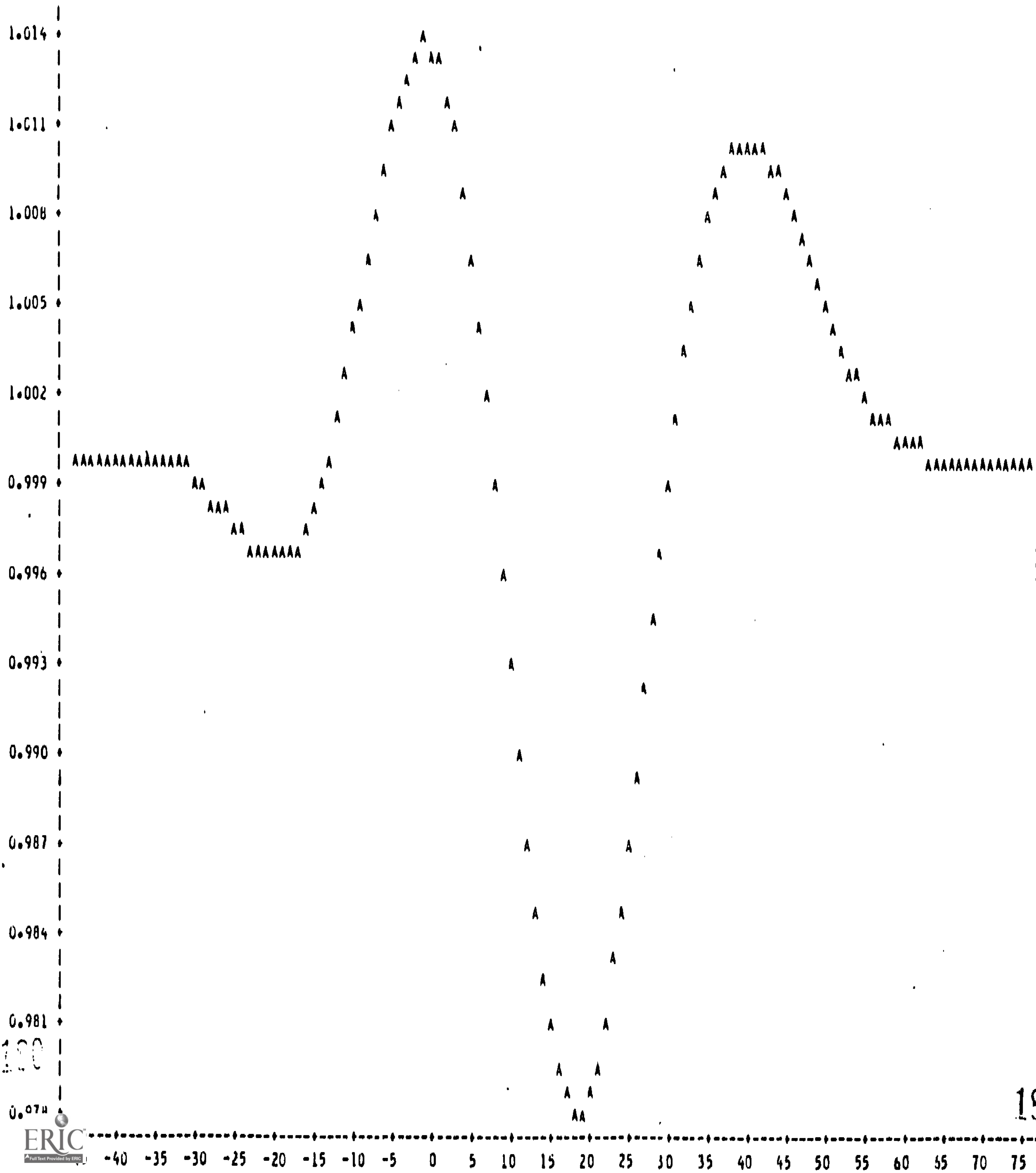
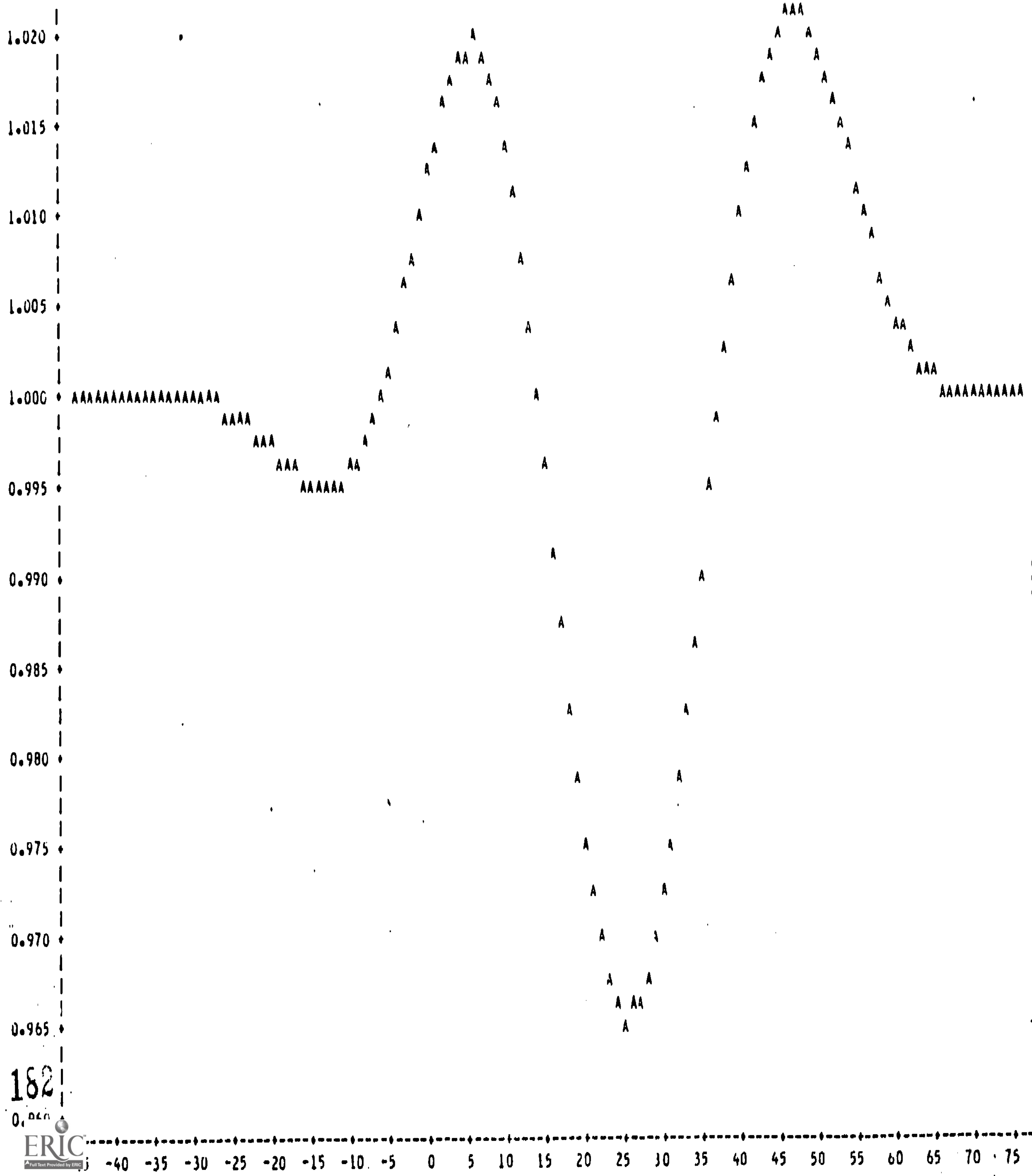


Figure A.56: Simulated Present Value of Earnings - 31 Year Baby Boom

16 Years of Schooling/Annual Income



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Appendix B

THE DETERMINANTS OF COLLEGE ENROLLMENTS

In this appendix we present our results concerning the determinants of college enrollments. The previous analysis indicates that the earnings of workers change with the demographic composition of the labor force, and clearly this affects the rate of return to investments in post-secondary education, and thus will affect enrollments in colleges and universities. In the previous analysis high school and college educated workers were treated as separate factors of production, and the effects of educational choice were in no way incorporated into the model. Clearly this is an important task for future research. In this section we look at a different set of data to analyze the determinants of college enrollments. Our results are negative in nature. In essence we found that the data necessary for a comprehensive analysis of this question are not available, and what analyses have been done are extremely sensitive to specification and time horizon.

The previous economic study of the determinants of college enrollments was done by Richard Freeman in his book The Over-Educated American. Freeman specifies a simple, three equation model of college enrollments to forecast the conditions of the job market for college graduates. The first equation states that the number of freshmen entering college in a given year is a linear function of the number of 18-19 year olds, the difference between college starting salaries and average annual earnings of the population and the number of freshmen entering in the previous year. The second equation specified that the number of bachelor's degrees granted in any given year was a linear function of the number of freshmen entering college four years earlier and the number of freshmen entering five years earlier. The third equation states that college graduates' starting salaries is a liner function of the number of bachelor's degrees granted in the previous year, an index of demand for college graduates, average annual earnings and the lagged value of college graduates starting salaries. Freeman's analysis covers the period from 1951 to 1973, with some estimated figures being used in 1973. As Freeman notes this small model, estimated over a very short time period ignores many factors determining college enrollments, but the lack of data prohibits anything more complex. We begin with Freeman's model, extend the time period of the estimation, add some other variables and also perform the analysis for female undergraduates.

Our first task was to attempt to duplicate Freeman's results, and to do that we set about gathering the appropriate data. The data we gathered is summarized in table B.1, and some comments are in order. There are two variables where Freeman's data and our data differ in construction. First, CSAL, the starting wage of college graduates is the median income of young (25-34 year old) college graduates as reported in the The Digest of Educational Statistics. Freeman uses instead data from a survey by Endicott which we could not find available for an extended time period. Secondly, the variable that characterizes the demand for college graduates is constructed in our data base as a weighted average of the number of people employed in certain sectors of the economy, the weights reflecting the percentage of individuals in that sector who have college degrees. Thus this demand index reflects changes in the industrial composition of the labor force assuming the educational structure of the labor force within industry remains constant. Freeman calculates a similar index, but uses 46 unnamed industries. We instead use broad industrial classifications. The weights in both studies were taken from the 1960 census. To see if these compositional weights affected the results substantially we also computed an index using weights from the 1970 census. For the population variable we used the number of 16 to 19 year old persons as reported by CITIBASE. Our one additional variable is tuition for four year institutions of higher education as reported in the Digest of Educational Statistics. Freeman does not include these data in his model. Note also that we gather all data for males and females separately. Freeman does his analysis for males only. Our complete data set runs from the late 1950's to 1980. This adds essentially seven years to the end of Freeman's data, but due to our different measure of college graduates' salaries we could not extend our data back as far as Freeman.

Given the differences in data bases, our first effort was to see if we could reproduce Freeman's results at all closely. In Table B.2, we exhibit the results of the freshmen enrollment regressions. Recall that the specification for this equation was:

$$FRSH = a_0 + a_1 POP + a_2 SAL + a_3 FRSH(-1)$$

Freeman's results are presented in column 1. He finds a significant positive effect of population of 16-19 year olds, a significant effect of the salary ratio and and insignificant coefficient on the number of freshmen lagged. We present our results for the most comparable time period available, given our data, in column 2. It is surprising how close the magnitudes of the coefficients are to those of Freeman's, the largest difference being in the coefficient on the relative salary of college graduates. This difference is certainly not surprising given the differences in the underlying data. The coefficient on the salary ratio is not significantly different from zero in our regression. There is clearly a very high degree of colinearity among the explanatory variables, given that none of them are significantly different from zero, but the R-squared measure is 95%. Essentially this tells us that it is difficult to discern among the measures as explanatory variables. In column three, we extend the sample to include the observations in the later years, 1974 to 1979. The most startling change is the coefficient on the salary ratio changes sign, although it is still not significantly different from zero. This is an important variant from the basic Freeman specification. Freeman's thesis centers around the sensitivity of enrollments to the relative salary of young college graduates. In particular, he hypothesizes that enrollments are highly sensitive to changes in the earnings of graduates--the lower the salary the lower the enrollment. This positive relationship is the driving force behind his cobweb simulation model. In their review of Freeman's work, Smith and Welch contend that decreases in relative wages of young earners do not necessarily signal smaller lifetime earnings, and thus the hypothesized positive relationship should not necessarily hold. If it does not, Freeman's simulations are rendered less meaningful. Our results show that for the time period Freeman studied, the relationship between relative salary and enrollment was positive, but extending the period to the late 1970's, the result is no longer valid. We stress again, that due to the colinearity in the short period regression it is difficult to discern which variables have the explanatory power. Our second regression indicates that the relative salary of young college graduates does not have much explanatory power.

In table B.3, we present the second equation of the model which computes the number of degrees conferred as a function of the number of freshmen four and five years earlier. Freeman's results are presented in the first column. The coefficient on the four year lag is significant and positive, the coefficient on the five year lag is insignificant and positive. Our results differ little from Freeman. In the long time period the coefficient on the five year lag changes sign, but is still insignificant.

The results of the regressions on the determinants of salaries of young college graduates are given in Table B.4. Freeman's results are given in column 1, and our best approximation to Freeman in column 2. There are some noticeable differences, as would be expected since the dependent variables in the two regressions are from different sources. The "supply" variable in this reduced form equation is the number of males graduated in the previous year (BA(-1)), and appears with a negative sign in both regressions. The demand variables (which are constructed in different manners) both enter with a positive sign, Freeman's being significantly different from zero. The coefficients on average annual earnings are insignificant in both regressions, ours is negative and small, Freeman's is positive and a bit larger. The lagged value of the dependent variable enters with a positive sign in both versions of the equation. When we extend the regression to a longer time period, the only significant variable is the lagged college entry salary, and the average annual earnings coefficient is large and positive. In the fourth column we enter the demand variable that uses 1970 weights instead of 1960 weights and it changes the other coefficient estimates very little. We conclude from this table that the specification of entry salaries for college graduates is critical in Freeman's regressions, and since the data series is not generally available, it casts some doubt on the validity of Freeman's conclusions.

In table B.5, we present the freshman enrollment regressions once again, but in the last two columns include measures of college tuition.

Freeman claims that these measures should make little difference, since the major cost of college is foregone earnings, not tuition. As we see from comparing columns two and three, the inclusion of publicly supported school tuition makes a large difference in the coefficient estimates and is a significant factor in explaining enrollments. Tuition at private colleges and universities has no explanatory power, and does not effect other estimates as can be seen from column four. With Freeman, we want to caution the reader about putting too much faith in these results. The number of observations is very small, the data are very colinear, and the results seem to be very sensitive to specification of the form of the equation and the time period. Reliance on these numbers for simulation or policy recommendations would be foolish.

In tables B.6 to B.9 we present the regressions for the model applied to female college graduates. The results in table B.6, the determinants of freshman enrollments are basically the same as that for men. The relative salary variable is positive and significant for the short period, but insignificant and negative for the extended period. The most significant explanatory variable is the lagged value of the dependent variable. Comparing table B.7 with table B.3 we see that there is little difference in the determinants of conferred bachelor's degrees. The regression of female college graduate salary shows some minor differences, but it seems the basic determinant is the average salary in the population (ASAL) and the previous year's salary. This set of regression supports the notion that the structure of the market for new college educated women is approximately the same as that for men, at least so far as these specifications characterize that market.

These regressions encompass our investigation of the determinants of college enrollment. We would have liked to have extended this analysis much farther, taking into account demographic shifts and the changing earnings structure between educated and uneducated workers. The problem we encountered, as did Freeman, is that the data available for such investigations are so poor in quality and quantity that any further investigation is impossible. Unlike Freeman, we conclude that the regressions estimated using this simple model have little theoretical content. The data are best explained, it seems, by their own lagged values, and there is sufficient sensitivity to specification and time horizon, that any simulations would be misleading. There is no doubt in our minds that research on the economic and demographic determinants of college enrollments needs to be done. The difficult question facing the investigator is where the data is to come from. We performed an extensive search of publicly held data and came up with a small data base, that at best weakly characterizes the last 20 years of history. The correct direction for research to proceed is towards compilation of a comprehensive data base that includes enrollments at major universities at least since World War II, costs of enrollment, salaries upon graduation in different fields, demographic composition of enrollments, geographic composition of enrollments, degrees conferred including a breakdown by field of specialization, faculty composition, administrative costs, and so on. Until such data is publically available, it is difficult for serious empirical work to be done. Furthermore, once this data is obtained, economists can combine analyses of cohort size and earnings determination with analyses of enrollment determination. Until that time, estimation of the determinants of college enrollments cannot provide the policy maker with any firm basis on which to make decisions.

TABLE B.1

****

VARIABLE LIST AND DATA SOURCES FOR COLLEGE ENROLLMENT STUDY

****

ASAL = AVERAGE ANNUAL EARNINGS (1950-81)

AVERAGE WEEKLY EARNINGS X 50 WEEKS WORKED PER YEAR.
All manufacturing industries, 1950-68, pvt. nonfarm establishments, 1969-81.
Monthly average, 1948-63, annual, 1964-81.
In 1967 dollars.
SOURCE: SURVEY OF CURRENT BUSINESS.

BA = B.A.'S CONFERRED (male/female, 1947-79)

AGGREGATE U.S. (50 STATES + WASH. D.C. + PUERTO RICO, ETC.).
1947-59 includes some 1st professional degrees.
1958 estimated.
SOURCE: EARNED DEGREES CONFERRED.

CSAL = COLLEGE GRADS' ANNUAL SALARY (male/female, 1958-81)

Median income of persons 25-34 years old with 4+ years of college.
1958(women), 1959, 1960, 1961(women), 1962 estimated.
In 1967 dollars.
SOURCE: DIGEST OF EDUCATIONAL STATISTICS, CPR P-60.

CONST = CONSTANT

DEM = DEMAND FOR COLLEGE GRADUATES (male/female/all, 1947-81)

No. employed by industry weighted by % with college degrees.
Employment is monthly average, 1947-63, annual, 1964-79.
Unadjusted, 1947, adjusted (Federal Reserve), 1948-81.
Industries are manufacturing, mining, construction, trade (wholesale and retail), finance, service (professional), government.
SOURCE: SURVEY OF CURRENT BUSINESS β 1960/70 CENSUS (WEIGHTS).

FRSH = COLLEGE ENROLLMENT (male/female, 1946-79)

First-time degree credit enrollment.
SOURCE: DIGEST OF ED STATS, FALL ENROLLMENT IN HIGHER ED.

POP = POPULATION (male/female, 1946-79)

16-19 year olds.
SOURCE: CITIBASE.

SAL = CSAL / ASAL (male/female, 1958-81)

TUIT = TUITION AND FEES (public/private, 1957-81)

1957-8, all 4-year instit's, 1959-81, 4-year universities.
1960, 1981 estimated.
In 1967 dollars.
SOURCE: DIGEST OF EDUCATIONAL STATISTICS.

TABLE B.2

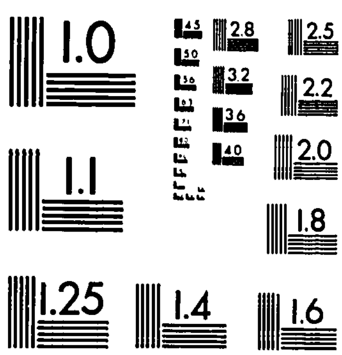
Determinants Of Male Freshman Enrollment

(Dependent Variable: FRSH*)

	Freeman ** 1951-73	1958-73	1958-79
CONST	-2.02	-3.05	-0.59
POP	0.88	0.89	0.72
	(0.21)	(0.53)	(0.34)
SAL	1.31	1.51	-0.64
	(0.26)	(2.12)	(1.20)
FRSH(-1)	0.21	0.31	0.60
	(0.16)	(0.39)	(0.20)
R SQUARED	0.987	0.948	0.953
DURBIN WATSON	1.79	1.47	1.95
n	22	15	21

* Standard errors in parenthesis

** Freeman's data base is different (see text)



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS
STANDARD REFERENCE MATERIAL 1010a
(ANSI and ISO TEST CHART No. 2)

TABLE B.3

Determinants Of Male B.A.'s Conferred

(Dependent Variable: BA*)

	Freeman ** 1954-73	1954-73	1951-79
CONST	-0.63	-0.06	-0.13
		(0.16)	(0.04)
FRSH(-4)	0.71	0.43	0.63
	(0.20)	(0.13)	(0.11)
FRSH(-5)	0.29	0.15	-0.12
	(0.20)	(0.14)	(0.11)
R SQUARED	0.98	0.96	0.96
DURBIN WATSON	0.55	0.88	0.77
n	19	19	28

* Standard errors in parenthesis

** Freeman's data base is different (see text)

TABLE B.4

Determinants Of Young Male College Graduate's Annual Salary

(Dependent Variable: CSAL*)

	Freeman ** 1951–73	1959–73	1959–80	1959–80
CONST	−2.25	2.79	−1.18	−1.20
BA(−1)	−0.15 (0.02)	−0.36 (0.35)	0.10 (0.22)	0.10 (0.22)
DEM	1.10 (0.51)	0.68 (0.40)	−0.04 (0.08)	−0.03*** (0.07)
ASAL	0.31 (0.24)	−0.13 (0.47)	0.63 (0.36)	0.63 (0.36)
CSAL(−1)	0.45 (0.11)	0.11 (0.40)	0.74 (0.19)	0.74 (0.19)
R SQUARED	0.99	0.95	0.81	0.81
DURBIN WATSON	1.51	2.16	1.94	1.95
n	22	14	21	21

* Standard errors in parenthesis

** Freeman's data base is different (see text)

***Uses 1970 weights (see text)

TABLE B.5

Determinants Of Male Freshman Enrollment

(Dependent Variable: FRSH*)

	Freeman** (1951-73)	1958-79	1958-79	1958-79
CONST	-2.02	-0.59	-2.74	-0.60
POP	0.81 (0.21)	0.72 (0.34)	1.42 (0.44)	0.72 (0.67)
SAL	1.31 (0.26)	-0.64 (1.20)	1.45 (1.43)	-0.63 (1.34)
FRSH(-1)	0.21 (0.16)	0.60 (0.20)	0.46 (0.19)	0.60 (0.20)
PUBLIC TUITION			-1.39 (0.61)	
PRIVATE TUITION				-0.001 (0.25)
R SQUARED	0.987	0.948	0.964	0.952
DURBIN WATSON	1.79	1.47	2.11	1.95
n	22	21	21	21

* Standard errors in parenthesis

** Freeman's data base is different (see text)

TABLE B.6

Determinants Of Female Freshman Enrollment

(Dependent Variable: FRSH*)

	1958-73	1958-79
CONST	-3.60 (1.12)	-0.60 (1.16)
POP	0.77 (0.28)	0.39 (0.38)
SAL	3.46 (1.12)	-1.49 (2.18)
FRSH(-1)	0.28 (0.18)	0.93 (0.11)
R SQUARED	0.987	0.970
DURBIN WATSON	1.372	2.052
n	15	21

* Standard errors in parenthesis

TABLE B.7

Determ… Of Female B.A.'s Conferred

(D… ent Variable: BA*)

	1954-73	1951-79
CONST	-0.19 (0.08)	0.053 (0.082)
FRSH(-4)	0.41 (0.13)	0.65 (0.15)
FRSH(-5)	0.22 (0.13)	-0.12 (0.15)
R SQUARED	0.985	0.978
DURBIN WATSON	1.457	0.689
n	19	28

* Standard errors in parenthesis

TABLE B.8

Determinants Of Young Female College Graduates Annual Salary

(Dependent Variable: CSAL*)

	1954-73	1958-80	1958-80
CONST	-1.45 (1.04)	-0.77 (1.37)	-0.76 (1.30)
BA(-1)	0.57 (0.57)	0.67 (0.31)	0.67 (0.31)
DEM	0.01 (0.70)	-0.38 (0.20)	-0.37** (0.20)
ASAL	0.65 (0.43)	0.62 (0.25)	0.62 (0.26)
CSAL(-1)	0.20 (0.32)	0.44 (0.22)	0.45 (0.22)
R SQUARED	0.919	0.905	0.905
DURBIN WATSON	1.912	2.070	2.06
n	14	21	21

* Standard errors in parenthesis

** Use 1970 Weights

TABLE B.9

Determinants Of Female Freshman Enrollment

(Dependent Variable: FRSH*)

	1958-79	1958-79	1958-79
CONST	-0.60 (1.16)	-1.38 (1.06)	-0.95 (1.32)
POP	0.39 (0.38)	1.22 (0.46)	0.80 (0.77)
SAL	-1.49 (2.18)	0.26 (2.02)	-1.49 (2.22)
FRSH(-1)	0.93 (0.11)	0.80 (0.11)	0.92 (0.11)
PUBLIC TUITION		-1.6 (0.61)	
PRIVATE TUITION			-0.16 (0.20)
R SQUARED	0.97	0.98	0.97
DURBIN WATSON	2.052	2.331	2.084
n	21	21	21

* Standard errors in parenthesis

Appendix C: Computation of Wage Elasticities

For the three-factor model the wage of a worker with experience i is

$$y(i) = \ell(i, 1)\, w(1) + \ell(i, 2)\, w(2) + \ell(i, 3)\, w(3) \tag{1}$$

The marginal products, $w(1)$, $w(2)$, and $w(3)$ are assumed to be determined using the model in the text:

$$\frac{w(2)}{w(1)} = \delta_{21} + \delta_{22} \frac{n(2)}{n(1)} + \delta_{23} \frac{n(3)}{n(1)} \tag{2}$$

$$\frac{w(3)}{w(1)} = \delta_{31} + \delta_{32} \frac{n(2)}{n(1)} + \delta_{33} \frac{n(3)}{n(1)} \tag{3}$$

where $n(1)$, $n(2)$ and $n(3)$ are the aggregate numbers of factors:

$$n(m) = \sum_{i=1}^{I} \ell(i, m)\, p(i), \quad m = 1, 2, 3 . \tag{4}$$

Recall that $p(i)$ is the number of workers in the population with experience i. We are interested in computing the elasticity of $y(i)$ with respect to $p(j)$ holding aggregate productivity, $w(1)$, constant. That is, we wish to calculate

$$\frac{p(j)}{y(i)} \quad \frac{dy(i)}{dp(j)} \Bigg|_{w(1) = \bar{w}} . \tag{5}$$

From equation (1) we get

$$\frac{dy(i)}{dp(j)} = \ell(i, 2) \frac{dw(2)}{dp(j)} + \ell(i, 3) \frac{dw(3)}{dp(j)} . \tag{6}$$

Diffferentiating (2) with respect to p(j) we get

$$\frac{1}{\bar{w}} \frac{dw(2)}{dp(j)} = \delta_{22} \left[\frac{n(1) \frac{dn(2)}{dp(j)} - n(2) \frac{dn(1)}{dp(j)}}{(n(1))^2} \right] + \delta_{23} \left[\frac{n(1) \frac{dn(3)}{dp(j)} - n(3) \frac{dn(1)}{dp(j)}}{(n(1))^2} \right]. \tag{7}$$

But from (4) we know that

$$\frac{dn(m)}{dp(j)} = \ell(j, m)$$

so (7) becomes:

$$\frac{1}{\bar{w}} \frac{dw(2)}{dp(j)} = \delta_{22} \left[\frac{\ell(j, 2)}{n(1)} - \frac{n(2)\ \ell(j, 1)}{n(1)^2} \right] + \delta_{23} \left[\frac{\ell(j, 3)}{n(1)} - \frac{n(3)\ \ell(j, 1)}{n(1)^2} \right]$$

and rearranging terms we get:

$$\frac{1}{\bar{w}} \frac{dw(2)}{dp(j)} = \frac{1}{n(1)} \left[\ell(j, 1) \left(-\delta_{22} \frac{n(2)}{n(1)} - \delta_{23} \frac{n(3)}{n(1)}\right) + \delta_{22}\ \ell(j, 2) + \delta_{23} \ell(j, 3) \right], \tag{8}$$

and similarly we operate on (3) to get:

$$\frac{1}{\bar{w}} \frac{dw(3)}{dp(j)} = \frac{1}{n(1)} \left[\ell(j, 1) \left(-\delta_{32} \frac{n(2)}{n(1)} - \delta_{33} \frac{n(3)}{n(1)}\right) + \delta_{23}\ \ell(j, 2) + \delta_{33}\ \ell(j, 3) \right]. \tag{9}$$

Define $L(j) = (\ell(j, 1), \ell(j, 2), \ell(j, 3))'$, then

$$\begin{pmatrix} \frac{dw(2)}{dp(j)} \\ \frac{dw(3)}{dp(j)} \end{pmatrix} = \frac{\bar{w}}{n(1)} \begin{pmatrix} -\delta_{32} \frac{n(2)}{n(1)} - \delta_{33} \frac{n(3)}{n(1)} & \delta_{22} & \delta_{23} \\ -\delta_{32} \frac{n(2)}{n(1)} - \delta_{33} \frac{n(3)}{n(1)} & \delta_{32} & \delta_{33} \end{pmatrix} L(j) \tag{10}$$

Using (6) and (10) we can then compute

$$\frac{dy(i)}{dp(j)} \text{ by evaluating } n(1)\ ,\ \frac{n(2)}{n(1)} \text{ and } \frac{n(3)}{n(1)}$$

at their respective means. We then divide the result by the mean of $y(i)$ and multiply by the mean of $p(j)$ to compute the elasticity.