1984

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LEVELING THE PEAKS AND TROUGHS IN THE DEMOGRAPHIC CYCLE: AN APPLICATION TO SCHOOL ENROLLMENT RATES

Michael L. Wachter and William L. Wascher*

Abstract—To maximize lifetime discounted earnings, individuals act so as to fill in the peaks and troughs of the demographic cycles exhibited by population and hence relative income. As a consequence, those born prior to the peak increase their school enrollment rates, while those trailing the peak decrease their school enrollment rates. Education thus provides a differential tracking mechanism. While individuals cannot choose the cohorts in which they are born, they are able to time their entry into the career labor market through education. This asymmetric demographic effect is tested in a time series equation. Our model helps to explain the "surprisingly" steep decline in school enrollment rates during the 1970s.

1. Introduction

ECONOMIC-DEMOGRAPHIC interrelationships have received considerable attention over the past decade. Of particular interest has been the effect of cohort size on labor market variables such as relative income, labor force participation, unemployment, and fertility. Richard A. Easterlin's (1968) seminal study analyzed the potential of a long-run economic cycle generated by shifts in the fertility rate. The key independent variable in his analysis was a measure of cohort size. Large cohorts suffered a depression in their relative wages and, hence, begot small cohorts. The higher relative income of the smaller cohorts was hypothesized to lead to a renewed upswing in fertility.

Studies on labor force participation rates (Wachter, 1972, 1976) indicated that large cohorts had higher labor force participation rates. Equilibrium unemployment rates were also shown to increase as large cohorts entered the labor market (Perry, 1971; Wachter, 1976; and Ehrenberg, 1980). The impact of cohort size on relative income was explored, for example, by Freeman (1979), Welch (1979), and Berger (1981).

Received for publication November 27, 1982. Revision accepted for publication August 11, 1983.

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Research support for this study was provided by grants from the General Electric Foundation and the National Institutes of Health. The authors would like to thank Daniel Hamermesh, participants of the Labor Workshop at the University of Pennsylvania, and the referees for helpful comments. The views expressed in this paper do not necessarily represent those of General Electric, NIH, or the Federal Reserve.

The effect of cohort size on school enrollment rates has received less attention than the demographic impact on unemployment and relative wages. Richard Freeman's important study, The Overeducated American, touched upon the influence of cohort size, but his focus was on the declining rate of return to education. In a review article, Smith and Welch (1978) emphasized the cohort theme and argued that this factor caused the decline in the rate of return to education. Mattila (1982) examined the effects of rates of return to education on school enrollment rates and mentioned that cohort size might be a cause of the changes in the rate of return. The notion that school enrollment rates have responded positively to cohort overcrowding received empirical support from Wachter and Kim (1982). That study found that cohort overcrowding led to a flow of individuals out of employment into unemployment, school, and out of the labor force.

In this study we argue that the effects of cohort overcrowding may be more complicated in that important asymmetric effects may be the dominant characteristics. Specifically, for some phenomena the size of the cohort may be less important to individual decisions than the position of individuals relative to the peaks and troughs of the demographic cycle. This model is tested on school enrollment rate fluctuations. The basic hypothesis, as applied to this time series, is that individuals born at the beginning of the baby boom are likely to have the highest enrollment rates while those born at the end are likely to have the lowest rates—even though both groups were born into cohorts of equal size (relative to the overall population). The rationale for the hypothesis, which we refer to as the differential tracking model, is that the maximization of discounted lifetime earnings pushes individuals to distance themselves as much as possible from the peak fertility year cohorts.

1 See also Freeman (1975, 1977).

2 Ahlburg, Crimmins, and Easterlin (1981), on the other hand, found the opposite result.

The international data on school enrollment rates have been analyzed by Reubens, Harrisson, and Rupp (1981).
The model is explained in section II. The empirical results, based on enrollment rate data for the United States, are presented in section III. Section IV draws the conclusions and implications of the model for economic policy.

II. The Differential Tracking Model

Consider a model where all individuals go through two stages—one where they combine schooling and work and the other where they only work. Individuals hold two jobs over their working life: a career job and an entry or youth job. The crucial demographic effect that individuals must deal with is that the career job wage varies inversely with cohort size.\(^3\)

Born into a specific cohort, individuals face either favorable or unfavorable prospects. They can, however, alter their initial fate or cohort size in order to improve their prospects. In our stylized model, individuals can be viewed essentially as shifting their career cohort by adjusting school enrollment rates so as to maximize discounted lifetime earnings.

The key to maximizing lifetime income is to be in the smallest size career cohort possible and thus have the highest career wage possible. If a small cohort is ahead, individuals take the fast track by attending school more intensively. This enables them to move ahead so as to be a member of and to compete with that smaller cohort. Trailed by a small cohort, individuals take the slow track, extending their noncareer entry jobs and absorbing their education at a leisurely pace. This tracking system is illustrated in figure 1. The fast track is depicted by curve \(FF\) and the slow track by \(SS\). Note that the slow track is slow only with respect to the delay in starting the career job.\(^4\)

After individuals devote a minimum amount of time to stage one, they choose how much of their remaining worklife to devote to each stage. Individuals taking the normal track (case A) spend \(T_1\) in the first period and obtain an average amount of schooling. They then find career jobs at a wage determined by the initial cohort size. Individuals taking the fast track (case B) also spend \(T_1\) in the first stage. However, these individuals obtain more than average schooling and so incur added costs associated with school enrollment during the first stage. In stage two, they are able to compete with earlier and smaller cohorts in order to earn a higher career wage. Individuals taking the slow track (case C) delay entering the career labor market until \(T_1\) and incur a cost which depends upon the differential between the career wage and the entry wage. They can then compete with a smaller cohort in stage two and earn a higher career wage.

The choices available to the individual are thus to move to an earlier career cohort through intensive schooling, to move to a later cohort via less or more leisurely schooling, or to stay in the same birth cohort.

Given that the career wage is assumed to be inversely related to cohort size, it can be shown that individuals will move away from the peak cohort by obtaining more schooling in the pre-peak region and by delaying career entry in the post-peak region. In particular, individuals move ahead in terms of their career cohort so that the marginal benefit or higher wage received from an additional unit of schooling equals the marginal cost of obtaining that unit in terms of forgone earnings on entry jobs and the marginal cost of education.

\(^3\) To a lesser extent this is also true of the youth wage, but in our formal development of the model, we assumed that the youth wage was constant to facilitate the analysis.

\(^4\) For ease of exposition, the fast and slow tracks in figure 1 have the same career wage. Note, however, that any single individual cannot move forward or backward with the same resulting career wage. The analysis in the next section will indicate which individuals can improve their career wage by moving forward and which individuals benefit from moving backward across cohorts.
Whereas the marginal cost of moving ahead is a function of the cost of schooling and the resulting forgone youth wage, for an individual moving backward, the marginal cost of moving is a function of the adult–youth wage differential for the extra time spent in youth jobs. The ability of individuals to move to a desired career cohort is limited by increasing marginal costs of switching cohorts. A rigorous development of this model can be found in Wachter and Wascher (1984).

The tracking effect depends in part on the existence of vintage effects in human capital; that is, rather than having a single career labor market across age groups, age groups are imperfectly substitutable for each other. In this case, the earnings of older adults are partially shielded from the degree of overcrowding in the entering cohort. Each new group has its own age–earnings profile that only partially reflects excess demand conditions before or after the career group.  

To the extent that specific training is pervasive, vintage effects should be important. If there is learning-by-doing, each year’s new job entrants will be differentiated and, hence, partially insulated from those coming before and after. Employers who use either formal or informal tenure procedures are validating vintage effects. Most professional and administrative markets function in this way, from universities with formal tenure rules to law firms with virtually formal tenure rules to management positions with a policy of “up or out.” Seniority systems for blue collar workers also create formal vintage effects. These employment policies suggest that vintage effects are widespread and, thus, that timing one’s entry into the tenure or vintage system can be used to alter one’s lifetime earnings stream.

### III. Empirical Results

We estimate a model in which individuals are assumed to base school enrollment decisions, ceteris paribus, on the relative sizes of the cohorts preceding and following them. This is measured by the ratios of the population approximately ten years ahead or behind to the own cohort population. $RS_y$ and $RS_o$ are the relative sizes of the younger and older cohorts, respectively.  

The hypotheses have been tested using an annual time series of school enrollment from 1948 to 1980. Six demographic groups are represented: three age groups—16 to 17, 18 to 19, and 20 to 24; and each age group for males and females. Since our purpose is to test our demographic hypothesis, we have adopted the basic time series schooling equation format generally used by others. In addition to the leading ($RS_y$) and lagging ($RS_o$) cohort barriers, we have included real income ($Y$), military ($MIL$ and $DRAFT$ in the male equations) and marriage ($MAR$ in the female equations) variables. A measure of labor market tightness proved to be statistically insignificant and has been omitted from the final results.

Following the specification adopted by Mattila (1982), two variables are used to capture separately military enlistment and draft effects on school enrollment. The argument is that although draft pressure encourages higher school enrollment rates, the rate of enlistment itself will decrease enrollment rates by taking some males who would have enrolled in school otherwise. Draft pressure is measured as the percentage of males inducted into the armed forces between 1960 and 1972, and the enlistment variable is simply the percentage of males in each age cohort in the armed forces.

The results in table 1 impose the restriction that individuals respond equally to changes in the size of leading and lagging cohorts; that is, the coefficients on $RS_y$ and $RS_o$ are equal in absolute values. (The ratio of $RS_y/RS_o$ is denoted by $RS$.) In table 2, $RS_y$ and $RS_o$ are entered separately.

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5 Absent this effect, there would be only one age-earnings profile for all career workers. The profile need not be flat in that seniority wage increases could be institutionalized. Excess demand conditions, however, would be uniform for all career workers, so that an oversized, entry career group would not experience a disproportionate wage effect compared with older career workers.

6 The demographic and school enrollment variables are in logarithmic form. Construction of all variables is presented in the appendix.

7 Due to data limitations, the sample period for the 16 to 17 age groups is 1953 to 1980.

8 See, for example, Wachter and Kim (1982); Ahlburg, Crimmins, and Easterlin (1981); and Mattila (1982).

9 The specific variable used was the aggregate unemployment rate divided by a demographically adjusted measure of the equilibrium unemployment rate $U^*$. The coefficients on the $UGAP = U/U^*$ variable were not significant for any of the age–sex groups when included in equations similar to those in tables 1 and 2. We have omitted $UGAP$ from the tables in the text due to probable multicollinearity between $UGAP$, $Y$, and the trend variable.
The results of table 1 show that the differential tracking system is highly significant for all of the six age–sex groups with the correct negative sign on the RS variable. Those individuals born prior to a peak fertility rate year have a larger group of competitors following them than ahead (that is, RS is low) and thus have high school enrollment rates. Those individuals with a larger number of competitors ahead of them have lower school enrollment rates.

Efforts to include both a time trend and the real income variable in the model were unsuccessful due to the high collinearity between them. However, the real income variable, when included alone, is always significant, presumably capturing the long-run positive income elasticity that is generally found for school enrollment.

The draft pressure variable is significant and positive for the age group most likely to be drafted, namely, the 18 to 19 year old male group. The enlistment rate variable is negative and significant for every male age group, capturing those males who would have otherwise been enrolled in school. A marriage rate variable is included in the female equations. That variable is negative and significant for every age group.

In table 2, we allow for unequal attention to leading and lagging cohorts by including RS and RS' as distinct variables. All of the leading barriers, RS', appear with the expected negative sign and all of the lagging barriers, RS, with the expected positive sign. Ten of the twelve coefficients are significant with t-values greater than 2. Hence, these results are highly supportive of the asymmetric or differential tracking model. Tests for the equality in absolute value of the coefficients on the leading and lagging barriers did not reject the null hypothesis that changes in the size of leading and lagging cohorts yield equal changes in the school enrollment decisions of individuals.

As mentioned above, our demographic variable measures a different phenomenon from that captured by the traditional cohort size variable. Specifically, the own cohort's size variable is equal.
to the percentage of the total population that is in a particular cohort. It is a measure of the height of the population density function. The demographic variables constructed here (RS and RS, or RS), however, can be viewed as an approximation to the slope of the density function at a particular cohort point.

A statistical test of the asymmetric demographic effect (measured by RS) against the traditional cohort size model (measured by the percentage of the population in a given cohort, denoted by RP) supports the former. Specifically, the F-statistics for the test of the model without RS versus the unconstrained version (table 3, column 2) are always significant, while the F-statistics for the test of the model without the traditional cohort size variable versus the unconstrained model (table 3, column 1) are not significant in any group. 10

An alternative structural approach would view enrollment rates as being determined by the rate of return to schooling, which is in turn a function of demographic variables. Our model, however, is a reduced form equation with exogenous variables on the right-hand side. The problem with implementing the structural approach is that our model indicates that observed rates of return are likely to be biased measures of the expected rates. Specifically, the observed rate of return only reflects cohort size pressure of older groups and necessarily excludes the impact of lagging cohort sizes on expected rates of return. Consequently, expectations based only on leading cohort sizes are biased.

We did, however, test our model against the alternative specification which included observable rates of return on education as independent variables. The specific rate of return variable that we used was constructed by Mattila (1982). In models which contained both the rate of return to education and our demographic variables, the rate of return effect was not statistically significant.

That individuals use lagging as well as leading cohort size indicators in their decision process means that they attempt to use all of the information currently available. There is some support in the literature that individuals are aware of demo-

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**Table 2.** — School Enrollment: Weighted Unequal Effects for Leading and Lagging Barriers

<table>
<thead>
<tr>
<th></th>
<th>Males 16-17</th>
<th>Females 16-17</th>
<th>Males 18-19</th>
<th>Females 18-19</th>
<th>Males 20-24</th>
<th>Females 20-24</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>-0.306</td>
<td>-0.407</td>
<td>-1.312</td>
<td>-1.312</td>
<td>-2.272</td>
<td>-1.605</td>
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<tr>
<td></td>
<td>(-4.83)</td>
<td>(-7.04)</td>
<td>(-7.78)</td>
<td>(-7.78)</td>
<td>(-13.26)</td>
<td>(-7.14)</td>
</tr>
<tr>
<td>RS,</td>
<td>0.213</td>
<td>0.222</td>
<td>0.773</td>
<td>0.280</td>
<td>0.718</td>
<td>1.148</td>
</tr>
<tr>
<td></td>
<td>(2.65)</td>
<td>(3.69)</td>
<td>(4.62)</td>
<td>(1.64)</td>
<td>(3.62)</td>
<td>(3.09)</td>
</tr>
<tr>
<td>RS,</td>
<td>-0.261</td>
<td>-0.263</td>
<td>-0.554</td>
<td>-0.564</td>
<td>-0.774</td>
<td>-0.283</td>
</tr>
<tr>
<td></td>
<td>(-4.80)</td>
<td>(-5.12)</td>
<td>(-3.84)</td>
<td>(-3.26)</td>
<td>(2.67)</td>
<td>(-1.94)</td>
</tr>
<tr>
<td>Y</td>
<td>0.028</td>
<td>0.042</td>
<td>0.054</td>
<td>0.101</td>
<td>0.084</td>
<td>0.214</td>
</tr>
<tr>
<td></td>
<td>(4.60)</td>
<td>(8.59)</td>
<td>(3.88)</td>
<td>(3.03)</td>
<td>(4.60)</td>
<td>(5.14)</td>
</tr>
<tr>
<td>MIL</td>
<td>-0.036</td>
<td>-0.017</td>
<td>-0.017</td>
<td>-0.006</td>
<td>-0.025</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(-2.84)</td>
<td>(-3.07)</td>
<td>(-2.38)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MAR</td>
<td>-0.019</td>
<td>-0.014</td>
<td>-0.014</td>
<td>-0.025</td>
<td>-0.023</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(-3.58)</td>
<td>(-2.28)</td>
<td>(-2.73)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DRAFT</td>
<td>0.0005</td>
<td>0.005</td>
<td>0.0006</td>
<td>-0.0006</td>
<td>0.0006</td>
<td>-0.0006</td>
</tr>
<tr>
<td></td>
<td>(1.04)</td>
<td>(3.82)</td>
<td>(-0.25)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R²</td>
<td>0.917</td>
<td>0.929</td>
<td>0.937</td>
<td>0.940</td>
<td>0.938</td>
<td>0.968</td>
</tr>
<tr>
<td></td>
<td>(1.61)</td>
<td>(1.68)</td>
<td>(2.11)</td>
<td>(2.20)</td>
<td>(1.81)</td>
<td>(1.88)</td>
</tr>
<tr>
<td>D.W.</td>
<td>0.0005</td>
<td>0.0005</td>
<td>0.0006</td>
<td>0.0006</td>
<td>0.0006</td>
<td>0.0006</td>
</tr>
<tr>
<td></td>
<td>(1.04)</td>
<td>(3.82)</td>
<td>(-0.25)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: See the key to table 1. Note the following exceptions:

- RS = the log of the ratio of the size of the neighboring younger cohort to the size of the own cohort.
- RS, = the log of the ratio of the size of the neighboring older cohort to the size of the own cohort.

The estimated values of p in the 20 to 24 age group equations were 0.316 for males and 0.163 for females.
graphic considerations. The foreword to Russell (1982) states that, "Probably no one born during the baby boom that extended from just after World War II to the early 1960s is unaware of belonging to a special generation."

Given current discussions over whether school enrollment rates have stopped or even reversed their historical upward swing, it is useful to decompose the enrollment equations to isolate the contribution of the differential tracking model. This decomposition is performed by comparing the fitted values of school enrollment rates using the coefficients in table 1 with the fitted values computed at the means of the demographic variables.

The contribution of the differential tracking model to school enrollment rate trends is shown in table 4.11 The results indicate that teenagers born prior to the peak fertility years increased their school enrollment rates during the 1960s approximately 2.5% above the benchmark level predicted by real income, military, and marriage rate considerations. Those who were 20 to 24 years of age during the 1960s exhibited a 2% increase in school enrollment rates above the benchmark.

By the late 1970s, demographic considerations had reversed. Although youth cohorts were still large, they were now composed of individuals born after the peak rather than before the peak fertility years. The shift from the fast to the slow track meant a swing of between 3 and 7 percentage points for school enrollment rates. Teenage enrollment rates were approximately 4 percentage points below our benchmark, while 20 to 24 year olds reduced their rates by less than 1 percentage point.

The results of this model indicate that the unusual swings in school enrollment rates over the past two decades have been an endogenous response to the unusually large swings in the population profile. The trend rate of increase in school enrollment rates seems to be intact, but the intermediate-run demographic cycle has caused large deviations from that trend. In this sense, school enrollment rates were "too high" in the 1960s and were then "too low" in the 1970s.

IV. Conclusion

In this paper we advance the hypothesis that individuals respond to cohort overcrowding differently depending upon whether they lead or trail the peak fertility year cohort. To maximize lifetime discounted earnings, individuals act so as to fill in the peaks and troughs of the demographic cycles exhibited by population and, hence, relative income.

The heuristic explanation for this phenomenon is the following: Baby boom individuals born before the peak in the fertility rate increase their human capital accumulation as a way of escaping from the huge cohort behind them. Education,
whether general or specific, can be viewed as a "fast track." By buying the ticket (the cost of additional training) and entering the fast track, the early arrivals can put greater distance between themselves and the peak group. Those born after the peak fertility year, however, face a different problem. With the bulk of the cohort ahead of them, there is no pressure to buy the ticket. The fast track only leads to an entry spot in the already oversized peak group. Hence, if anything, this group has the incentive of paying for the least amount of education. This allows them to use the least costly slow track and, hence, to draw closer to the undersized baby bust cohort.

Education thus provides a differential tracking mechanism. While individuals cannot choose the cohorts in which they are born, they are able to time their entry into the career labor market through education. Those who want to speed ahead in order to compete with earlier cohorts engage in intensive education during their youth. Those who want to slow down in order to compete with later cohorts extend their noncareer job period and take a more leisurely approach to education.

This asymmetric demographic effect dominates the more traditional cohort size hypothesis. According to the latter view, it is the size of the cohort rather than one's position relative to the peak and trough that counts. Those born five years before the peak birth rate are predicted to behave in a similar fashion to those born approximately five years after the peak. Although empirical results based on this model suggest that large cohorts tend to have large school enrollment rates, the issue is empirical since the theory itself does not yield a predicted sign.

The asymmetric or differential tracking system indicates that position in the cycle rather than the size of one's initial cohort dominates certain types of decisions such as schooling. This effect helps to explain the surprisingly steep decline in school enrollment rates during the 1970s (in relation to past trend rates of growth) as well as the very high enrollment rates observed during the 1960s. Essentially, our empirical results indicate that attempts to escape the peak in cohort overcrowding resulted in a negative swing in school enrollment rates of 3 to 7 percentage points between the 1960s and 1970s.

If it is position rather than cohort size that matters, then the tendency to move away from peak-sized cohorts toward trough-sized cohorts should continue to contribute negatively to enrollment rates for several more years. Cohorts entering their youth period will be smaller than preceding cohorts, but more importantly, they will be post-peak cohorts. Thereafter the effect should turn positive.

Although we have applied the asymmetric demographic model only to school enrollment rates, it may also affect other labor supply and investment decisions. We view our model and results as tentative but perhaps suggestive of these more general applications to the study of demographic and economic relationships.

DATA APPENDIX

Definition and Construction of Variables

1. School Enrollment Rates are the percentage of the total noninstitutional population in each age-sex group enrolled in school.


2. The Relative Younger Cohort variable \((RS_i)\) is the ratio of the size of the neighboring younger cohort to the own cohort size.

For the 16 to 17 groups:

\[ POP_{6-15}/POP_{16-17} \]

For the 18 to 19 groups:

\[ POP_{8-17}/POP_{18-19} \]

For the 20 to 24 groups:

\[ POP_{10-19}/POP_{20-24} \]
The weighting scheme gives a weight of 1.0 to the closest neighboring single age groups and decreases the weight by \(1/m\) for every additional year. \(m\) is the group in the cohort of interest. For example, for the 16 to 17 groups, the neighboring lagging cohort is defined as:

\[
0.1 \cdot \text{POP}(6) + 0.31 \cdot \text{POP}(7) + 0.125 \cdot \text{POP}(8) + \\
\ldots + 0.5 \cdot \text{POP}(14) + 1.0 \cdot \text{POP}(15).
\]

The weights on these are arbitrary and are meant to capture the declining vintage effects. Changing the weights had little effect on the results.

Population in any age-sex group is the total noninstitutional population for a given year.


3. The Relative Older Cohort variable \((R)\) is the ratio of the size of the neighboring older cohort to the size of the own cohort.

For the 16 to 17 groups:

\[
\text{POP}_{18-27}/\text{POP}_{16-17}.
\]

For the 18 to 19 groups:

\[
\text{POP}_{20-29}/\text{POP}_{18-19}.
\]

For the 20 to 24 groups:

\[
\text{POP}_{25-34}/\text{POP}_{20-24}.
\]

The weights are similar to those above.

4. The Symmetric Demographic variable is the relative size of the older cohort to the younger cohort. The breakdown is similar to that used above.

5. The Own Cohort's Size variable is measured as the population in a given cohort relative to the total population.

6. Real Income is median annual income for males 45 to 54 years of age in thousands of 1967 dollars.


7. The Draft variable = 0 for 1948 to 1959 and for 1973 to 1980 = (inductees per 1,000 males 16 + ) 1960 to 1972.


8. Marriage variable = the percentage of females in each age group ever married.


9. Military variable = the percentage of males in each age group in the armed forces in each year.


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