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Changes in Teacher Salaries During the 1970s: The Role of School District Demographics

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Abstract — This paper analyzes changes in the teacher salary schedules of Michigan school districts between 1970 and 1980. We find that starting salaries, expressed in 1970 dollars, decreased by an average of 20% over the decade. Real maximum salaries decreased by 15%. The between-district variability of starting salaries increased markedly over the decade, making the average starting salary a much poorer estimate of the starting salary a particular teacher earned in 1980 than was the case in 1970. The between-district variability of maximum salaries did not increase over the decade. Student enrollment changes were a significant predictor of the changes in maximum salaries. Districts that experienced the greatest percentage losses in students tended to experience the greatest declines in real maximum salaries. Student enrollment changes were also related to changes in starting salaries, but the relationship was more complex.

I. INTRODUCTION

WHILE IT is widely recognized that teacher salaries did not keep up with inflation during the 1970s, the statistic typically displayed to make this point, the change in the average salary of U.S. public school teachers over the decade, can be misleading for three reasons. First, because the salaries of almost all U.S. public school teachers are determined by their positions on locally determined uniform salary schedules that reward experience and educational credentials, changes in average teacher salary reflect changes in both the salary schedules themselves *and* changes in the distribution of teachers along the schedules. Between 1971 and 1981, the average experience of the U.S. public school teaching force increased from 11 to 13 years, and the percentage of the teaching force with a Master's Degree increased from 27 to 49 (National Education Association, 1982). These changes in the demographic characteristics of the teaching force provide one reason why the change in average teacher salary does not reflect accurately changes in teacher salary schedules, information important to college students deciding whether to become teachers or not.

A second reason concerns the structure of salary schedules. Local school districts and local teachers' unions bargain not only over how much money will be allocated to teacher salary increases, but also over how the allocated funds will be divided between increases in starting salaries and increases in the salaries paid to experienced teachers, often with attention focused on the increase in the maximum salary. In other words, the districts and unions bargain over the structure of the salary schedules. Monk and Jacobsen (1985) report that in many New York State school districts during the late 1970s and early 1980s, the structure of the salary schedules changed, with maximum salaries increasing more rapidly in percentage terms than starting salaries did. When this occurs, the change in the average salary teachers are paid does not provide accurate information on the change in average starting salary, even if the demographic characteristics of the teaching force had not changed.

A third limitation of information on the change in

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average salary over time is that it does not reveal patterns of change over time in the variation across districts in starting salaries and maximum salaries. College students making career decisions may care about the variation in starting salaries among districts because it conveys information about the extent to which their starting salaries in teaching depend on which district hires them.

For these three reasons, we believe that an analysis of teacher salary changes over time should distinguish changes in the between-district distribution of starting salaries from changes in the between-district distribution of maximum salaries, and should investigate not only the change over time in the average starting salary and average maximum salary, but should also examine the change over time in the between-district variance of the starting salary and maximum salary distributions. Section II of this paper describes the methodology for, and results of, such an investigation, using data from 436 school districts in Michigan. Section III investigates whether the changes in the starting salaries and maximum salaries of individual Michigan school districts were associated with changing demographic conditions in these districts. As explained in Section III, this analysis provides a test of a provocative set of hypotheses proposed by Preston (1984).

II. CHANGES IN TEACHER SALARY SCHEDULES

Analytic Strategy

Our research strategy had two parts. First, we conducted a *within-district* analysis to estimate the starting salary and maximum salary in each Michigan school district in our sample for the years 1970 and 1980. This within-district analysis is described in Section II. Then, as described in Section III, we used the district-specific salary estimates in a *between-district* analysis to investigate whether changes in teacher salaries were associated with changes in the demographic characteristics of the districts.

Within-District Estimation of Salary Schedule Parameters

Our estimation of salary schedule parameters was carried out using data from the professional personnel registers that the Michigan State Department of Education compiles each year. The register provides information on the salary, education, and years of experience of every teacher employed by every public school district in the state in a given year. We used data from the 1970 and 1980 registers to estimate the parameters of the 1970 and 1980 salary schedules for 436 Michigan school districts. Our model, which was adopted from Barro and Carroll (1975), specifies that teacher salaries within a given school district are a piecewise linear function of teaching experience and education. This model is expressed as a conditional expectation in equation 1:

$$\begin{aligned} E(S_{ij} \mid EMAX_{ij}, E_{ij}, MA_{ij}) = {} & a_{1j}\,(1 - EMAX_{ij})] \\ & + a_{2j}[E_{ij}\,(1 - EMAX_{ij})] \\ & + a_{3j}[MA_{ij}] \\ & + a_{4j}[EMAX_{ij}] \end{aligned} \tag{1}$$

where:

- S_{ij} = the salary of teacher i in district j expressed in 1970 dollars (salaries were deflated by the CPI, adjusted to have a value of 1.00 for 1970).
- E_{ij} = the number of years of teaching that teacher i in district j had completed prior to the current year.
- $EMAX_{ij}$ = 1, if teacher i in district j had completed at least 15 years of teaching prior to the current year; 0, otherwise.
- MA_{ij} = 1, if teacher i in district j had a Master's Degree; 0, otherwise.

In this specification, a_{1j} is an ordinary least squares estimate of the starting salary in district j, a_{2j} is an estimate of the salary increment in district j associated with in additional year of teaching experience (up to a total of 14 years), a_{3j} is an estimate of the salary increment in district j associated with a Master's Degree, and a_{4j} is an estimate of the maximum salary in district j obtainable by a teacher who does not have a Master's Degree. The Michigan salary data fitted this specification well for almost all districts in both 1970 and 1980, producing estimates of the coefficient of determination typically higher than 0.95. We further improved each fit by adopting a hierarchical trimming technique to eliminate atypical datapoints.[1] The trimming process improved our estimates of the salary schedule parameters by reducing the influence of transcription errors in the data. We also estimated the standard errors associated with the estimates of

a_{1j} and a_{4j} for use in estimating weights to be applied in the between-district weighted least-squares analyses described in Section III of the paper.

Our within-district regressions produced estimates of the starting salary and maximum salary in 1970 dollars for each of 436 school districts in the years 1970 and 1980. Excluded from our sample were 76 school districts employing fewer than 20 teachers in 1970 or 1980 because it proved impossible to estimate reliably the parameters of the salary schedules in these small districts. This exclusion does mean, however, that the sample of school districts we have examined has not been drawn randomly from the population of Michigan school districts. However, our sample of districts employed more than 98% of the teachers working in Michigan public schools in 1970 or 1980. For ease of exposition, we will henceforth refer to the district-specific salary parameter *estimates* as the "starting salaries" and "maximum salaries".

Patterns of Chronological Change in the Estimated Salary Schedules

Table 1 presents summary statistics describing the between-district distributions of real starting salary and real maximum salary in 1970 and 1980 for the 436 Michigan school districts in the sample. First, consider starting salaries. In 1970, the average starting salary in the sample was $7581, with a standard deviation of $337. The interquartile range was $473. Thus, in 1970, starting salaries were remarkably homogeneous among school districts; in terms of salary, it made little difference in which district a beginning teacher chose to work.

By 1980, however, the sample distribution of real starting salaries had changed in two respects. First, the average real salary had decreased to $6065, a 20% decline since 1970. Second, the between-district variability of real starting salaries had increased considerably over the decade. In 1980, the sample standard deviation of real starting salaries was $856, and the interquartile range was $859, both approximately twice the corresponding 1970 estimate. Figure 1, which displays the changes in real starting salary for 91 school districts randomly selected from our sample, illustrates that the between-district distribution of starting salaries "fanned out" considerably from 1970 to 1980 (a pattern referred to subsequently as "fanspread"). Consequently, the salary of a teacher starting to teach in Michigan in 1980 depended much more strongly on the choice of district than had been the case for beginning teachers a decade earlier.

Consider now the maximum salaries. In 1970, the average maximum salary in the sample was $11,563.

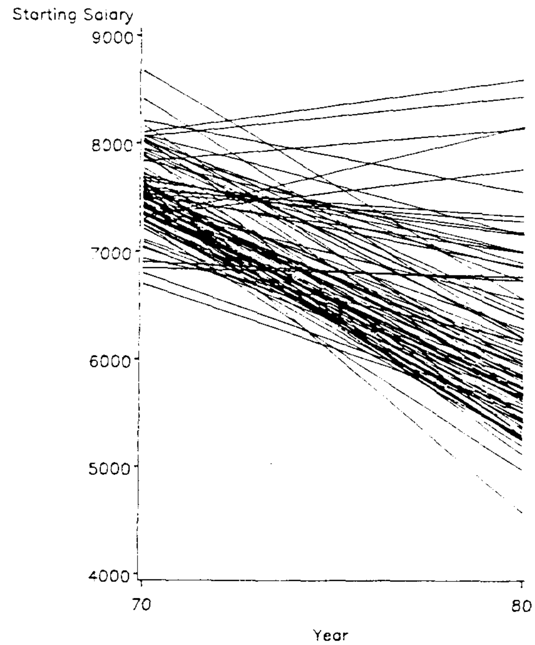

Figure 1.

Table 1. Summary statistics describing the between-district distributions of estimated starting and maximum salaries in 1970 and 1980, with each school district weighted equally

	Starting salary		Maximum salary	
	1970	1980	1970	1980
Mean	7,581	6,065	11,563	9,862
Standard deviation	337	856	1,130	947
Interquartile range	473	859	1,502	1,275

By 1980, the average maximum salary, expressed in 1970 dollars, had fallen to $9,862, a 15% decrease. Thus, during the 1970s, the decrease in real maximum salaries was smaller on average than the decrease in real starting salaries. Monk and Jacobsen (1985), who observed this same pattern for New York State school districts, refer to this phenomenon as "backloading", meaning that local districts and teachers' unions agreed, tacitly or otherwise, to allocate a disproportionate share of funds available for salary increases to senior teachers.

Another respect in which the change in the between-district empirical distribution of real maximum salaries differs from the change in the distribution of starting salaries concerns the variability of the distributions in 1970 and 1980. Between 1970 and 1980, the estimated standard deviation of the maximum salary distribution decreased marginally from $1,130 to $947, and the estimated interquartile range decreased from $1,502 to $1,275. This pattern is evident in Fig. 2, and can be contrasted with the fanspread pattern displayed in Fig. 1. In summary, changes in estimated teacher salary schedules in Michigan school districts during the 1970s meant that, in 1980, the salary of a very experienced teacher depended less on the district in which the teacher taught than it had in 1970, whereas the salary of a beginning teacher depended more on the choice of district than it had 10 years earlier.

To this point, all of the sample statistics we have presented are estimates based on equal weighting of the 436 school districts in our sample. This reflects our focus on the *school district* as the unit of analysis. However, it is also interesting to ask what happened over the decade to the salaries of *teachers* working in Michigan. To address this set of questions, we re-estimated our sample statistics

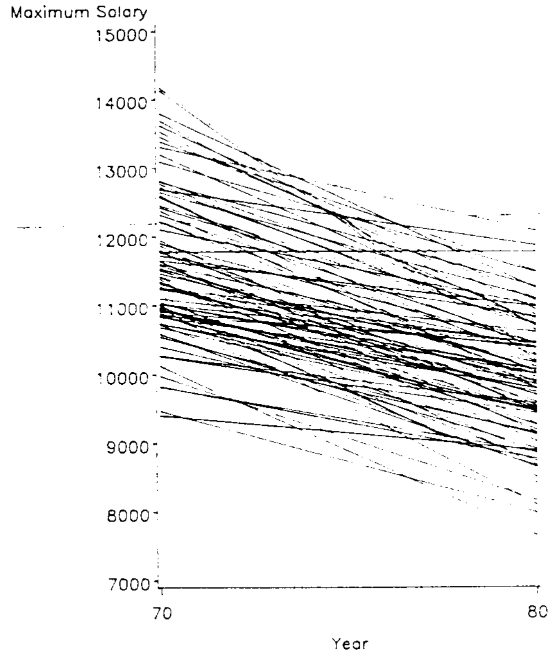

Figure 2.

using the number of teachers in each district in 1970 as a weight. Table 2 presents these weighted estimates.

Before discussing the weighted sample statistics, it is important to note that one extremely large school district in Michigan, Detroit, employs six times more teachers than the next largest district, and approximately 10% of all teachers in the state. As a result, weighted salary schedule summary statistics are heavily influenced by the salary schedule in Detroit. The estimated starting salary and maximum salary in Detroit for 1970 and 1980 are listed in the last row of Table 2.

Table 2. Statistics describing the between-district distributions of estimated starting and maximum salaries in 1970 and 1980, weighting each district by the number of teachers employed in 1970

	Starting salary		Maximum salary	
	1970	1980	1970	1980
Mean	7,828	6,575	12,553	10,503
Standard deviation	394	1,033	1,125	874
Interquartile range	619	1,183	1,856	971
Detroit	8,367	7,075	13,490	10,920

There are two important differences between the unweighted salary statistics reported in Table 1 and the weighted estimates reported in Table 2. First, the average starting salaries and maximum salaries for both 1970 and 1980 in Table 2 are higher than the corresponding estimates reported in Table 1. For example, the average starting salary in 1970 is $7,828 in Table 2 and $7,581 in Table 1. This difference is, to a large extent, a result of the large weight given in the Table 2 estimate to the $8,367 starting salary in Detroit in 1970. Second, the percentage decrease between 1970 and 1980 in the average starting salary reported in Table 2, 6%, is the same as the percentage decrease in average maximum salary reported in that table. By contrast, the unweighted salary estimates reported in Table 1 describe a greater percentage decrease in average starting salary over the decade than the corresponding decrease in maximum salary. Again, the weighted estimates in Table 2 reflects the considerable influence of Detroit, where the estimated starting salary decreased by 15% between 1970 and 1980, while the estimated maximum salary decreased by 19%. It is important to note one respect in which the weighted statistics in Table 2 reflect the same pattern as the unweighted statistics in Table 1 — namely, the increase between 1970 and 1980 in the between-district variation in starting salaries.

III. CHANGES IN STARTING SALARIES AND MAXIMUM SALARIES AS FUNCTIONS OF DEMOGRAPHIC CHANGES: A BETWEEN-DISTRICT ANALYSIS

The Role of Demographic Changes

Our interest in demographic changes stems from a 1984 essay by Samuel Preston in which he explored two complementary hypotheses concerning the roles of demographic changes in influencing teacher salaries. The first is that school enrollment changes are positively associated with teacher salary changes. The rationale underlying this hypothesis is that enrollment declines reduce the demand for teachers, and lead teachers' unions to bargain away salary increases in favor of job security. The second hypothesis is that changes in the proportion of the population aged 65 and over are negatively associated with teacher salary changes. While Preston does not specify a behavioral model underlying this hypothesis, one plausible rationale is that the elderly are less likely to vote in favor of taxes to support teacher salary increases than are younger residents who are more likely to have children of school age.

Preston tested his hypotheses by estimating OLS regressions relating changes in average teacher salaries *by state* between 1972–1973 and 1982–1983 to changes in state enrollment levels, and changes in the proportion of each state's population that was aged 65 and over. The estimated coefficients had the right signs to support the hypotheses, but the associated t statistics were too small to reject the conclusion that the true coefficients were zero.

In our view Preston's hypotheses can be better tested using the school district, instead of the state, as the unit of analysis. The reason is that salary schedules are determined at the local school district level and, as our analysis in Section II revealed, there was significant variation across school districts in the change in starting salary and maximum salary between 1970 and 1980. We do recognize that using the school district as the unit of analysis makes the implicit assumption that salary changes in district j depend only on demographic changes in district j and not on demographic changes in districts adjacent to district j. As Chambers (1977) has shown, this is a strong assumption. Nonetheless, we believe that empirical work using the school district as the unit of analysis is an important complement to Preston's work and contributes to understanding of the factors affecting teacher salaries.

Michigan is an attractive site for investigating Preston's hypotheses using district level data because many Michigan districts experienced dramatic changes in demographic conditions during the 1970s, and these changes varied widely from district to district. For example enrollment in the Michigan school districts in our sample declined by an average of 16%, with the percentage change in enrollment varying from an increase of 76% to a decline of 66%. The proportion of the population aged 65 and over increased by 7% on average, with the percentage change varying from an increase of 87% to a decrease of 55%.

Models

All of the regression models for which we report estimates are reduced-form change models in which the key variables are expressed as differences in the logarithms of 1980 and 1970 values.[2] The dependent variable in each model is either the logarithm of the 1980 starting salary expressed in 1970 dollars minus the logarithm of the 1970 starting salary

(*LCHMIN*), or the analogous calculation for maximum salaries (*LCHMAX*), where the starting salaries and maximum salaries are estimates of the salary schedule parameters obtained in the within-district analyses reported in Section II. For each of these two dependent variables we estimated three types of models. The first type of model focused exclusively on the impact of the two demographic variables, the change in the logarithm of school district enrollment (*LCHENROL*), and the change in the logarithm of the percentage of the adult population that was aged 65 and over (*LCHP65*). In the case of *LCHMIN*, we found that the influence of the demographic variables was mediated by district size, as measured by the logarithm of 1970 enrollment (*LENROL70*). Thus, we also included as variables in the model *LENROL70*, and a pair of interaction terms: the product of *LENROL70* and *LCHENROL* (forming *ENRINT*), and *LENROL70* and *LCHP65* (forming *P65INT*).

The second type of model contained all of the variables included in the first model plus an additional variable defined as the change in the logarithm of the value of the property tax base per pupil (*LCHSEVP*). The rationale underlying the inclusion of this variable was that, enrollment declines increased property tax base *per student*. As a result, it seemed plausible that the negative effect that enrollment declines might have on teacher salaries through the mechanism of a reduction in the demand for teachers might be counterbalanced by the increase in tax base per pupil. Thus, a key question is whether the estimated coefficient on *LCHENROL* was sensitive to the inclusion of *LCHSEVP* in the model.

The third type of model contained all of the variables that were included in the second model, and added the logarithm of the 1970 minimum salary (*LNMIN70*) to the model predicting *LCHMIN*, and added the logarithm of the 1970 maximum salary (*LNMAX70*) to the model predicting *LCHMAX*. The motivation for this specification is Ehrenberg and Chaykowski's (1986) finding of a strong negative correlation between the starting (or maximum) salary level in a school district at one point in time, and the change in the starting (or maximum) salary in subsequent years. They explain this negative correlation as reflecting a "catch-up" phenomenon, whereby districts with atypically low salaries at one point in time "caught up" with other districts over time. Not only did we want to learn whether this catch-up phenomenon was also present for the districts in our sample, we also wanted to explore whether the estimated impact of demographic changes on salary schedule changes was sensitive to the inclusion of the base year salary variable in the model.

We did not include in our models variables depicting the change in the state aid formula between 1970 and 1980 because prior work on Michigan school districts had shown that changes in aid had not influenced school districts' instructional expenditures during this period (Park and Carroll, 1982). If aid changes did not influence instructional budgets, of which teacher salaries are a large part, it is difficult to believe that aid formula changes would influence salaries. In preliminary analyses not reported here, we did explore whether aid changes, defined in a variety of ways, influenced salary changes, and found no significant relationships. Nor did we find that inclusion of aid variables in our models caused marked changes in other estimated coefficients. Ehrenberg and Chaykowski (1986), addressing the same set of issues with information on New York school districts, reported similar findings.

Efficient estimation of the parameters of the between-district change models requires that the precision of the within-district salary schedule estimates be accounted for. Hanushek (1974) has provided a statistical technology for the inclusion of such information when estimated coefficients from earlier (within-district) regressions constitute the dependent variables in subsequent (between-district) regression analyses. As described in the Appendix, we used a modified version of Hanushek's weighted least squares approach to estimate our regression models.

Results: Change in Starting Salary

In this section we report the results of our investigation of the role of district-specific demographic changes in predicting district-specific changes in starting salary (*LCHMIN*). Table 3 presents estimates of the regression coefficients and R^2 values for the three models.

The effect of enrollment change. The relationship between changes in starting salary and changes in student enrollment depends on the size of the school district. In districts with fewer than 2000 students,

Table 3. Between-district analysis of the impact of school district demographic changes on the change in the logarithm of real starting salary* (*t* statistics in parentheses)

	Model 1	Model 2	Model 3
LCHENROL	0.41	0.43	0.44
	(1.69)	(1.78)	(1.81)
LCHP65	−0.70	−0.63	−0.66
	(−2.44)	(−2.16)	(−2.28)
LENROL70	0.20	0.02	0.03
	(2.70)	(3.09)	(3.60)
ENRINT	−0.05	−0.06	−0.06
	(−1.81)	(−1.87)	(−1.90)
P65INT	0.09	0.08	0.09
	(2.64)	(2.35)	(2.50)
LCHSEVP		0.03	0.03
		(1.61)	(1.54)
LNMIN70			−0.27
			(−2.12)
R^2	0.16	0.17	0.18

* Each model included an intercept term. Sample size for all models = 436.

the relationship is positive, as Preston hypothesized. In a district with 500 students in 1970, the estimated elasticity is 0.08, indicating that a 10% decrease in enrollment is associated with a 0.8% decrease in real starting salary. The estimated coefficients in model 1 of Table 3 imply that enrollment change is *negatively* associated with the change in starting salary for school districts with 1970 enrollment of more than 2000 students. We have no compelling explanation for the negative relationship in larger districts. (Removing Detroit from the subsample of large districts does not markedly affect the results).

The effect of change in the proportion of adult population aged 65 and over. The relationship between *LCHP65* and the change in starting salary is also sensitive to district size. In districts with fewer than 1700 students, an increase in the proportion of the adult population 65 years of age and over is associated with a decrease in starting salary, as Preston hypothesized. However, in larger districts, an increase in the proportion of the population that is elderly is associated with an *increase* in starting salary. Again, we have no compelling explanation for this phenomenon.

Figure 3 presents a simultaneous graphical representation of the estimated interaction effects described above. The slope of the lines in each panel

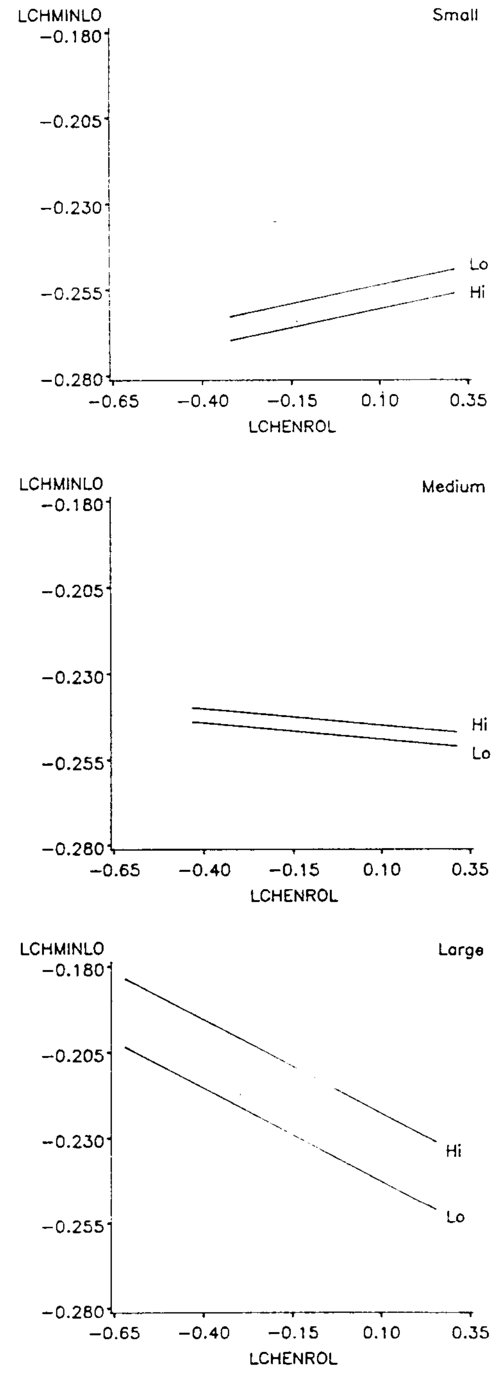

Figure 3. The fitted relationship between *LCHMINLO* and *LCHENROL*, for high and low values of *LCHP65*, for different sized school districts.

depict the relationship between the change in starting salary and enrollment change for a district with a particular 1970 enrollment. As seen in the left panel (based on a district with 1970 enrollment of 1236), the relationship is positive for small districts. As illustrated in the middle panel (district with 1970 enrollment of 2208), the change in starting salary is relatively insensitive to enrollment change for middle-sized districts. As illustrated in the right-hand panel (district with 1970 enrollment of 5014), the relationship between change in starting salary and change in enrollment is negative in large districts.[3]

In addition, each panel in Fig. 3 contains a pair of fitted lines the relative positions of which indicate, for a district with a particular 1970 enrollment, how the change in starting salary depends on the change in the proportion of the population that is aged 65 and over. The left panel illustrates that small districts with large increases in the proportion of the adult population that is elderly experienced smaller increases in starting salaries than did small districts with small increases (or decreases) in the proportion elderly. The middle panel illustrates that in middle-sized districts the change in starting salary is relatively insensitive to the change in the proportion of the population that is elderly. The right hand panel illustrates that large districts with large increases in the proportion of the adult population that is elderly experienced larger increases in starting salaries than did large districts with small increases (or decreases) in the proportion elderly.

The effects of other variables. The estimated coefficient describing the relationship between the change in starting salary and the change in district wealth per student is positive, as expected, but is not significantly different from zero at the 0.05 level of significance in either model 2 or model 3. In addition, the estimated coefficient on the logarithm of the 1970 salary is negative and significantly different from zero in model 3. This is consistent with Ehrenberg and Chaykowski's (1986) report of a "catch-up" phenomenon, by which districts with the lowest initial salaries experience the least decline in real starting salaries. The most important point to notice in comparing the estimates of the parameters in models 1, 2, and 3 in Table 3 is that the estimated coefficients of the demographic change variables are remarkable stable from model to model.

Results: Change in Maximum Salary (*LCHMAX*)

In this section, we report the results of our between-district analysis of the effects of demographic changes on the change in maximum salary (*LCHMAX*) over the decade. Table 4 presents the relevant parameter estimates.

The effects of enrollment change. Enrollment change is positively and significantly associated with the change in the maximum salary in Michigan school districts with an estimated elasticity of 0.07 (in model 1). The estimate is very insensitive to specification differences among the three models. Unlike the case with starting salaries, the interaction between *LCHENROL* and *LENROL70* plays no significant role in predicting the change in maximum salary, and therefore no interaction effects were included in the models in Table 4.

The effects of changes in the proportion of the adult population aged 65 and over. Inspection of the estimated coefficients in all three models in Table 4 indicates that there is no statistically significant relationship between *LCHP65* and the change in maximum salary.

The effects of other variables. Change in wealth per student (*LCHSEVP*) is estimated to be positively related to the change in the maximum salary. However, the size of the estimated coefficient (and its associated t statistic) are sensitive to specification: both are much smaller in model 3, which includes *LNMAX70*. The negative and statistically significant coefficient on *LNMAX70*

Table 4. Between-district analysis of the impact of school district demographic changes on the change in the logarithm of real maximum salary* (t statistics in parentheses)

	Model 1	Model 2	Model 3
LCHENROL	0.07	0.08	0.07
	(4.60)	(4.87)	(4.40)
LCHP65	−0.03	−0.02	0.00
	(−1.42)	(−1.29)	(0.23)
LCHSEVP		0.02	0.01
		(2.09)	(0.61)
LNMAX70			−0.18
			(−5.44)
R^2	0.11	0.12	0.17

* Each model included an intercept term. Sample size for all models = 436.

suggests that districts with low maximum salaries in 1970 experienced the greatest growth in maximum salaries (the least decline in real maximum salaries) over the decade. Given the focus of this paper, the important point to note is that the estimated coefficients on the demographic change variables are extremely stable across the three models.

IV. SUMMARY

One must be careful in attempting to answer the question, what happened to teacher salary schedules, controlling for inflation, over the 1970s? The answer is different for starting salaries than it is for maximum salaries. On average, real starting salaries in Michigan school districts decreased by 20% between 1970 and 1980. During this period, the between-district variability of starting salaries increased markedly, making the average starting salary in 1980 a much poorer estimate of the starting salary a particular teacher earned in 1980 than was the case in 1970. Real maximum salaries also decreased on average in Michigan school districts; but the average decrease, 15%, was smaller than the corresponding decrease in starting salaries. Also, unlike the variability of the empirical distribution of starting salaries in the state, the between-district variability of maximum salaries decreased from 1970 to 1980.

Instead of asking what happened to real starting salaries and real maximum salaries in Michigan school districts (a question that implies equal weight to each district), if one asks what happened to the real starting salaries and real maximum salaries that teachers in Michigan were paid (a question that implies equal weight to each teacher), the answer is somewhat different. In particular, both starting salaries and maximum salaries fell by approximately 15% on average.

Student enrollment changes were a significant predictor of the changes in maximum salaries across Michigan school districts. Districts that experienced the greatest percentage losses in students tended to experience the greatest declines in real maximum salaries. Student enrollment changes were also related to changes in starting salaries, but the relationship was more complex. In relatively small districts (enrollments of fewer than 2000 students) enrollment increases were positively associated with increases in starting salaries, just as they were positively associated with changes in maximum salaries. However, in larger districts, there was a negative association between enrollment changes and changes in starting salaries.

The analyses presented in this paper increase our understanding of the changes that took place in teacher salary schedules over the 1970s, and of the reasons for these changes. Perhaps of greater importance, the paper demonstrates that focusing solely on the change in the average teacher salary can be deceiving because it masks important changes in the means and variances of starting salaries and maximum salaries. It is this hidden information, rather than the change in average salary, that matters to college students when they are deciding whether to become teachers or not.

NOTES

1. The fit of the within-district models was further improved by systematically eliminating extreme and atypical datapoints from the analysis. This elimination was achieved hierarchically in that, initially, only those datapoints with standardized residuals greater than 6 were removed. Subsequently, the models were re-fit and datapoints with standardized residuals greater than 5 were removed. This process was repeated a third time for those datapoints with standardized residuals greater than 4. Rather than simply removing in one pass all datapoints with standardized residuals greater than 4, this hierarchical elimination strategy was adopted because the existence of one or more atypical datapoints can greatly influence an OLS fit and seriously disturb the estimation of the very residuals on which the trimming is based.
2. To avoid difficulty arising as a consequence of taking logarithms of zero, each of the variables in our between-district models were "started" by the addition of a small constant (1/6); see Mosteller and Tukey (1977), pp. 91–93.
3. The 1970 enrollment values used to make the predictions illustrated in Fig. 3 were chosen in the following way. The sample of 436 districts was arrayed by 1970 enrollment, and divided into three percentile groups: 5–35, 35–65, and 65–95. Predictions were based on the percentile falling at the midpoint of each of the three groups.

REFERENCES

BARRO, S.M. and CARROLL, S.J. (1985) *Budget Allocation by School Districts: An Analysis of Spending for Teachers and Other Resources*. Santa Monica, CA: Rand.

CHAMBERS, J.G. (1977) Impact of collective bargaining for teachers on resource allocation in public school districts. *J. Urban Economics* **4**, 324–339.

EHRENBERG, R.G. and CHAYKOWSKI, R.P. (1986) On Estimating the Effects of Increased Aid to Education. Paper presented at National Bureau of Economic Research Public Sector Labor Relations Conference, Cambridge, MA.

GOLDBERGER, A.S. (1974) *Econometric Theory*. New York: Wiley.

HANUSHEK, E.A. (1974) Efficient estimators for regressing regression coefficients. *Am. Statist.* **28** (2), 66–67.

MONK, D. and JACOBSEN, S. (1985) The distribution of salary increments between veteran and novice teachers: evidence from New York State. *J. Education Finance* **11**, 157–175.

MOSTELLER, F. and TUKEY, J.W. (1977) *Data Analysis and Regression*. Reading, MA: Addision-Wesley.

NATIONAL EDUCATION ASSOCIATION (1982) *Status of the American Public School Teacher, 1980–1981*. Washington, DC: NEA.

PARK, R.E. and CARROLL, S.J. (1982) *Michigan School District Response to a Guaranteed Tax Base: A Time-Series Cross-Sectional Analysis*. Santa Monica, CA: Rand.

PRESTON, S.H. (1984) Children and the elderly: divergent paths for America's dependents. *Demography* **21**, 435–457.

APPENDIX

Estimates of the regression parameters in the between-district models were obtained by weighted least-squares regression using Aitken estimators. Weights of the form, $\hat{\sigma}^2/(\hat{\sigma}^2 + \hat{w}_j^2)$, were applied (Hanushek, 1974, equation 4). $\hat{w}_j^2$ is an estimate of w_j^2, the sampling variance of the appropriate dependent variable in our between-district regressions. Recall, for example, that in the between-district regressions involving the minimum salary, the dependent variable is the difference in the logs of the 1980 starting salary and the 1970 starting salary. We knew the estimated sampling variances of the 1980 starting salary and the 1970 starting salary from the between-district regressions. We used a Taylor-series expansion to obtain an approximate estimate of the sampling variance for the differences in the logs. $\hat{\sigma}^2$ is an estimate of σ^2, the variance of the stochastic (error) terms in a between-district model in which the difference in the logs of the true, unobserved 1980 and 1970 starting salaries (or maximum salaries) is a function of the exogenous (demographic) variables (Hanushek, 1974, equation 2). Hanushek (1974, equation 8), based on earlier work by Goldberger (1964, equation 4.52), points out that the classical estimate of σ^2 obtained in an OLS fit of the between-district model is biased, and suggests a correction (Hanushek, 1974, equation 9). In the current application, in which $\hat{\sigma}^2$ is much greater than w_j^2 for all j, it can be shown algebraically that this bias correction has a negligible effect on the final form of the estimated weights used in the second round Aitken estimation (following similar order of magnitude calculations by Goldberger, 1964, pp. 242–243). Thus, this vanishingly small correction of $\hat{\sigma}^2$ has been ignored in the current analysis, for a considerable saving of computer time and expense.