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ABSTRACT

This study examines the demand for teachers, the mobility of teachers, and the relationship between school district size and the level of costs/expenditures on education. The material focuses on individual school districts and on the implications of district behavior that are developed from the economics theory of the firm. Examination of the teacher demand by use of a stock-adjustment model suggests that roughly half the difference between the desired stock of teachers and the actual stock will be made up in any one school year and that the sole factor with considerable impact on the desired stock is pupil enrollment. A human capital approach was used to examine the mobility of teachers across school districts. Experience, age, and training distributions of teachers were the teaching force characteristics most significantly related to turnover, and turnover appears higher in those districts having a greater proportion of young teachers with little experience. In general, it was found that the greater the district size and the greater its growth rate the smaller was the turnover. Findings indicate there appear to be economies of scale in the operation of school districts. A 20-item bibliography concludes the document. (Author)

Three Aspects of the Economics of Education in Alberta

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Human Resources Research Council

ED 066

THREE ASPECTS OF THE ECONOMICS OF EDUCATION IN ALBERTA

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David Shapiro

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THREE ASPECTS OF THE ECONOMICS OF EDUCATION IN ALBERTA

ABSTRACT

The study examines three aspects of the economics of education in Alberta: the demand for teachers; the mobility of teachers; and the relationship between school district size and the level of costs/expenditures on education. The individual school district is the focus of analysis. An analogy is drawn between the school district and the firm, and implications for school district behavior are developed from the theory of the firm.

Examination of the demand for teachers, making use of a stock-adjustment model, indicated that in order to understand this demand, one must take account of both the determinants of the desired stock of teachers and the lag of adjustment of the actual stock to the desired stock. The estimates of this lag suggest that roughly half of the difference between desired stock and (previous) actual stock will be made up in any one school year. In addition, the desired-stock demand functions implied by the empirical work indicate that the sole factor with considerable impact on the desired stock of teachers is pupil enrollment.

An attempt was made to explore the relationship between the structure of the salary schedule and the distribution by years of training of newly hired teachers. This attempt failed when it proved impossible to specify an appropriate equation which was identified in practice. A reduced-form equation was estimated instead,

with average training of newly hired teachers as the dependent variable. This equation indicates that the average training of new teachers increases as district size and the education of adults in the school district increases and is significantly lower for Catholic districts.

A human capital approach, with pecuniary and non-pecuniary returns of current and alternative employments viewed as determining mobility, was used to examine the mobility of teachers across school districts. The explanatory variables consisted of characteristics of the district's teaching force and of the district itself.

Of the former group, the experience, age, and training distributions of teachers were most significantly related to turnover. The greater the proportion in the district of young teachers with little experience, the higher will be the turnover of teachers. Districts with either relatively high or relatively low average levels of teacher training experience lower turnover than districts with intermediate levels of average training.

Two district characteristics related to turnover are size and growth of the teaching force. Up to a substantial district size, turnover declines as size increases, at a declining rate. The greater the rate of growth (and consequent creation of new positions) in a district, the less will be the turnover of teachers.

To be meaningful, examination of the relationship between school district size and the level of costs/expenditures on education must take account of additional variables which are likely to affect costs/expenditures. This was done, and there do indeed appear to be economies of scale in the operation of school districts. It was not possible to describe cost-minimizing school district size, however, since costs will be influenced by the density of population.

Use of the analogy between the school district and the firm thus proved quite helpful in examining these aspects of the economics of education in Alberta. While the parameters obtained are specific to Alberta, the results suggest that this approach is a useful one for analyzing the behavior of school districts in general.

CHAPTER I

INTRODUCTION

I.1. THE PROBLEMS TO BE CONSIDERED

There has been considerable discussion in Alberta (and elsewhere) in recent years concerning the end of the teacher "shortage."[1] The discussion generally makes use of projections of school enrollments, university enrollments in Faculties of Education, and teacher-pupil ratios and concludes that the long-run "shortage" is coming to an end. Such analyses are characterized by lack of an explicit framework for examining the demand for teachers. Instead, they make use of implicit notions of aggregate demand in which the demand for teachers presumably depends upon two factors: school enrollments and time (it is generally assumed that teacher-pupil ratios will continue to rise over time).

Chapter II provides an explicit framework -- including additional variables -- for examining the demand for teachers. Such a framework will allow us to see if the projection method's implicit aggregate demand function is omitting relevant variables. Chapter II also explores the quantitative and qualitative aspects of the demand for teachers by individual school districts, a specific approach which may be viewed as being geared to answering part of two more general questions: What determines how many teachers are (and will be) demanded in the province? What types of qualifications will these teachers have?

The framework developed is a micro-economic one, with the individual school district as the focus of analysis. It is carried over to Chapter III in which the turnover of teachers is examined. For the individual school district, turnover generates additional demand for teachers, over and above that generated by changes in the determinants of net demand. Examination of the determinants of turnover of teachers across districts thus adds to our understanding of the determinants of the gross demand for new teachers by school districts. In addition, ascertaining the determinants of teacher mobility across school districts is one approach to the larger question of how mobility of teachers serves as a mechanism for market adjustment.

Finally, Chapter IV examines the relationship between school district size and per-pupil costs of education. Examination of this relationship provides some information relevant to the more general question of whether or not there is an "optimal" school district size, and if so, what it is. In an era when many school districts find their costs straining the limits of their sources of revenue, this study of economies of scale in the operation of school districts seems particularly timely.

The problems considered in the following chapters are thus of interest in that consideration of them sheds light on the structure of the market for teachers, in terms of both demand and turnover. In addition, there is also information on the determinants of educational costs/expenditures across school districts. In particular, it is of interest to note the impact on demand, turnover, and costs of variables which are subject to manipulation by public policy. More general questions might have been the focus of attention, with some sort of analysis at the aggregate level. Instead, the analysis is at the micro level, and is aimed at providing a firmer understanding of the structure of certain aspects of the economics of education in Alberta.

I.2. THE ALBERTA SCHOOL SYSTEM

It is appropriate at this point to give a broad description of the Alberta system of public education,[2] so that the reader will have a better feel for the system which is being analyzed and a better understanding of the rationale for the development of the analysis.

By 1969-70, there were approximately 150 school districts in operation in Alberta, about 90 percent of the corresponding figure for 1961-62. These districts fell into a wide variety of classifications and subclassifications. The three major classifications are school divisions, counties, and independent school districts. Within the last group are city, town, village, rural, and consolidated districts. These in turn may be either public or separate.[3]

In 1968-69, the average district had approximately 2,700 pupils. However, there was an extraordinary variance in district size. The two largest districts, the public districts of Edmonton and Calgary, accounted for 145,000 students, and the two corresponding separate districts accounted for another 48,000 students. Hence, the largest districts in the province covered almost half of the entire student population. The 13 districts in the other seven cities throughout the province had another 8 percent of the provincial student population -- the public districts averaging 4,200 students and the separate districts averaging 1,000. The 60 school divisions and counties averaged just under 2,500 pupils each and the remaining

72 independent school districts averaged just over 400 pupils each.

Hence, the dispersion in district size is quite substantial, and the prominence of the four largest districts noteworthy. Without them, the average district size drops to under 1,500. In the empirical work, an effort is made to account for the unique position of these districts within the framework of the provincial system of public education.

The individual school district is the decision-making unit for most of the affairs of the district, with the important exception of financing. The vast bulk of school board revenue comes from a province-wide program for financing education, and only a relatively small percentage comes from autonomous local property taxation. This program for school finance -- the Foundation Program -- was established in 1961, based on five principles:[4]

1. The main grant should be of an equalization type.
2. Its purpose should be to raise local school revenues to some previously defined level.
3. The previously defined level, known as the foundation program, should be set realistically so that it compares closely to the cost of essential services at current prices.
4. All school units should raise tax funds at a common mill rate to provide their share of the foundation program.
5. The balance of the foundation program should be secured by grant.

These five principles outline the heart of the program. All districts contribute a fixed proportion of their equalized assessed property values to the program. This is supplemented by a government contribution to the program from provincial general revenues and these funds are disbursed under regulations of the Foundation Program. These regulations, in turn, place most emphasis on two factors: the number and grade level of pupils and the number and years of training of teachers. Hence, there is no direct connection between what districts contribute to the program and what they receive from it.

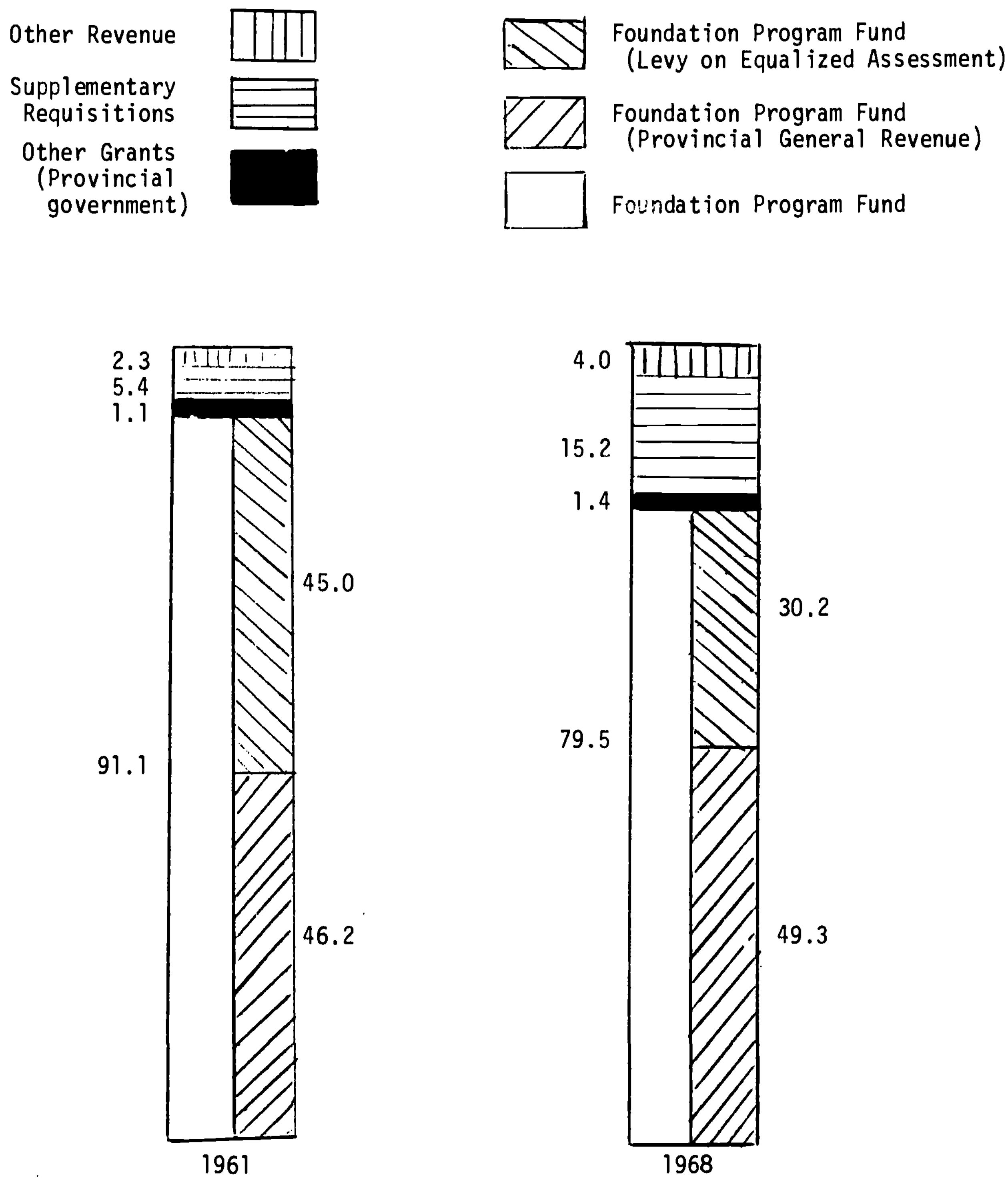
The money that a district receives exceeds the amount contributed because of the support from provincial general revenues. "Some jurisdictions with high assessments per pupil contribute sixty cents for every dollar received in return; other lower assessment jurisdictions contribute only thirty cents for their dollar support. This thirty to sixty cent spread is the essence of the financial scheme. Without such a variation no equalizing would occur and there would be little point in having a fund."[5]

At the same time, "The inherent principle of local autonomy to provide services beyond the minimal or basic program [is] reflected in the statutory right to levy supplementary requisitions. Supplementary requisitions are requested by boards to make up the difference between what is received from the Foundation Fund and the budgeted expenditure."[6] Presumably, large supplementary requisitions reflect low assessments, extensive services, and/or high regional costs.

The percentage distributions of sources of revenue of school boards for the years 1961 and 1968 are shown in Fig. 1.1. Three major trends over the period might (correctly) be inferred:

1. The quantitative impact of supplementary requisitions

FIGURE 1.1 PERCENTAGE DISTRIBUTIONS OF SOURCES OF REVENUE OF SCHOOL BOARDS: 1961 and 1968



has increased, with a consequent decline in the impact of the Foundation Program Fund.

2. The share of the province-wide levy on equalized assessment in both the Foundation Program Fund and the total revenue of school districts has declined.

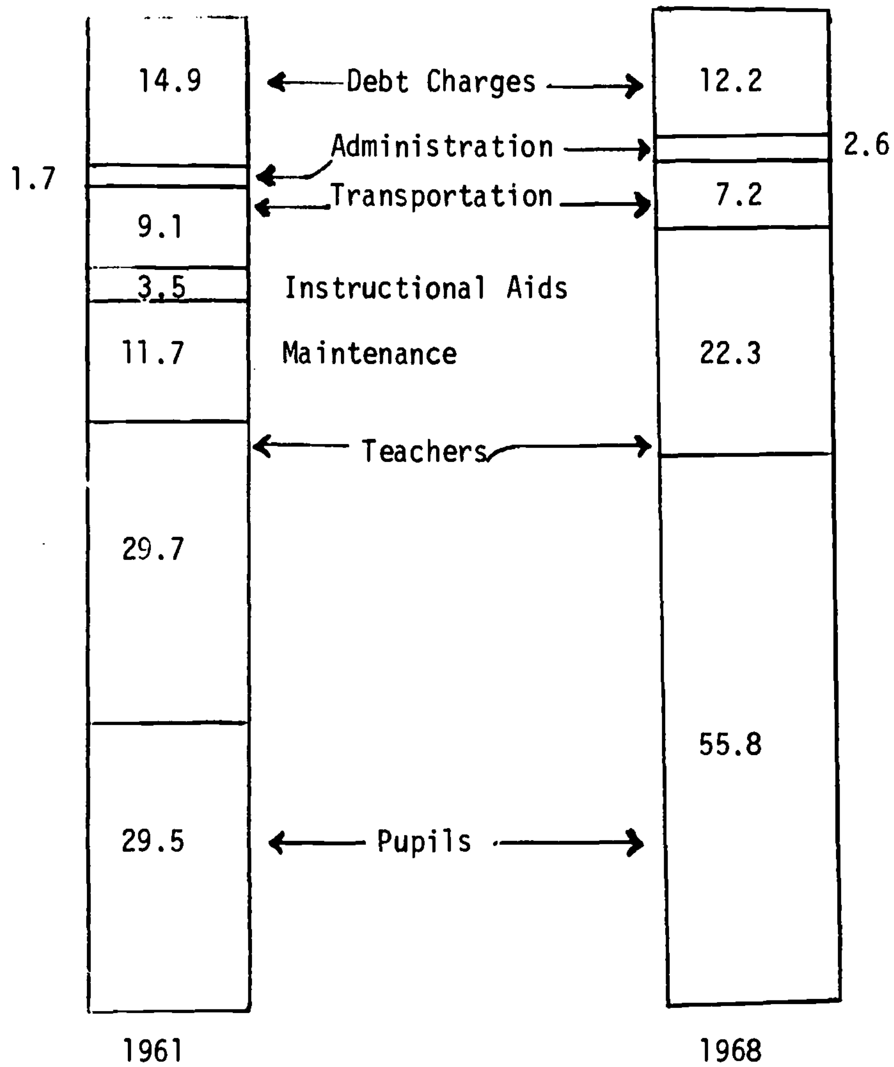
3. While the share of provincial general revenues in the total revenue of school boards has not changed much, the proportion of the Foundation Program Fund attributable to provincial general revenues has increased.

Thus, revenues from the levy on equalized assessed property have failed to grow as rapidly as expenditures for education; hence, the increasing role of provincial general revenues in the Foundation Program Fund. At the same time, the impact of supplementary requisitions has increased, and this factor is one which tends to obviate the equalizing effects of the Foundation Program.

The bases for payments from the Foundation Program Fund, and their relative shares, are shown in Figure 1.2 for 1961 and 1968. When the program was initiated in 1961, there were more factors specified in the grant formula than there are currently. Since 1961, payments on the basis of numbers and types of pupils have almost doubled their relative share, while payments on the basis of numbers and training of teachers have fluctuated somewhat and are currently holding roughly three-quarters of their original relative share.

In summary, the bulk of the financing of districts is accounted for by the province-wide Foundation Program, while local districts are able to raise supplementary revenues and thereby

FIGURE 1.2 PERCENTAGE DISTRIBUTIONS OF PAYMENTS FROM FOUNDATION PROGRAM FUND: 1961 and 1968



adjust their expenditures at the margin.

I.3. THE DISTRICT AS THE FOCUS OF ANALYSIS

The focus of analysis is the school district -- the decision-making unit on the demand side of the market for teachers -- rather than on the province as a whole. The district may be viewed as analogous to the firm: it aims to produce a given output ("educated" students) with minimal amounts of various inputs (teachers, administrators, physical plant, etc.). In addition, however, there may be differences in units of output, depending on the "tastes" for education of the school districts. Districts with relatively high demand for education will devote more resources to the education of a fixed number of students, ceteris paribus, in order to provide "better" education for their students. Also, districts may merge or split over time, in order to achieve either lower costs or higher quality of education.

The empirical work of the following three chapters may be readily viewed in the context of the brief framework outlined directly above. The stock-adjustment model of Chapter II is an attempt to ascertain the determinants of the demand for the major labor input. This demand is seen as depending on both the quantity and desired quality of output, as well as on the price of the particular input. The examination of turnover of teachers in Chapter III attempts to ascertain the determinants of mobility of the labor input, drawing upon characteristics of both the "firm" and its labor force for explanatory variables. Finally, Chapter IV examines the relationship between "firm" size and unit costs of "production."

The empirical work is thus applied microeconomics, relating to the theory of the firm -- where the school district assumes the role of the firm, and teachers are the bulk of the labor input.

I.4. KINDS AND SOURCES OF DATA

The data used in the following empirical work come from three major sources. Data describing characteristics of the teaching force of each school district -- viz., age, sex, training, and teaching experience distributions -- were obtained from the Dominion Bureau of Statistics Annual Teacher Report Forms. These questionnaires are filled out by almost all teachers each September, and provide both personal and professional information. A computer tape containing the information on these forms for the period from 1961-62 through 1969-70 was obtained from the Dominion Bureau of Statistics, and this tape generated the data used, which grouped teachers by district.

Data describing (most of the) characteristics of the school districts themselves were taken from the Annual Reports of the Alberta Department of Education. These data include the number of teachers, number of pupils, equalized assessed property value, and operating expenditures in each school district for the appropriate year(s). Data on the education of adults were obtained from Dominion Bureau of Statistics reports from the 1961 Census (the reports themselves were provided by the Alberta Bureau of Statistics). Salary figures for most school districts were made available by the Alberta Teachers'

Association, and some additional salary figures were provided directly by school districts.

The data are both time-series and cross-section in nature, since they cover roughly 150 school districts for a period of nine years. They are pooled, and this pooling might conceivably cause difficulty. However, a test of the advisability of pooling the data is developed and discussed in Appendix A.

The three chapters that follow will each cover one problem and the discussions of the empirical work will be relatively independent. Chapter V attempts to explore the implications of the empirical work and to relate each individual chapter to the others.

FOOTNOTES FOR CHAPTER I

[1]For example, see G. Loken, "Quantitative and Qualitative Aspects of Teacher Demand and Supply", (mimeo), Alberta Universities Commission, Staff Study No. 5, December 1969; or "Statistical Evidence of an End of the Teacher Shortage Within Three or Four Years", (mimeo), Alberta Teachers' Association, January, 1969.

[2]The data used in the empirical work cover the period from the 1961-62 school year through 1969-70; hence, this discussion of the Alberta school system will concentrate on this period.

[3]The provincial government regulations, recognizing Protestants and Catholics as the two major religious groups in the province, provide for establishment of publicly supported school districts by each group in a given area. The first district established in an area becomes the public district. If a second district is established, it becomes the separate district. In most cases, the separate districts are Catholic districts, and Catholic districts constitute approximately one-third of the school districts in Alberta. It should be stressed that, in contrast with U.S. practices, financial support from the provincial government is equally available to both public and separate school districts.

[4]These five principles and much of the following discussion of the Foundation Program are taken from "The Alberta Foundation Program of School Finance. A Brief Review" by A. Bredo in Education '69: The Sixty-Fourth Annual Report of the Alberta Department of Education, Edmonton, Alberta, 1970, pp. 83-93.

[5]*Ibid.*, p. 85.

[6]*Ibid.*, p. 83.

CHAPTER II

THE DEMAND FOR TEACHERS

PART 1 THE STOCK-ADJUSTMENT MODEL[1]

Teaching services, the fundamental object of the "demand for teaching," are provided by the stock of teachers in existence at any point in time. Variations in the stock of teachers over time should thus depend on the determinants of the demand for teaching and it is of interest to estimate how much this stock would ultimately change in response to changes in these determinants. The inflow of new teachers is the means by which the stock of teachers is adjusted to changing conditions. Hence, changes in the rate of inflow of new teachers permit the simultaneous estimation of both the pace at which adjustments take place in the market for teachers and the responsiveness of stock demand to the relevant variables. The focus is thus on the demand for stock, as derived from the demand for services.

II.1.1. A MODEL OF TEACHING DEMAND

II.1.1.a. Demand for Services and Stock Demand

The fundamental demand for teaching relates the quantity of teaching services to teachers'salaries, community income, pupil enrollment and other relevant variables. Consider a long-run equilibrium stock of teachers -- i.e., a set of conditions under which there would be no tendency for the number of teachers to change over time.[2] In such a case, there would be just enough new entrants to the stock of teachers to offset losses due to deaths, retirements, and withdrawals from teaching (and to provide for the "natural" growth of the stock). This long-run equilibrium will be referred to as the desired stock of teachers. Since the demand for stock is derived from the demand for services, the desired-stock demand will depend upon the long-run equilibrium salary of teachers and upon income and enrollment. But, if there is to be no net addition to the stock of teachers over time, the long-run equilibrium salary must be just sufficient to induce the appropriate number of people to become teachers.

In the short run, there will be an implied desired stock -- i.e., the desired stock that would prevail if the values of the relevant variables determining the demand for teaching were to remain constant. If, as is usually the case, the values of the determinants of demand do not remain constant, this simply means that the implied desired stock of teachers will fluctuate as well. It does not undermine the notion of a desired stock.

II.1.1.b. The Demand for New Teachers

In dealing with the pace of adjustment of the actual stock of teachers to the desired or equilibrium level, it is assumed that a certain fraction, d, of the gap between actual and desired stocks will be filled within a year. If adjustment is rapid, d will be close to 1.0; if it is sluggish, d will be close to zero.

The basic idea underlying the model below is that there is a desired stock of teachers for each school district at any point in time, and that movement towards this stock is spread out over a period longer than a year, rather than being completed in a single year. There are several reasons why one might anticipate slow adjustment of teaching stocks from both the supply and demand sides of the market for teachers. First, given that there are teachers with varying amounts of teacher training, and that school boards desire some training mix in their teaching forces, it is clear that the existence of inelasticities of supply of teachers with given amounts of training may result in a school board's failing to hire as many teachers as it otherwise might. That is, at the margin, a board may choose not to hire an available teacher with "insufficient" training rather than pay the extra salary required to attract a well-qualified teacher. Thus, a quality constraint of sorts will tend to limit the quantity of teachers hired.[3]

A second possible reason for less than complete adjustment of actual to desired stock is a recognition lag concerning fluctuations in wealth or income. A permanent increase in the income of a school district may initially be seen as only transitory and may only gradually result in an increase in the demand for new teachers.

A third factor that was initially presumed to contribute to the incomplete adjustment of teaching stocks was a lag in recognition of changes in district size. By this reasoning, school districts would fail to recognize fully their own enrollment changes; hence,the stock of teachers would not adjust very quickly to these changes. Further reflection revealed weaknesses in this rationale. Factors resulting in enrollment changes are likely to be readily perceptible and rough estimation or prediction of such changes should not be difficult. These considerations led to the development of an alternate third factor -- the lag in construction of new physical plant. This lag is relevant to the bulk of districts whose enrollment is growing. It may result from lags in the recognition of theneed for expansion in the formation and approval of plans, and in the construction of new physical plant. It will impede the adjustment of teaching stocks, since unavailability of space may constrain the number of teachers that can be hired.

Finally, it has been shown that if the costs of adjustment are quadratic, then the optimal course to follow is to spread the adjustment over several periods.[4] The assumption of quadratic costs is more realistic than the assumption of linear costs. Beyond some point, increases in the teaching stock will disproportionately raise transaction costs (as the capacity of the "employment office" is reached). In addition, large changes in the teaching force in either direction will generate disproportionately higher costs of reorganization due to the extensive planning required. Hence, small changes in the teaching stock will be preferable to large dramatic changes in terms of the costs associated with such changes.

If the cumulative effect of the factors inducing a lag in adjustment of actual to desired stock generates a lag that is long enough relative to a school year, then none of the observed combinations of end-of-year stock, salary, income, enrollment, etc., need coincide with a point on the desired stock-demand function. Rather, they would lie on the path of dynamic adjustment to the long-run equilibrium stock level.

It seems plausible to assume as a first approximation that the net increase per unit of time in a school district's stock of teachers will be proportional to the divergence between desired stock and actual stock. That is,

$$T_t' = d(T_t^* - T_{t-1}) \quad (1.1)$$

where

T_t' = the net increase in stock this year (i.e., this year's number of teachers minus last year's number of teachers);

T_t^* = this year's desired stock of teachers;

T_{t-1} = last year's stock of teachers; and

d = the constant of proportionality, or adjustment coefficient.

While this equation specifies the rate at which the stock of teachers increases over time, it is of no use for empirical analysis because it contains the desired-stock variable, which is not observable. In order to be able to estimate an equation corresponding to (1.1), the desired-stock variable must be expressed as a function of its determinants; this function can then be substituted back into equation (1.1).

From the analogy of the school district to a business firm in Chapter I, it is clear that the desired stock of teachers (the labor input) will depend on both the number of pupils (quantity of output) and the salary level of teachers (factor price). In addition, desired stock will depend upon the "quality" of education offered by the school district, since the teacher-pupil ratio is seen as one important component of educational "quality."[5] The "quality" of education may in turn be affected by income or wealth, and by factors affecting the "tastes" for education of a school district.

Hence, an equation expressing the relationship between a school district's desired stock of teachers for a given year and the determinants of that desired stock might take the following form:

$$T_t^* = a_0 + a_1 P_t + a_2 S_t + a_3 V_t + a_4 E_t + a_5 t , \qquad (1.2)$$

where

- P_t = the current number of pupils;
- S_t = a measure of the salary level of teachers in the district;
- V_t = the district's equalized assessed property value per pupil;
- E_t = a measure of the education level of the adult population of the district;[6] and
- t = a time trend to allow for changes over time in "tastes" for education apart from those reflected in E_t.

The coefficients a_1, a_3, a_4, and a_5 should be positive and a_2 should be negative.

Substituting equation (1.2) into equation (1.1) in order to eliminate the non-observable T_t^* gives

$$T_t' = da_0 + da_1 P_t + da_2 S_t + da_3 V_t + da_4 E_t + + da_5 t = dT_{t-1} . \qquad (1.3)$$

Equation (1.3) can readily be estimated, since all of the variables in it are observable. The equation relates the net rate of inflow of new teachers per year to the determinants of desired stock and to actual stock. Estimates provide information on both the speed of adjustment of actual stocks of teachers to their desired levels and the determinants of desired stock.

Equation (1.3), once estimated, will provide the coefficients of the desired stock-demand function and the partial elasticities; and it will also yield an estimate of d, the rate of adjustment parameter. If d is really less than 1.0, then the net inflow of new teachers can be explained not only by changes in the determinants of desired stock but also by the dynamic lag of adjustment of actual to desired stock.

II.1.2. THE SUPPLY OF NEW TEACHERS

Casual observation suggests not only that the supply of new teachers is highly elastic in the long run, but also that even over short periods of time there is a high degree of mobility into the teaching profession. There appears to be a fairly substantial "reserve labor force," composed primarily of married females, whose members are able and willing to serve as teachers in times of substantial demand. When demand decreases, these individuals then frequently leave teaching and the labor force and return to working as full-time housewives. Thus, there are always more individuals in the population "qualified" to teach than there are individuals engaged in teaching,[7] and sufficient demand (and salaries) should attract some of these "marginal" teachers as well. Hence, there is good reason to expect a fairly high short-run elasticity in supply of teachers.

This high elasticity is simply in quantitative terms, however. As was implied earlier, there may be inelasticities in supply of teachers with given amounts of training. Thus, the supply of teachers in general and of teachers with little training is quite elastic, but, as the training of teachers increases, the short-run elasticity in supply of these teachers decreases.

II.1.3. THE DEMAND FOR TEACHERS: COMPLETE ADJUSTMENT

The model described above is structured on the premise that there will be an incomplete adjustment of teaching stocks to their desired levels in a year's time. If there were a complete adjustment of stocks in a year's time, it would be shown by an estimated value of d equal to one, since d is that fraction of the difference between desired and actual stock which is made up within a year.

However, if the teaching stock were to adjust so rapidly that at the end of any given school year the actual stock equalled the desired stock, under currently prevailing conditions, estimating the stock demand would be no different from estimating the demand for the services of any asset. Each observed combination of end-of-year stock, salary, income, enrollment, etc., would give one point on the desired stock-demand curve (assuming stability of this curve over time).

If this were the case, then stock demand could be estimated directly, as follows:

$$T_t = b_0 + b_1P_t + b_2S_t + b_3V_t + b_4E_t + b_5\, t \,. \qquad (1.4)$$

Actual stock (T_t) would be the same as desired stock (T_t^*), and there would be no difference between the a_i's of equation (1.2) and the b_i's of equation (1.4).

On the other hand, if the incomplete adjustment model is the appropriate model in this case, equation (1.4) could be expected to have relatively little explanatory power compared to equation (1.3), and it would also provide less information about the workings of the market for teachers.

II.1.4. THE EMPIRICAL RESULTS

For clarity of exposition, the discussion of the results will begin with the estimation of equation (1.4), and then proceed to equation (1.3). When equation (1.4) was first estimated, it gave the rather obvious result that most of the variance in the number of teachers across districts could be explained by the number of pupils. Since this conclusion is of little interest, the equation was respecified with the teacher-pupil ratio as the dependent variable. In addition, P^2 was added to the new specification to allow for economies of scale. The reconstituted equation took the following form:

$$\frac{T_t}{P_t} = c_0 + c_1 P_t + c_2 P_t^2 + c_3 S_t + c_4 V_t + c_5 E_t + c_6\, t\,. \quad (1.5)$$

The estimated coefficients of (1.5) are presented in Table 1.1 for four different samples: all districts,[8] all districts over two years old, all districts with more than 250 pupils, and all

TABLE 1.1

ESTIMATED COEFFICIENTS OF EQUATION (1.5)

Dependent Variable = T_t / P_t (mean = 4.82 - Sample A)

Independent Variables (t values in parentheses)

Sample	Constant	P_t	P_t^2	S_t	V_t	E_t	t	R^2	N
A	5.12 (19.8)	-0.0040 (-5.8)	0.0000051 (4.7)	-0.017 (-2.9)	0.41 (8.4)	-0.0059 (-0.5)	0.11 (6.2)	0.212	1,047
B	5.10 (20.1)	-0.0040 (-5.8)	0.0000049 (4.7)	-0.018 (-3.1)	0.41 (8.4)	-0.0003 (-0.0)	0.12 (6.5)	0.218	1,036
C	5.06 (20.4)	-0.0036 (-5.5)	0.0000043 (4.4)	-0.018 (-3.2)	0.40 (7.7)	-0.0005 (-0.0)	0.13 (7.1)	0.273	859
D	5.07 (20.7)	-0.0036 (-5.6)	0.0000043 (4.4)	-0.019 (-3.5)	0.41 (8.0)	0.0032 (0.3)	0.13 (7.3)	0.280	855
Mean of variable for Sample A		29.0	8,047.9	56.1	0.51	8.1	5.0	---	---

T_t = number of teachers in the district this year;

P_t = hundreds of pupils in the district this year;

S_t = current starting salary for a teacher with the B.Ed. degree in hundreds of dollars;

V_t = current equalized assessed property value of the district, in millions of dollars, divided by P_t;

E_t = median years of education of adults in the census division or city of which the district is a part, 1961;

t = time trend (= 1 for 1961-62, ... , 9 for 1969-70); and

N = number of observations in the sample.

districts over two years old with more than 250 pupils.[9] These four samples will be referred to as A, B, C, and D, respectively.

With the exception of the coefficients of the education variable,[10] all of the estimated coefficients had the expected signs and were highly significant. The teacher-pupil ratio varies positively with per-pupil wealth and negatively with the salary level of teachers.[11] However, the impact of these variables on the teacher-pupil ratio is quite small: for sample A, the elasticity of T_t/P_t with respect to V_t is 0.04, while the elasticity with respect to S_t is -0.20.

The coefficients on P and P^2 suggest economies of scale up to quite a large district size, but again the relevant elasticity is extremely low -- -0.02. Thus, for example, a ten-fold increase in pupil enrollment from 1,000 to 10,000 is associated with a decline in the number of teachers per hundred pupils of 0.31 -- roughly 6 percent of the mean of T_t/P_t. The positive coefficient on the time trend suggests an increasing demand for quality education over time, over and above that generated by the other variables. Finally, as expected, the explanatory power of the equations is relatively low.

Attempts to estimate equation (1.3) as specified above would (and did) run into the same problem encountered in the first estimates of equation (1.4) -- viz., much of the variance in the dependent variable would be attributable to differences in district size. Hence, it became necessary to re-specify equation (1.3) as well, and to do it so that the dependent variable was a rate of flow, rather than the flow itself. This might be done by dividing both sides of (1.3) by T_{t-1}, but this procedure generates a rather intractable equation. Alternatively, equation (1.3) may be re-specified in exponential form:

$$\frac{T_{t-1} + T_t'}{T_{t-1}} = \left(\frac{T_t^*}{T_{t-1}}\right)^d \qquad (1.6)$$

Since the left hand side of (1.6) is equal to the current actual stock divided by the previous actual stock, the equation simply states that this ratio will be determined by the ratio of desired stock to actual stock, subject to the adjustment coefficient, d (which presumably takes a value between zero and one).

It may readily be seen that this is an alternate specification of the initial premise -- viz., that the net increase per unit of time in a school district's stock of teachers will be proportional to the divergence between desired stock and actual stock. Adjustment over time to a given change in desired stock will differ slightly in the exponential form from the linear form in equation (1.1). In the limit, the difference will approach zero, and in most cases, it will be minor.[12]

For the purposes of compatibility and ease of estimation, the desired-stock equation (1.2) is re-specified as:

$$T_t^* = e_0 \cdot P_t^{e1} \cdot S_t^{e2} \cdot Y_t^{e3} \cdot E_t^{e4} \cdot t^{e5} \quad . \qquad (1.7)$$

Substituting (1.7) into (1.6) gives

$$\frac{T_t}{T_{t-1}} = \left(\frac{e_0 \cdot P_t^{e1} \cdot S_t^{e2} \cdot V_t^{e3} \cdot E_t^{e4} \cdot t^{e5}}{T_{t-1}} \right)^d , \qquad (1.8)$$

or in logarithmic form,

$$\ell n\ T_t - \ell n\ T_{t-1} = d\ \ell n\ e_0 + de_1\ \ell n\ P_t + de_2\ \ell n\ St + de_3\ \ell n\ V_t + de_4\ \ell n\ E_t + de_5\ \ell n\ t - d\ \ell n\ T_{t-1} . \qquad (1.8')$$

Equation (1.8') can be estimated, and this estimation provides information as to the size of the adjustment coefficient, d -- i.e., the estimated coefficient on $\ell n\ T_{t-1}$. In addition, the coefficients of the implied desired-stock equation may be ascertained by dividing the relevant coefficients of equation (1.8') by d.

Table 1.2 shows the estimated coefficients of the stock-adjustment equation (1.8'), while Table 1.3 gives both the coefficients/exponents of the implied desired stock equations and the estimated adjustment coefficients from the estimates of Table 1.2. With but one exception, the coefficients in Table 1.2 have the anticipated sign. In addition (and in contrast with the results of Table 1.1), the estimated size and significance of some of the coefficients vary according to the sample being considered.

The enrollment variable, P_t , is clearly the dominant

TABLE 1.2

ESTIMATED COEFFICIENTS OF THE STOCK-ADJUSTMENT EQUATION (1.8')

Dependent Variable $= \ln \frac{T_t}{T_{t-1}}$ (mean=0.042-Sample A)

Independent Variables (t values in parentheses) in logarithmic form

Sample	Constant	P_t	S_t	V_t	E_t	t	T_{t-1}	R^2
A	-1.17 (-4.0)	0.53 (28.2)	-0.055 (-1.6)	0.0035 (0.8)	0.011 (0.7)	0.037 (5.2)	-0.54 (-27.7)	0.463
B	-1.03 (-3.6)	0.51 (27.5)	-0.066 (-2.0)	0.0025 (0.06)	0.019 (1.2)	0.039 (5.7)	-0.51 (-27.1)	0.456
C	-1.18 (-4.2)	0.51 (24.8)	-0.051 (-1.6)	-0.00027 (-0.01)	0.032 (2.1)	0.039 (5.8)	-0.52 (-24.7)	0.482
D	-1.01 (-3.7)	0.49 (24.3)	-0.064 (-2.1)	0.0018 (0.4)	0.036 (2.5)	0.041 (6.3)	-0.50 (-24.2)	0.469
Mean of variable for Sample A		6.93	8.62	-5.50	2.07	1.43	3.86	--

P_t and S_t are expressed in their actual amounts; otherwise, definitions of the variables may be found at the bottom of Table 1.1.

Levels of significance of t(one-tailed test):

$$t = \begin{Bmatrix} 1.65 \\ 1.96 \\ 2.58 \end{Bmatrix} \text{ is significant at the } \begin{Bmatrix} 0.10 \\ 0.05 \\ 0.01 \end{Bmatrix} \text{ level}$$

TABLE 1.3

EXPONENTS OF THE IMPLIED DESIRED-STOCK EQUATION (1.7)

AND ESTIMATED ADJUSTMENT COEFFICIENT (d)

	Variables					
Sample	P_t	S_t	V_t	E_t	t	d
A	0.99	-0.10	0.0065	0.020	0.068	0.54
B	0.99	-0.13	0.0048	0.037	0.075	0.51
C	0.98	-0.10	-0.00051	0.061	0.075	0.52
D	0.98	-0.13	0.0036	0.071	0.082	0.50

element in the determination of desired stock, as measured by both the size and significance of the coefficient. That is, because the desired-stock equation (1.7) is in exponential form, the elasticity of desired stock with respect to a particular variable is given by the exponent of that variable. Hence, the first five columns of Table 1.3 make up a table of elasticities, and the dominance of enrollment in affecting desired stock is evident in this table. In addition, the desired teacher-pupil ratio may be obtained by dividing both sides of equation (1.7) by P_t. When this is done, the resulting elasticity of the desired teacher-pupil ratio with respect to the number of pupils is -0.01 or -0.02, depending on the sample being considered. These elasticity estimates are in accord with those for the actual teacher-pupil ratio and again suggest the existence of economies of scale.

The estimated coefficients of the salary variable increase in both absolute value and significance when the relatively new districts are omitted from the observations, even though these districts are only a small fraction of the total. Since it is likely that new districts will have to offer relatively high salaries in order to attract sufficiently large teaching forces, this is not surprising. What is surprising is the extremely low elasticity of desired stock with respect to the salary level: -0.13. This suggests that an increase in the starting salary for B.Ed. teachers of 8 percent will be associated with a decline in desired stock of only about 1 percent, <u>ceteris paribus</u>. This inelasticity of the demand for teachers with respect to their price will be returned to subsequently.

The variable least related to desired stock appears to be V_t, the equalized assessed property value per pupil. The estimated coefficients are extremely small, and consistently smaller than their own standard errors. To the extent that the Foundation Program Fund is successful in equalizing financial situations across school districts, the impact of per-pupil wealth will be mitigated, but so long as equalization is not complete -- which it cannot be in the presence of supplementary requisitions -- per-pupil wealth should have some impact on the demand for education. In any case, the evidence from Table 1.2 is that wealth has no significant impact on the desired stock of teachers.[13]

The size and significance of the estimated coefficients on E_t increase steadily as one moves from Sample A to Sample D, and for the last two equations, the coefficient is significant at the 0.05 level. This is logical, since themeasurement error in E_t will be diminished somewhat by exclusion of the very small districts. Again, however, the impact of the variable on desired stock is quite small. In this case, the highest estimated elasticity is still less than 0.1.

The positive and highly significant coefficients on the time trend variable imply that each year, apart from changes in the other variables, the desired stock of teachers will increase. Thus, there appear to be unmeasured factors which, over time, contribute to an increase in the demand for education.

The estimates of d, the adjustment coefficient, are all slightly greater than 0.50. This means that, in any given year, just over half of the divergence between the desired stock and the (previous) actual stock will be made up in net growth of the teaching force. In turn, this suggests that for a given change in desired stock away from an equilibrium situation, it will take four years before 95 percent of the difference between the new desired stock and the initial actual stock is made up by net increases in the actual stock.

In general, then, the results presented above were in accord with _a pricri_ expectations with regard to the signs of the variables, but the responsiveness of the demand for teachers to all of the variables except pupils was surprisingly low. The data support the hypothesis that the demand for teachers is best understood if one takes into account the slowness of adjustment of actual stock to desired stock, and the size of the adjustment is an increasing function of the divergence between desired and actual stock.

Looking further into the adjustment process, one may argue that the adjustment coefficient, d, will be inversely related to the size of the desired adjustment. That is, the actual rate of growth of the teaching stock will increase as the desired rate of growth increases, but at a declining rate. This may be put in terms of our equations by modifying equation (1.6) to give

$$\frac{T_t}{T_{t-1}} = \left(\frac{T_t^*}{T_{t-1}}\right)^d \left(\frac{T_t}{T_{t-1}}\right)^\gamma . \qquad (1.9)$$

Here, then, the adjustment coefficient itself will depend on the desired rate of adjustment, and presumably γ will be negative, but not so large relative to d as to overwhelm the first-order effects of desired growth on actual growth.

Equation (1.9) can not be estimated, however, since the term $\frac{T_t^*}{T_{t-1}}$ is not independent of the estimation. As an alternative, an equation was specified that attempted to capture the spirit of equation (1.9) and yet at the same time was amenable to empirical estimation. The proposed specification is

$$\frac{T_t}{T_{t-1}} = \left(\frac{T_t^*}{T_{t-1}}\right)^d \left(\frac{P_t}{P_{t-1}}\right)^\gamma \quad . \tag{1.10}$$

In equation (1.10), the actual growth in enrollment is substituted for the desired growth in the teaching stock in the exponent. This is justified on the basis of the evidence above, which indicated that enrollment is the dominant determinant of desired stock.

Substituting equation (1.7) into (1.10) to eliminate T_t^* gives

$$\frac{T_t}{T_{t-1}} = \left(\frac{e_0 \cdot P_t^{e1} \cdot S_t^{e2} \cdot V_t^{e3} \cdot E_t^{e4} \cdot t^{e5}}{T_{t-1}}\right)^d \left(\frac{P_t}{P_{t-1}}\right)^\gamma \tag{1.11}$$

or in logarithmic form,

$$\ell n\ T_t - \ell n\ T_{t-1} = d \left(\frac{P_t}{P_{t-1}}\right)^{\gamma} [\ell n\ e_0 + e_1\ \ell n\ P_t + $$
$$+ e_2\ \ell n\ S_t + e_3\ \ell n\ V_t + e_4\ \ell n\ E_t$$
$$+ e_5\ \ell n\ t - \ell n\ T_{t-1}] \quad . \qquad (1.11')$$

Estimation of equation (1.11') proceeded as follows: $\left(\frac{P_t}{P_{t-1}}\right)^{\gamma}$ was computed over a wide range of values for γ.[14] In each case, the variables in the brackets were multiplied by the term $\left(\frac{P_t}{P_{t-1}}\right)^{\gamma}$, and the equation was then estimated by means of ordinary least squares. This was done for each of the four samples and the estimated equations were then compared on the criterion of explanatory power.

For each of the four samples, the graph relating R^2 to γ reached a peak at $\gamma = .75$.[15] Table 1.4 gives the estimates of the coefficients of the equation derived from (1.11), with $\gamma = 0.75$. The estimated coefficients have the same interpretation as those in Table 1.2, while the constant and variables in Table 1.4 equal those in Table 1.2 multiplied by $\left(\frac{P_t}{P_{t-1}}\right)^{.75}$. Table 1.5 gives the exponents of the desired-stock equations implied in Table 1.4, as well as the estimates of the parameter d.

Comparison of Table 1.3 and 1.5 reveals that the coefficients/exponents of the implied desired-stock demand functions are quite similar for equations (1.8') and (1.11'). The only difference of note is that the estimated adjustment coefficient, d, is slightly

TABLE 1.4

ESTIMATED COEFFICIENTS OF EQUATION DERIVED FROM (1.11'),

WITH $\gamma = +0.75$

Dependent Variable $= \ell n \dfrac{T_t}{T_{t-1}}$ (mean = 0.042 - Sample A)

Independent Variables in logarithmic form,

multiplied by $\left(\dfrac{P_t}{P_{t-1}}\right)^{0.75}$

(t values in parentheses)

Sample	Constant[a]	P_t	S_t	V_t	E_t	t	T_{t-1}	R^2
A	-1.10 (-3.9)	0.51 (28.4)	-0.051 (-1.6)	0.0034 (0.8)	-0.0035 (-0.2)	0.036 (5.3)	-0.51 (-28.0,	0.483
B	-0.96 (-3.5)	0.49 (27.4)	-0.064 (-2.0)	0.0019 (0.5)	0.0060 (0.4)	0.038 (5.8)	-0.49 (-27.0)	0.471
C	-1.09 (-4.1)	0.47 (24.8)	-0.046 (-1.5)	-0.0015 (-0.4)	0.018 (1.2)	0.037 (5.9)	-0.48 (-24.8)	0.507
D	-0.92 (-3.6)	0.46 (24.2)	-0.061 (-2.1)	0.00043 (0.1)	0.023 (1.7)	0.040 (6.4)	-0.46 (-24.1)	0.490
Mean of variable for Sample A	1.03	7.12	8.85	-5.66	2.13	1.46	3.96	--

a The "constant" was also multiplied by $\left(\dfrac{P_t}{P_{t-1}}\right)^{0.75}$ and hence has a mean equal to the mean of that term.

TABLE 1.5

EXPONENTS OF THE DESIRED-STOCK EQUATIONS AND ESTIMATED ADJUSTMENT COEFFICIENTS IMPLIED BY EQUATION (1.11'), WITH $\gamma = +0.75$

	Variables					Coefficient
Sample	P_t	S_t	V_t	E_t	t	d
A	0.99	-0.10	0.0066	-0.0069	0.071	0.51
B	1.0	-0.13	0.0039	0.012	0.079	0.49
C	0.99	-0.10	-0.0032	0.037	0.078	0.48
D	0.99	-0.13	0.00093	0.049	0.086	0.46

smaller for the latter equation, and this difference is compensated for by the pupil growth term.

Contrary to our expectation, γ was positive rather than negative. This means that the rate of adjustment of actual stock to desired stock varies positively with the ratio of this year's enrollment to last year's enrollment. This unexpected result may well be due to the substitution of $\left(\frac{P_t}{P_{t-1}}\right)$ for $\left(\frac{T^*_t}{T_{t-1}}\right)$ in equation (1.9), since the former term represents more immediate pressures on a school board to change the size of the teaching force than does the latter term.

It would appear that the estimated equations did not really test the original hypothesis that the rate of adjustment of the teaching stock varies inversely with the size of the desired adjustment. However, the increase in the explanatory power of the equations suggests that the pupil growth term is of some significance in determining teaching stocks, at least in the short run.

In order to test this last suggestion, the term C_7 G was added to equation (1.5), where G equals $\frac{P_t - P_{t-1}}{P_{t-1}}$ -- i.e., the growth in enrollment. The results of the re-estimation of equation (1.5) -- presented in Table 1.6 -- reveal that G is highly significant in helping to explain variations in the teacher-pupil ratio. In addition, the negative sign on G indicates that the impact on the teacher-pupil ratio of the faster rate of adjustment of the teaching stock associated with higher values of G is more

TABLE 1.6

ESTIMATED COEFFICIENTS OF EQUATION (1.5) PLUS

THE TERM c_7 G

Dependent Variable = $\frac{T_t}{P_t}$

Independent Variables (t values in parentheses)

Sample	Constant	P_t	P_t^2	S_t	V_t	E_t	t	G	R^2
A	5.10 (20.2)	-0.0039 (-5.7)	0.0000049 (4.7)	-0.016 (-2.8)	0.34 (7.0)	0.00078 (0.1)	0.11 (6.0)	-1.03 (-7.1)	0.249
B	5.07 (20.5)	-0.0038 (-5.6)	0.0000047 (4.6)	-0.016 (-3.0)	0.34 (7.1)	0.00069 (0.6)	0.11 (6.3)	-1.06 (-7.3)	0.257
C	5.06 (20.8)	-0.0035 (-5.5)	0.0000043 (4.5)	-0.018 (-3.3)	0.32 (6.2)	0.0085 (0.7)	0.12 (7.1)	-0.88 (-6.0)	0.302
D	5.07 (21.1)	-0.0035 (-5.6)	0.0000043 (4.5)	-0.019 (-3.5)	0.33 (6.5)	0.012 (1.0)	0.13 (7.3)	-0.87 (-6.0)	0.309

See Table 1.1 for definitions of the variables.

than offset by the increase in enrollment.

II.1.5. SUMMARY AND IMPLICATIONS

The data support the hypothesis that the net inflow of teachers can be explained not only by changes in the determinants of the desired stock of teachers, but also by the dynamic lag of adjustment of the actual stock to the desired stock. Roughly one-half of the gap between desired stock and actual stock is made up in a single year; hence, it takes four years for 95 percent of such a gap to be eliminated.

The desired-stock demand function(s) implied by the data are in accord with the expectations derived from the analogy of the school district to the firm. However, using partial elasticities as measures of the responsiveness of desired stock to its determinants, it is clear that desired stock is responsive to only one variable -- enrollment. Other variables are statistically related to desired stock, but their quantitative impact is minor. This is somewhat surprising, especially regarding the salary variable, and it implies that salary increases will have relatively little impact on the demand for teachers.

The elasticity of desired stock with respect to enrollment suggests that there will be some economies of scale in the operation of school districts. This point is pursued and developed more fully in Chapter IV.

Finally, it should be noted that the stock-adjustment model used here has treated "teachers" as a single commodity, when in fact there are numerous types of teachers, in terms of differences in both amounts of training and fields of training. Thus, for example, salary increases might not have much effect on the number of teachers demanded, but they might affect the kinds of teachers demanded (in terms of amount of training). The following section of this chapter takes a brief look at some of these qualitative aspects of the demand for teachers.

PART 2 SOME QUALITATIVE ASPECTS OF THE DEMAND FOR TEACHERS

Results generated by the stock-adjustment model suggest that, of the major variables of interest (i.e., property value, number of pupils, and salary level), only the number of pupils has a strong impact on the desired number of teachers. Both property value and salary level seem to be related to the desired stock, but their quantitative impact -- as measured by the demand elasticities -- is extremely small.

However, the stock-adjustment model measured only the simplest and most readily quantifiable dimension of demand - viz., the demand for quantity, or numbers, of teachers. Qualitative dimensions of demand, such as the demand for teachers with various levels of training, were ignored. These qualitative dimensions are examined here, and perhaps the impact of property value and salary structure will be greater in this case than in the case of the stock-adjustment model. The general hypothesis, then, is that while the question of <u>how many</u> teachers a district will have is largely determined by the number of pupils in the district and is relatively insensitive to both the wealth of the district and the price of teachers, the question of what kinds of teachers a district will hire, in terms of the distribution of teachers by years of training, may well be much more responsive to the wealth and price variables.

We begin by looking at the distribution by years of training (post-secondary education) of "new hires" in each school district, and relating a measure of this distribution to the various independent variables which theory indicates will be relevant. Since the independent variables are all current, new hires are the appropriate focus of attention; the experienced teachers in the district having been hired under different conditions and over a long past period.

The measure of the distribution of new hires by years of training which is used as the dependent variable is simply the average training of new teachers in the district, denoted by $\bar{T}^e_o$. If we view the average training of teachers as an indicator of the demand for "quality" education by school districts, the implication is that the independent variables should be determinants of this demand.

Consequently, the independent variables used are V, property value per pupil; P, the number of pupils; P^2; C, a dummy variable taking the value of one for Catholic districts and zero for Protestant districts; E, a variable intended to measure the level of education of adults in the school district -- either median years of schooling (E_m) or the percentage of adults with three or more years of high school (E_{pc}); I, an index of relative salaries.[16] An index of relative salaries is clearly more appropriate here than S , the general level of salaries, since the dependent variable is determined by the decision about how many teachers to hire at each level of taining, and this decision in turn is presumably related to the structure rather than the level of salaries.

For example, we may consider the case of a school board choosing teachers with two different levels of training. The relative numbers of each kind of teacher hired will depend on the slope of the price line for the two levels, and the slope of the price line is determined by the relative salaries. A change in the level of salaries, holding relative salaries constant, is most likely to result in a change in the total quantity of teaching services purchased, while the relative quantities of each kind of teacher are likely to remain unchanged.

Hence, if we are interested in differences in the distribution by years of training of teachers hired, we should be looking at differences in <u>relative</u> salaries, rather than at differences in the <u>level</u> of salaries. Differences in relative salaries are expressed as an index of relative salaries.

Since relative salaries are determined by the school district in bargaining with the teachers of the district, the index of relative salaries, I , is endogenous, and hence may be a possible source of least squares bias in the estimation of the demand for teachers by years of training. It would seem appropriate, then, to posit a more formal model of demand for and supply of teachers by years of training, and to use a two-stage least squares approach in our attempt to identify the demand equation.

A very simple linear model was constructed, with the demand for average training of newly hired teachers given by

$$\bar{T}_o^e = a_0 + a_1V + a_2P + a_3P^2 + a_4C + a_5E + a_6I \qquad (2.1)$$

and the supply given by

$$\begin{aligned}\bar{T}_o^e &= b_0 + b_1V + b_2P + b_3P^2 + b_4C + b_5E + b_6I + \\ &+ b_7R_1 + b_8R_2 + b_9R_3 + b_{10}R_5 \qquad (2.2)\end{aligned}$$

where R_1, R_2, R_3, and R_5 are dummy variables which refer to the large urban, small urban, northern, and southern regions of Alberta (central Alberta serving as the base group).

Demand and supply are assumed to be equal, and $\bar{T}_o^e$ and I are the only endogenous variables in the model. While equation (2.2) is not identified, equation (2.1) is over-identified, and hence it can be estimated. This was done across districts for the 1969-70 school year. Estimation of equation (2.1) was stymied, however, by the fact that the sign on I, the index of relative salaries, was consistently in the wrong direction. This result held across several different specifications of I, and since the coefficient was consistently significant as well, the inescapable conclusion was that while the demand equation had been theoretically identified, it had not been identified empirically.

Since the demand equation could not be identified, a reduced-form equation was estimated instead, with $\bar{T}_o^e$ as the dependent variable and all of the exogenous variables in the model as independent variables, plus a time trend, t . The reduced-form equation was estimated for the period 1962-63 through 1969-70, in several forms. The linear and log-linear results are presented in Table 2.1, and the results for other forms are quite similar.

In general there appears to be a weak but positive correlation between the average training of newly-hired teachers and both property value per pupil and the level of education of adults. The time trend is quite significant, indicating that variations in the dependent variable occur around an upward-rising trend line.

The dummy variable for Catholic districts is also quite significant, indicating (in the linear form) that, other things equal, new hires in Catholic districts had an average of about three-tenths of a year of training less than new hires in Protestant districts. It should be noted here that when the Catholic dummy variable was introduced into the stock-adjustment equations presented in Part 1 of this chapter, its coefficient was insignificant and generally smaller than its standard error. This suggests, in conjunction with the result just noted, that Catholic districts differ from Protestant districts in terms of qualitative, but not quantitative, aspects of the demand for teachers.

The coefficients on the regional dummy variables indicate that districts in the North region hire teachers with lower levels of training, while those in the urban areas and in the South region hire teachers with somewhat higher levels of training, relative to the Central region base group. The quadratic term for pupils is also significant, indicating (in the linear form) that the average

TABLE 2.1

COEFFICIENTS OF THE REDUCED-FORM EQUATION FOR $\overline{T}_o^e$

(mean of $\overline{T}_o^e$ = 2.57)

Form	Equation	Constant	V	P	P^2	t	R1	R2	R3	R5	E_m	E_{pc}	C	R^2
Linear	a)	1.75	0.055	0.0031	-0.0000041	0.13	0.24	0.15	-0.18	0.11	0.0075	---	-0.28	0.285
		(11.9)	(0.8)	(2.3)	(-2.5)	(15.2)	(1.1)	(2.2)	(-2.8)	(2.2)	(0.4)		(-5.0)	
	b)	1.67	0.055	0.0028	-0.0000038	0.13	0.15	0.11	-0.18	0.08	---	0.0064	-0.29	0.287
		(15.7)	(0.8)	(2.1)	(-2.3)	(15.2)	(0.7)	(1.6)	(-2.7)	(1.5)		(1.6)	(-5.2)	
Log-Linear	c)	0.54	0.032	0.0017	-0.0000023	0.053	0.077	0.072	-0.069	0.029	0.0059	---	-0.14	0.287
		(8.6)	(1.0)	(3.0)	(-3.3)	(14.5)	(0.8)	(2.5)	(-2.5)	(1.3)	(0.8)		(-5.8)	
	d)	0.51	0.033	0.0016	-0.0000022	0.054	0.034	0.055	-0.066	0.013	---	0.0034	-0.14	0.289
		(11.2)	(1.0)	(2.8)	(-3.1)	(14.5)	(0.3)	(1.8)	(-2.4)	(0.6)		(2.0)	(-6.0)	
Mean of variable in linear form			0.52	30.1	8645.7	5.5	0.04	0.12	0.13	0.29	8.0	25.0	0.30	---

V = property value (millions of dollars) per 100 pupils
P = hundreds of pupils
t = linear time trend
R1 = dummy variable for large urban areas
R2 = dummy variable for small urban areas
R3 = dummy variable for Northern region
R5 = dummy variable for Southern region
E_m = median years of education of adults in census division, 1961
E_{pc} = percentage of adults in census division with more than 3 years of high school, 1961
C = dummy variable for Catholic districts

training of newly-hired teachers increases as district size increases, but at a declining rate and only to a peak of about 38,000 pupils.

Finally, the hypothesis that Edmonton and Calgary are qualitatively different from the rest of the province was tested by estimating the linear reduced-form equations for these two groups and then comparing the results with those obtained earlier by means of a Chow test. The F-statistic generated in this way was insignificant and the hypothesis was rejected.

The hypothesis set forth at the beginning of this part of the chapter thus finds no support from the data; the relationship between wealth and the average training of newly hired teachers is quite weak, and that between salary and training could not be tested. The average training of newly hired teachers is related to a number of variables on both the demand and supply sides of the market for teachers, however, although the total explanatory power of these variables is disappointingly low.

FOOTNOTES FOR CHAPTER II

[1]The general aspects of this model are adapted from the stock-adjustment model developed by Richard F. Muth in "The Demand for Non-Farm Housing", in Arnold C. Harberger, ed., The Demand for Durable Goods, pp. 28-96.

[2]Alternatively, this is a set of conditions under which there would be no tendency for the rate of growth of the number of teachers to change over time.

[3]This point is more relevant than might seem at first glance to one not familiar with the training of Alberta teachers. During the period covered by the data, Alberta teachers had from one to six years of post-secondary education, and although by 1969-70 three years of teacher training were required for a new teacher, "holdovers" with one and two years of training were still in plentiful supply. Hence, at the extremes are teachers who in many ways are of limited substitutability.

[4]Holt et. al., Planning Production, Inventories, and Work Force.

[5]For example, see P.J. Atherton et. al., Quality Education: What Price?, The Alberta Teachers' Association, Edmonton, December, 1969, pp. 8-11.

[6]Other studies have suggested that this variable is related to the taste for education. For example, see H. Thomas James et. al., Wealth, Expenditure, and Decision-Making for Education, pp. 69-100.

[7]Many of these individuals who are "qualified" have only minimal qualifications for teaching, and their services will generally be demanded only in the case of an acute shortage.

[8]"All districts" refers to all districts for which observations were available on all of the variables. The only variable difficult to obtain in this regard was the salary variable, for which almost one-fourth of the observations were missing over the nine-year period. Since missing observations for the salary variable were most frequent for smaller districts, the equations reported here

have disproportionately omitted observations on smaller districts. However, equations have been run over all districts, with a salary estimate based on year and region for each district for which the salary variable was missing, and these equations differed very little from those run over only the completely "clean" observations.

[9]Relatively new school districts were omitted since their behavior might differ somewhat from that of older, established districts; and similarly, very small districts were omitted since their behavior might differ from that of larger districts.

[10]As was indicated at the bottom of Table 1.1, it was not possible to obtain data on the education of adults by school district. The only available data were those from the 1961 Census of Canada, and these were available only for the fifteen census divisions and the three largest cities. These eighteen observations were "spread out" over the district observations, with a district being assigned the value for E_t of the census division or city in which the district is located. The measurement error resulting from this imputation tends to bias the coefficient on E_t toward zero; however, the variable is included here both for its theoretical relevance and because it is significant elsewhere.

[11]The particular measure of the salary level used in these and subsequent equations -- the starting salary for a teacher with a B.Ed. degree -- was chosen for two reasons: it is a "standarized" figure, free of influence from the distribution of teachers by years of training and experience; and it is probably the best single figure to summarize a salary schedule which is actually a matrix of salaries with up to seventy-two elements. The use of this figure results in a loss of some of the variation across districts, as compared with, say, an average salary figure. However, a standardized figure is desirable because the distribution of teachers by years of training and experience is itself likely to depend on the district's demand for education, so that a variable incorporating the effects of this distribution is likely to cause a least-squares bias in the estimation of demand. The case for S_t as representative of the level of the salary schedule rests on the fact that in bargaining for determination of salary schedules, this figure is viewed as the cornerstone of the schedule. The implication, then, is that districts with high values of S_t will tend to pay relatively well for all levels of training, and vice-versa.

One might still argue that there are sufficient endogenous aspects to S_t as to suggest using a two-stage least squares approach. This was tried for the equations in Table 1.1 and for the stock-adjustment equations, with the general result that the salary variable became insignificant, as did several other variables. For this reason, and the *a priori* case made above, only the ordinary least squares results are reported here.

[12]With a "once and for all" change in desired stock from an equilibrium position, the linear form will move a greater proportionate distance toward equilibrium than the exponential form if desired stock exceeds actual stock, and vice-versa. In both cases, the difference converges to zero as t increases. For a fuller and more rigorous treatment of this point see Ronald Soligo, "The Short-Run Relationship Between Employment and Output," Yale Economic Essays, Vol. 6, No. 1, Spring, 1966: pp. 176-181.

[13]In light of the significant relationship between wealth and teacher-pupil ratios indicated in Table 1.1, this finding is puzzling; however, I am unable to explain this puzzle.

[14]The set of values for γ was $\{-5.0, -2.0, -1.0, -0.75, -0.5, -0.25, 0, +0.25, +0.5, +0.75, +1.0, +2.0, +5.0\}$.

[15]A table showing the values of the R^2 obtained for various values of γ is presented as Appendix D.

[16]Time subscripts are omitted here because all variables are current.

CHAPTER III

THE MOBILITY OF TEACHERS

III.1. CONCEPTS AND DEFINITIONS

In looking at the turnover of teachers from year to year, several components should be distinguished. Termination of employment may be initiated on either the demand or the supply side. In the former case, since there are tenure provisions for teachers after some provisional employment period, termination is initiated by the school board when it does not want to retain a teacher who has not completed the provisional period.

On the supply side, termination of employment may be due to withdrawals from the labor force (including retirements), or to movements to alternative employments. These latter two components of turnover, excluding retirements, constitute the bulk of what are usually referred to as "quits."[1]

Unfortunately, although three major components of teacher turnover may be distinguished conceptually, the available data do not allow us to separate out the individual components. Hence, there is only a single measure of turnover, and in attempting to explain variations in turnover rates across school districts, we must draw upon whatever variables may help to explain movements in one or more of the three components.

III.2. THE THEORETICAL FRAMEWORK

Turnover of teachers across school districts is simply a measure of the mobility of teachers. Viewing labor mobility from a human capital standpoint,[2] we argue that, <u>ceteris paribus</u>, teachers will allocate their employments between school districts in order to maximize their net rates of return over costs over their lifetimes. With perfect information, a teacher will move from one school district to another if the latter will yield higher discounted net returns. Private returns are composed of monetary earnings plus non-pecuniary benefits from employment in a particular school district, over the length of the teacher's working life. The private costs associated with employment in a given district consist of the returns that could be earned in an alternative employment minus the pecuniary and non-pecuniary costs of moving into that alternative employment.

In this context, then, we attempt to identify observable variables which are related to either returns or costs associated with employment in various districts. These variables, in turn, should be related to the turnover behavior observed across districts.

Beginning with pecuniary returns, we assume that the teacher's expectation of discounted lifetime earnings in a given school district is based on the current salary level of the district. As in Chapter II, variations in the starting salary for a teacher with the B.Ed. degree are assumed to reflect variations in the general salary level, and since the observations of turnover are across districts rather than across individuals, it is this starting salary which is used in the estimated equations.[3]

Turning to non-pecuniary returns, a number of variables appear to be relevant. They may conveniently be subdivided into two groups: those variables that refer to characteristics of the school district itself, and those variables that refer to characteristics of the teaching force in the district. In the former group are the per-pupil level of wealth, the education level of adults, whether the district is Catholic or not, and the general location (i.e., region) of the district. In the latter group are included the percentage of the teaching force newly hired in the previous year, and some measure of the training of teachers in the district.

The wealth and education level of adults in the district will affect the turnover of teachers to the extent that teachers prefer to live in wealthier and better-educated communities. In addition, pupils from these communities are likely to be more favorably disposed towards the process of education than pupils from lower socio-economic groups -- and as such would be viewed as more desirable from the teacher's point of view.

It is hypothesized that turnover rates in Catholic districts will be lower than those in non-Catholic districts. It is likely that Catholic teachers are drawn disproportionately to Catholic districts, and it also seems plausible to suggest that they may enjoy utility from teaching in these districts, while non-Catholic teachers will not experience similar utility from teaching in non-Catholic districts. Hence, the non-pecuniary returns of employment in Catholic districts are expected to exceed those of employment in non-Catholic districts, other things being equal, so teacher turnover in Catholic districts is expected to be lower.

The general location of districts is represented by dummy variables for the five major regions of the province: the two large urban centers, the smaller urban centers, and the northern, central, and southern non-urban areas in the province. _A priori_, it seems likely that alternative employment opportunities outside of teaching will be greater in the urban centers of the province than elsewhere. Since greater employment opportunities within a relatively small geographic area tend to reduce both the pecuniary and non-pecuniary costs of changing employment -- i.e., one can change jobs without having either to change one's residence or leave one's friends -- it is anticipated that, _ceteris paribus_, turnover of teachers will be higher in the urban centers than in the non-urban areas. Turning to the three non-urban areas, it is clear that any characteristics which tend to make an area desirable to live in will affect turnover. In this context, the northern region stands out as an undesirable area to live in, both for the harshness of its climate and the sparseness of population and development. Hence, after controlling for other variables, turnover is expected to be relatively high in northern Alberta.

Turning to the characteristics of the teaching force in a district which are correlated with non-pecuniary returns to teaching in that district, we first consider the experience in the district of the teaching force. Several observers have suggested that experience in a given job is positively correlated with both the amount of specific training which the jobholder has and with nonwage benefits (e.g., seniority rights) which the employer grants to the employee.[4] If this is indeed the case, then the returns associated with a given job would tend to increase as experience on that job increases; hence, turnover should decrease.

Conversely, those teachers with the least experience in a district should exhibit the highest turnover.

In addition, there is a certain amount of "learning about the job" which takes place after an individual has taken a job -- i.e., discovering the various non-pecuniary aspects of the job which were not known previously. This ongoing process of information gathering is most likely to lead to quits for new teachers.[5] Finally, it should be noted that the first type of turnover discussed -- termination initiated by the school board -- is relevant to inexperienced teachers, and the more new teachers there are, the greater the number of such terminations is likely to be. For all these reasons, the turnover rate is expected to be positively correlated with the proportion of newly hired teachers in the district.

The years of training of teachers in a district may also be related to turnover. As a teacher acquires increasing amounts of formal teacher training, that training becomes more specific to teaching. Consequently, the returns associated with remaining in teaching will be higher than those associated with leaving teaching, and mobility out of teaching should decline as training increases, <u>ceteris paribus</u>. In addition, a relatively well-trained teaching force is likely to provide greater professional stimulation to a teacher, and this non-pecuniary benefit should also result in lower mobility.

Teachers with relatively low amounts of formal training are expected to exhibit turnover behavior similar to that of teachers with relatively high training, but for quite different reasons.

We postulate that teachers with little training will tend to be older and to have more experience in teaching than will other teachers. During the period covered by the equations, one could not become a teacher in Alberta with less than two years of training unless one had previous teaching experience elsewhere. Hence, those teachers with one year of training are likely to be older and more experienced, on the average, than are other teachers. For these reasons, turnover of teachers with low amounts of training should also be relatively low. Hence, in the estimated equations, a quadratic form of average training of teachers and average training squared is used, and we expect the graph of turnover with respect to average training to peak over the middle range of average training, and be low at both extremes, _ceteris paribus_.

Two additional characteristics of the teaching force of a district which might affect turnover are the age and sex composition. The younger an individual is, the longer will the net returns of a move accrue to him. In addition, the non-pecuniary costs of a move are likely to be lower for younger teachers than for older teachers, since attachments to one's community and one's job, and immobilizing factors such as marriage and family responsibilities, are likely to be more strongly felt among older teachers. Hence, the younger the teaching force in a school district, _ceteris paribus_, the greater is the anticipated turnover. However, since retirements are included in the measure of turnover, it is likely that the greater the proportion of teachers over age 65 in a district, _ceteris paribus_, the higher will be the turnover in the district.

The sex composition of the teaching force will influence turnover only if one sex is more mobile than the other. The usual argument is that females are more mobile than males: "Owing to their higher productivity in household activities, women spend less of their time in the labor force than do men. They tend to invest less in non-household skills, and this smaller investment is reflected in their lower earnings. These lower earnings imply a lower opportunity cost of their quitting employment and also of their quitting the labor force altogether."[6] Examination of the data indicates that women teachers do tend to invest less in training than male teachers, on the average. However, this will be reflected in the turnover equations by the terms for average training of teachers. Hence, since salary level is also included in the equations, we must ask if, holding training and earnings constant, we expect females to be more mobile than males. Given the higher productivity of women in household activities[7]-- especially as related to the production and care of children -- they may be expected to exhibit somewhat more turnover than men.

Finally, two additional characteristics of the school district are expected to be related to turnover: district size (measured by the number of pupils) and growth of the teaching force in the district. In terms of previous studies of the quit rate, district size corresponds to firm size, and the argument is similar. The larger the district, the greater will be the number of different schools in the district. Hence, transfer of teachers across schools within the same district will increase as district size increases, <u>ceteris paribus</u>, and, since such transfers are not included in the turnover data, the measure of turnover should be inversely related to district size.

In addition, it seems plausible to suggest that, at least to some point, teachers will prefer larger districts to smaller districts. That is, the larger the district, the more likely it is that a teacher will be able to find interesting colleagues, and that he will be able to receive an assignment -- in terms of school, grade level, and subject matter -- that he is happy with. At the extreme, however, a teacher in a very large school district may tend to experience feelings of alienation and frustration -- he may feel that he is but a small cog in a big machine, with insufficient power to implement desirable changes. Hence, the inverse relationship between turnover and district size may tend to reverse itself at the upper extreme of district size. Thus, in the estimated equations, both the number of pupils and this number squared have been included, so that this quadratic term will allow for curvature in the relationship between turnover and district size.

In a school district where the teaching force is growing, opportunities for transfer (either within a school or between schools) and/or promotion will be greater than those in a district where the teaching force is not growing (or where it is shrinking). Thus, even after taking account of differences in the size of districts, it is clear that the change in the size of the teaching force is an additional variable related to turnover, and the growth of the teaching force is expected to be inversely related to turnover.

But the growth in the teaching force was the dependent variable in the demand equations (1.8) and (1.11) of Chapter II. Consequently, the simultaneous determination of turnover and growth presents the possibility of least-squares bias, so the turnover equations were estimated by both ordinary least squares and two-stage least squares methods. The results were quite similar, and the two-stage least squares results are presented and discussed below.

The preceding arguments imply the following specification of the rather lengthy equation for estimating turnover across school districts:

$$
\begin{aligned}
K = {} & a_0 + a_1 S + a_2 V + a_3 E + a_4 C + a_5 R1 + \\
& + a_6 R2 + a_7 R3 + a_8 R5 + a_9 N + a_{10} \bar{T}^e + \\
& + {}_{11} (\bar{T}^e)^2 + a_{12} A_y + a_{13} A_{65} + a_{14} F + a_{15} P \\
& + a_{16} P^2 + a_{17} G \qquad (3.1)
\end{aligned}
$$

where:

K = the turnover rate in the district (per hundred teachers);

S = the starting salary for a teacher with the B.Ed. degree;

V = the property value per pupil;

E = the median years of schooling of adults;

C = a dummy variable equal to one for Catholic districts;

R1 = regional dummy variable for Edmonton and Calgary;

R2 = regional dummy variable for Alberta's smaller cities;

R3 = regional dummy variable for northern Alberta;

R5 = regional dummy variable for southern Alberta;

N = the percentage of newly hired teachers in the district;

$\overline{T}^e$ = average training of teachers;

A_y = percentage of teachers who are young;

A_{65}= percentage of teachers who are over age 65;

F = percentage of teachers who are female;

P = number of pupils (in hundreds); and

G = growth in the teaching force.[8]

Our hypotheses, in the context of equation (3.1), are

$a_1, a_2, a_3, a_4, a_5, a_6, a_{11}, a_{15}, a_{17} < 0$, and

$a_7, a_9, a_{10}, a_{12}, a_{13}, a_{14}, a_{16} > 0$. It is the examination of these hypotheses, then, to which we now turn.[9]

III.3. EMPIRICAL RESULTS

The results of estimating equation (3.1) are presented in Table 3.1 for two slightly different specifications of A_y and for two different samples. A_{30} equals the proportion of teachers in a district who are 30 years of age or under; and A_{35} is the corresponding proportion, with 35 as the cut-off age. The larger sample is for all of the districts which satisfy the constraint (B.2) in Appendix B while the smaller sample omits those districts with 250 or fewer pupils from the larger sample. The smaller districts were originally omitted on the presumption that there might be greater unexplained variance in the turnover experienced by smaller districts. While this initially appeared to be the case, the results in Table 3.1 suggest that the presumption was incorrect.

Before discussing the results in the table, it should be

TABLE 3.1

COEFFICIENTS OF EQUATION 3.1

Independent Variables (t values in parentheses)

Equation	Constant	S	V	E	C	R1	R2	R3	R5	N	$\bar{T}^e$	$(\bar{T}^e)^2$	A_{30}	A_{35}	A_{65}	F	P	P^2	G	t
3.1a	43.42	0.22	4.20	-0.17	4.77	3.69	-0.78	2.64	0.43	0.31	12.68	-2.34	0.14	---	0.035	0.035)	-0.069	0.000080	-62.24	-0.58
	(2.8)	(1.0)	(2.6)	(-0.4)	(3.1)	(0.5)	(-0.5)	(1.6)	(0.4)	(7.4)	(1.8)	(-1.6)	(3.4)	---	(0.3)	(0.7)	(-1.7)	(1.8)	(-8.3)	(-0.7)
3.1b	43.28	0.19	3.98	-0.086	3.78	1.00	-0.57	2.67	0.66	0.29	11.20	-2.02	---	0.18	0.090	0.078	-0.054	0.000063	-64.88	-0.50
	(2.8)	(0.8)	(2.5)	(-0.2)	(2.4)	(0.1)	(-0.4)	(1.6)	(0.6)	(6.9)	(1.6)	(-1.4)	---	(4.5)	(0.7)	(1.6)	(-1.3)	(1.4)	(-8.7)	(-0.6)
3.1c	28.58	-0.063	3.81	-0.19	1.35	10.05	0.34	5.15	-0.056	0.39	17.17	-3.65	0.10	---	0.20	-0.00014	-0.079	0.000087	-38.78	0.78
	(1.7)	(-0.3)	(2.7)	(-0.6)	(0.9)	(1.5)	(0.2)	(3.1)	(-0.1)	(8.1)	(1.6)	(-1.8)	(2.4)	---	(0.8)	(-0.0)	(-2.4)	(2.3)	(-5.1)	(1.1)
3.1d	27.12	-0.11	3.89	-0.12	0.58	8.36	0.47	4.98	0.17	0.35	17.13	-3.63	---	0.17	0.27	0.024	-0.073	0.000080	-40.26	0.85
	(1.6)	(-0.6)	(2.8)	(-0.4)	(0.4)	(1.3)	(0.3)	(3.0)	(0.2)	(7.1)	(1.7)	(-1.8)	---	(3.7)	(1.1)	(0.4)	(-2.2)	(2.2)	(-5.3)	(1.2)
Mean of Variable for 3.1a & 3.1b		57.8	0.56	8.0	0.30	0.03	0.13	0.10	0.32	24.9	2.43	6.12	32.0	43.9	1.3	65.6	28.1	8,211.3	1.02	5.0

Number of Observations = 469 for 3.1a and 3.1b, and 377 for 3.1c and 3.1d
Mean of K = 22.3 for 3.1a and 3.1b, and 21.1 for 3.1c and 3.1d

noted that there is one difference between the specification of equation (3.1) and the estimated equations -- the latter include a time trend, to allow for changes in turnover behavior over time exclusive of variations in the other independent variables. This time trend is used since the data are both cross-section and time series -- covering Alberta school districts over a period of eight years.

Comparison of the signs of the coefficients in Table 3.1 with the predictions of these signs gives the general impression that we have done fairly well in describing the determinants of turnover. There are at best two coefficients with the wrong sign, and at worst, four. If one-tailed tests are used, and the 10 percent level is considered to be significant, the predictions yielded statistically significant coefficients with the correct sign on up to half of the variables, and only one variable is consistently significant with the wrong sign.

Examining first the characteristics of the teaching force, the most significant variable is N , the percentage of newly hired teachers. The mean value of N is just under 25 -- i.e., on the average, about one-quarter of a district's teaching force is new to the district that year, and an increase in N of ten percentage points is associated with an increase in turnover per 100 teachers of three or four. Hence, the implication that teachers "shop" for desirable school boards while on the job, and vice-versa, is supported by the data.

The two specifications of A_y both do quite well, suggesting that younger teachers are indeed considerably more mobile than older teachers. The coefficient on A_{65} , while having the expected sign, is consistently insignificant. In any case, the hypothesis that teachers not at the extremes of age will exhibit relatively low turnover seems to have been substantiated.

The signs of the coefficients on average training and average training squared are as expected, and the coefficients themselves hover around the 10 percent level of significant, on average. The maximum value of the quadratic term $(a_{10}\,\bar{T}^e + a_{11}\,(\bar{T}^e)^2)$ may be found by taking $\frac{\partial K}{\partial \bar{T}^e}$, setting it equal to zero (making sure that $\frac{\partial^2 K}{\partial \bar{T}^{e2}} < 0$) , and solving for $\bar{T}^e$. For equations (3.1a) and (3.1b), this yields values of 2.7 and 2.8 respectively, while for equations (3.1c) and (3.1d), the corresponding value is 2.4. These maximizing values of average training may be compared with the mean values, viz., 2.4 and 2.5 respectively.

In addition to noting the maximizing values of average training with respect to turnover, we can also observe the impact of average training on turnover across the range of logical values for average training. This is done graphically for equations (3.1a) and (3.1d) in Figure 3.1. As expected, turnover is highest in the middle range of average training and lower at the extremes. However, a cursory look at the graphs reveals that the drop in turnover associated with movements away from the peak is much greater when training is increased rather than when it is decreased. This implies that the arguments for low mobility of highly trained teachers are stronger than those relating to teachers with relatively little

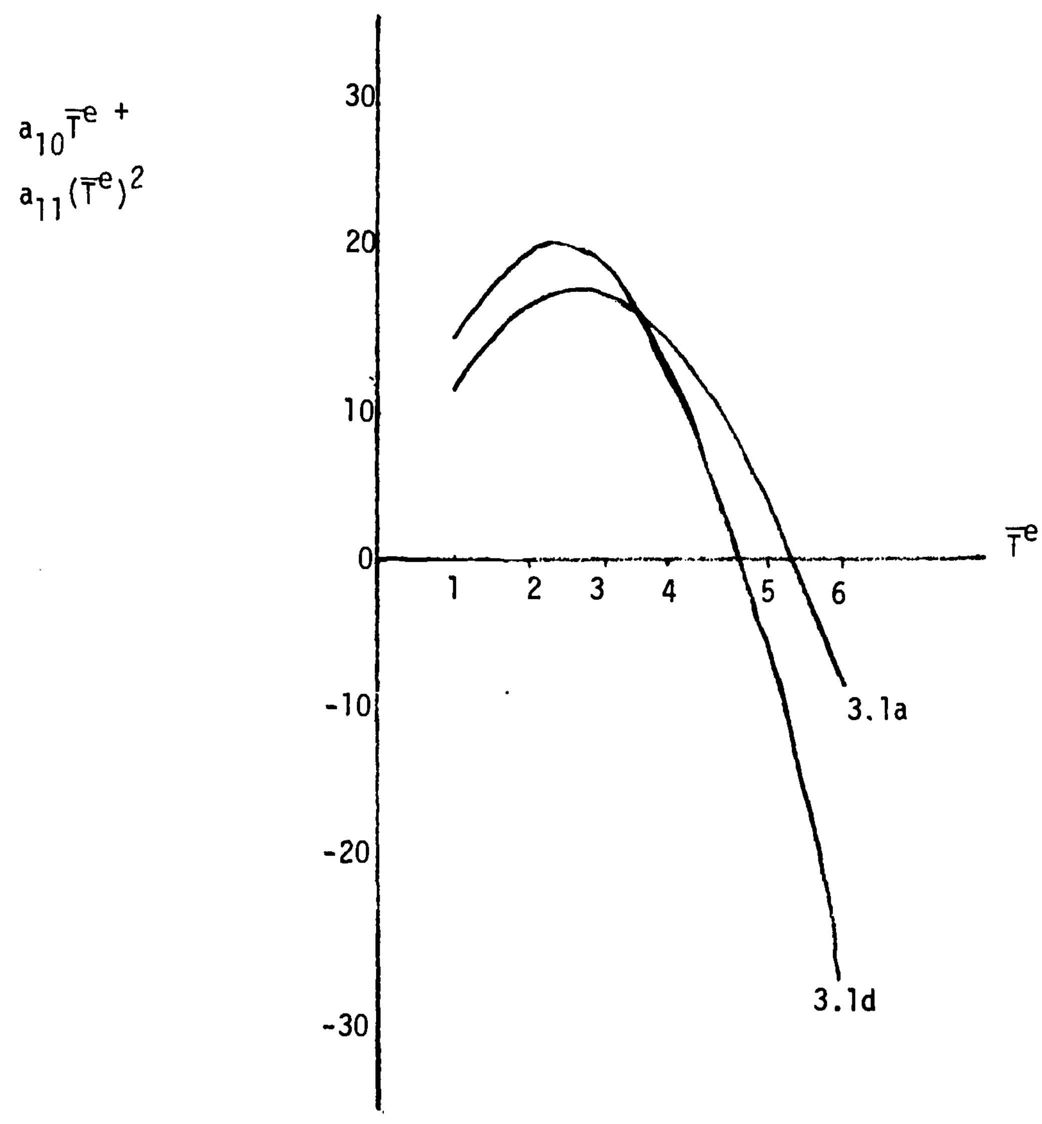


FIGURE 3.1

$a_{10}\overline{T}^e + a_{11}(\overline{T}^e)^2$, FOR EQUATIONS 3.1a and 3.1d formal training, and in turn, suggests a factor which was omitted in the earlier discussion -- teachers with little formal training have, by definition, much less invested in teaching as an occupation than have highly trained teachers. Thus, the opportunity cost of dropping out of the labor force entirely is much lower for the former group than for the latter group. Hence, ceteris paribus, we might have anticipated the relatively low mobility of highly trained teachers.

The final characteristic of the teaching force included in equation (3.1) is F , the percentage of teachers in the district who are female. While the coefficients of this variable were generally in the expected direction, they were also unambiguously insignificant. One might argue that in the presence of discrimination against women, women might be relatively reluctant to leave employment for fear of difficulty in finding subsequent employment. This, in turn, would imply lower turnover for women than for men, and the presence of this factor in conjunction with those implying higher turnover for women would bias the coefficient on F toward zero. However, this argument rests on the premise that discrimination against women will take the form of discrimination in hiring, and this seems to be an implausible form of discrimination. Indeed, more plausible forms of discrimination would imply a higher turnover of women.[10] Hence the discrimination argument does not seem to be likely for explaining the insignificance of F . In any case, the evidence from the regressions suggests that on the whole, there is no difference in turnover behavior between men and women.[11]

Turning now to characteristics of the districts themselves which affect turnover of teachers, the variable which stands out most strongly is G , the growth in the teaching force. The elasticity of K with respect to G , evaluated at the means of the variables, is equal to -2.8, -3.0, -1.9, and -2.0 for equations (3.1a), (3.1b), (3.1c) and (3.1d), respectively.[12] Two points arise from looking at the elasticities: first, turnover appears to be quite responsive to fluctuations in the growth of the teaching force; second, the impact of growth appears to be greater for smaller districts than for larger districts.[13] Reviewing the argument for inclusion of G as an explanatory variable, this is not really so surprising, since this argument may be viewed as a dynamic extension of the (static) argument for inclusion of district size as an explanatory variable.

The only other district characteristic to perform fairly well was the quadratic term for district size. The signs of the coefficients were consistently in the expected direction, and in six of the eight cases, the coefficients themselves were significant. As expected, there is curvature in the relationship between turnover and district size -- initially, turnover declines as district size increases, but eventually a trough appears and further increase in district size is associated with an increase in turnover. These troughs occur where P equals about 430 for equations (3.1a) and (3.1b), and at P = 455 for equations (3.1c) and 3.1d). Since P is expressed in hundreds of pupils, however, the minimizing values for district size with respect to K are roughly 43,000 and 45,500 pupils, respectively.

The implication, then, is that, excluding the Edmonton and Calgary public districts, turnover declines as district size increases, but at a declining rate. In addition, it should be noted that the relatively high turnover implied for the two large districts need not be construed as support for the "alienation hypothesis" advanced earlier. A priori, Edmonton and Calgary would seem to be the two areas of the province most likely to have an abundance of alternative job opportunities which would draw teachers away from teaching. If this were indeed the case, it would explain the upturn in the curve relating turnover to district size, and thus, in the absence of hard data on the availability of alternative employment, one cannot really give a definitive explanation of the reason for this upturn.

The district characteristic which was most disappointing in terms of its inability to contribute to the explanation of variations in turnover was S ,the starting salary for a teacher with the B.Ed. degree. The insignificance of S may be due to the lack of variance in this measure across districts for any given year, and/or it may be that differences in the non-pecuniary benefits of employment substantially outweigh the effect of differences in alternative salary opportunities in determining turnover across districts.[14]

The dummy variables for the different regions of the province were consistently insignificant, with the exception of the dummy for northern Alberta. A priori, we had anticipated positive signs on R1, R2, and R3. For the large urban areas of Edmonton and Calgary (R1), the sign was consistently positive, but never significant. This insignificance may be due to the correlation of R1 with the upper end of the distribution of the district size variable, P . The dummy variable for northern Alberta is highly significant for large districts, indicating that, ceteris paribus, the turnover rate of teachers will be almost 25 percent higher in the North region than elsewhere in the province. For all districts, however, the coefficient on R3 is not quite significant, and is smaller in size. The implication is that across small districts, turnover is not much higher in the North region.

The signs of the coefficients on E , the median education of adults in the district, were consistently in the right direction; but the coefficients themselves were never significant and always small in magnitude. It should be noted here that the specification of E used was the education of adults in the census division or city that the district was located in, as of 1961. Hence, measurement error was present in the specification of E , and this would tend to bias the coefficient toward zero.

The dummy variable for Catholic districts yielded somewhat surprising results -- in every case, the coefficient was positive instead of (the expected) negative. For the sample containing all districts, the coefficient was significant, while for that containing only the large districts, it was not. The implication is that only for small districts does turnover of teachers differ between Catholic and non-Catholic districts. Examination of the data indicates that the small Catholic districts have teaching forces with high proportions of female teachers. If there is in turn a tendency for account for the higher turnover of teachers in small Catholic districts. In any case, there is no support in the data for the "religious returns" hypothesis advanced earlier.

The final district characteristic variable, V , is perhaps the most puzzling of all. A negative sign was anticipated for the coefficient on V , on the grounds that teachers would prefer to live and work in wealthier areas, but for each of the four equations, a positive and highly significant coefficient was generated for V . Hence, it is not simply that the original hypothesis was not confirmed by the data. In addition, there is a distinct positive relationship between turnover of teachers and property value per pupil. There are two plausible explanations for this phenomenon. First, it is possible that districts with high values for V are also those where attractive alternative job opportunities for teachers are most numerous. If this were the case, then V would really be serving as a proxy for the availability of alternative employments. Alternatively (or in addition), to the extent that per-pupil wealth is correlated with per capita personal income, and to the extent that female teachers are the secondary income earners in their households, it is clear that teachers in wealthy areas will more readily be able to choose more leisure and/or household activities and still enjoy relatively substantial family incomes. In this case, variations in V would be roughly measuring variations in husbands' incomes, and given that one is currently teaching, the pressures to remain in the labor force would be lower in high-income areas and hence, turnover would vary positively with V .

The one remaining variable is t , which was entered in the equations simply as a linear trend term. Several studies of turnover and quits have devoted considerable attention to the question of whether or not there is a trend in quit rates over time, after accounting for other relevant variables.[15] While these studies have covered a much broader spectrum of the labor force than this one, it seemed worthwhile to include a time trend here in order to get at the question in a rudimentary fashion. As indicated in Table 3.1, the time trend is never significant; hence, there is no support for the notion of either an upward or downward trend in quit rates over time for teachers in Alberta.

Finally, it should be noted that the equations presented in Table 3.1 were re-run, omitting two variables -- time and E . The results, in terms of both size and significance of the estimated coefficients were quite similar to those presented in Table 3.1.

III.4. SUMMARY AND CONCLUSIONS

Using a large number of variables, all but one of which described either characteristics of the teachers in a district or characteristics of the district itself, we were able to account for just under half of the variance in estimated turnover rates across school districts in Alberta for the seven years 1963-64 through 1969-70. The basic approach was a human capital one, and many of the variables were included due to their relation to non-pecuniary aspects of employment. In general, the results appear to give credence to the approach, although there were a few anomalies.

Those variables that described characteristics of the teachers in a district tended, as a group, to perform better than those that described characteristics of the district itself. More specifically, the proportion of teachers who were newly hired, the proportion who were young, and the average training of teachers in the district all were significantly related to teacher turnover, while the district characteristics most closely related to turnover were district size, the growth of the teaching force, and property value per pupil in the district.

Finally, we may note that there were some differences in the implied impact of particular variables on small districts as compared with large districts -- most noticeably regarding growth in the teaching force and Catholic districts. On the whole, however, the structure of the determinants of turnover was not very different for small districts and given the human capital approach used, this is just what would be expected.

FOOTNOTES FOR CHAPTER III

[1]The U.S. Department of Labor defines "quits" -- measured monthly -- as follows: "Quits are terminations of employment initiated by employees for any reason except retirement, transfer to another establishment of the same firm, or service in the Armed Forces. Included in quits are persons who failed to report after being hired (if previously counted as accessions), and unauthorized absences which, on the last day of the month, have lasted more than seven consecutive calendar days." (U.S. Dept. of Labor, Bureau of Labor Statistics, Measurement of Labor Turnover, rev. June, 1966, p. 2.)

[2]As do, for example, Larry Sjaastad, "The Costs and Returns of Human Migration," Journal of Political Economy, Supplement, 70:5 (Oct., 1962), pp. 80-93; and John Pencavel, An Analysis of the Quit Rate in American Manufacturing Industry, Industrial Relations Section, Princeton University (Princeton, N.J.): 1970. The discussion in this section is largely adapted from the latter study.

[3]If the turnover observations were for individuals, then the appropriate salary figure might be the starting salary for teachers with the given individual's amount of training -- i.e., the salary most relevant to the particular teacher.

[4]For a concise discussion of these points, and more detailed references, see Pencavel, Op.Cit., p. 12.

[5]Alternatively, we may say that the deviation between actual and expected returns will be greatest for new teachers.

[6]Pencavel, Op.Cit., p. 17.

[7]This higher productivity seems to be generated more by social convention than by natural phenomenon, with the exception of the bearing of children.

[8]For purposes of clarity and simplicity of exposition, time subscripts have been omitted. In summary, K refers to turnover from the previous year to the current year; all of the other variables except G refer to the previous year, and G measures the growth of the teaching force from the previous year to the current year.

[9]The nature of the data is such that K is not measured directly, but is an estimated figure. The methodology used to derive K, and the consequent omission of a number of observations, is described in Appendix B.

[10]It seems more likely that discrimination against women would take the form of discrimination in promotion to administrative positions, and discrimination in granting other non-pecuniary benefits of employment, such as choice assignments. If this is indeed the case, then the non-pecuniary benefits of employment would be greater for men than for women, ceteris paribus; and we would thus expect turnover of women to be higher than that of men.

[11]This result differs from that obtained by Pencavel, among others -- Op.Cit., Chapter III. However, this difference may be due to the presence here of an explicit variable measuring training. That is, in the absence of an explicit measure of taining, Pencavel's measure of female employment may be picking up differences in turnover due to differences in investment in training, while here, the training variable will pick up these differences.

[12]It should be noted here that G is expressed in ratio form, and hence, has a mean value of the order of 1.02 or 1.03.

[13]That is, in comparing equation (3.1c) with equation (3.1a), for example, the addition of the smaller districts increases the number of observations by almost 25 percent, and at the same time increases the elasticity of K with respect to G by almost 50 percent. In this connection, it is interesting to note that in comparing the equations run without G to those run with G, the increase in the R^2 resulting from the addition of G was over 50 percent for all districts, while it was only 33 percent for the larger districts. This implies, then, that fluctuations in G have a greater impact in explaining variations in K for small districts than for large districts.

[14]One might argue that the appropriate specification of the salary variable should have been $\overline{S}$, the average salary paid in the district. However, $\overline{S}$ is derived from the product of two matrices -- the salary schedule, and the distribution of teachers by years of training and experience. Hence, $\overline{S}$ is determined by both the opportunities for pecuniary returns and two factors which themselves are related to non-pecuniary returns. Since we are presumably concerned here with the opportunities for pecuniary returns (i.e., the other factors are specifically taken account of in the regression equations), some measure of the level of the salary schedule is most appropriate.

[15] For example, see Arthur Ross, "Do We Have a New Industrial Feudalism?" <u>American Economic Review</u>, Dec., 1958, pp. 903-920; and John Pencavel, <u>Op.Cit.</u>, pp. 41-51.

CHAPTER IV

ECONOMY OF SCALE AS A COST FACTOR IN THE OPERATION OF SCHOOL DISTRICTS

IV.1. THE FRAMEWORK FOR ANALYSIS

Community concern over the rising costs of providing public primary and secondary education is widespread. In many cases, taxpayers have refused to ratify school bond proposals -- arguing in the process that they have already been taxed to the hilt to pay for education. In this context, then, it seems quite relevant to ask if there is any relationship been the costs of education and school district size. More specifically, we may ask in a given context whether there is some "optimal" (i.e., cost-minimizing) school district size. The implication, of course, is that if there is such an "optimal" size, consolidation or division of existing districts could serve to lower the cost of public education.

A priori, a case for the existence of a cost-minimizing school district size can readily be developed from basic elements of micro-economic theory, simply by considering the school district as analogous to the firm. The district produces an output, educated students, by using a variety of inputs -- e.g., teachers, physical plant, and administrators. At very low levels of output, indivisibilities of the inputs tend to drive up unit costs. Hence, extremely small school districts may have relatively high per - pupil costs of education due to the improbability of hiring fractional teachers or maintenance men, or more fundamentally to the inefficiency of combining limited inputs.[1]

As school district size increases, it is likely that types as well as numbers of teachers may be combined in increasingly efficient ways, up to a point. The same holds for the organization of schools within a district. Beyond some level of size, however, it is likely that these economies will cease. Two possibilities are then likely: as size increases, costs may remain at their low level, since no further economies are attained with increases in district size, or alternatively, costs may begin to rise again, as districts become so large as to require relatively high expenditures for administration or for transporting students efficiently.

The preceding discussion suggests that relating unit costs of education to school district size should yield a curve similar to either AB or AC of Fig. 4.1. In the former case, districts of size OM or larger will all have minimal unit costs; while in the latter case, only districts of size OM will have minimal unit costs.

The two-dimensional relationship depicted in Fig. 4.1 is incomplete, however, in that it omits consideration of other variables which are likely to affect unit costs of education. These other variables,by influencing the demand side and/or the supply side of the market for teachers,[2] or other components of unit cost, can result in differences in unit costs among school districts of identical size. For example, if a district has characteristics that make it a desirable place for teachers to live and work, its attractiveness should mean that it is able to hire teachers of given quality at lower cost than a less attractive district of the same size. Similarly, if a district has a relatively high demand for education, it may well hire better teachers and provide better facilities and more diverse programs than other districts, and this higher demand will be reflected in higher per-pupil costs (expenditures) of (on) education.[3]

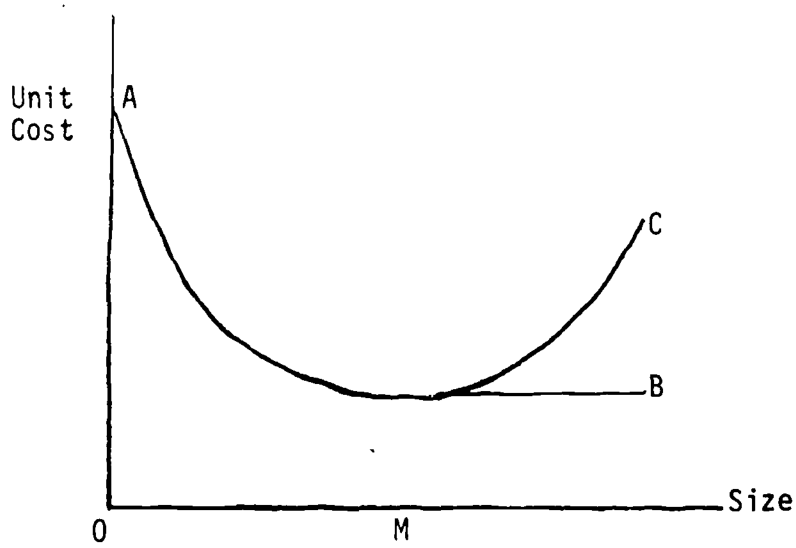


FIGURE 4.1

UNIT COST CURVES AND DISTRICT SIZE

Hence, only after we take account of other variables that may affect unit costs can we examine the relationship between district size and unit costs. Included in these other variables are

V , the equalized property value per pupil. Since a good portion of the operating funds for Alberta's school districts comes from property tax revenues, this variable should directly reflect the ability of each district to pay for education. Presumably, those districts with relatively high equalized property values per pupil will be both more able and more willing to provide better teachers, schools, and other facilities for their students than will districts which are less well-endowed. Thus, V should be positively related to C_n, the measure of current operating costs (expenditures).

E , the median years of education of the adult population of the district. It is likely that, *ceteris paribus*, districts with high values of E will tend to hire relatively well-trained teachers and purchase better facilities than districts with low values of E , and consequently they will tend to have higher operating expenditures. Hence, E should be positively related to C_n .

C , a dummy variable taking the value of one for Catholic districts, and zero for other districts. In Part 2 of Chapter II, it was noted that Catholic districts hire teachers with smaller amounts of formal teacher training than do non-Catholic districts. In Chapter III, we saw that turnover of teachers often tended to be higher in Catholic districts. These two phenomena, taken together, suggest that the unit costs of education will be lower for Catholic districts, since expenditures on teachers' salaries will be less due to the lower levels of training and experience of the teachers. Thus, the estimated coefficient on C should be negative.

R, a vector of four dummy variables to account for the five distinct regions of the province: the large urban centers of Edmonton and Calgary, the smaller urban centers, southern, central, and northern Alberta. In looking at variations in expenditures on teachers' salaries across different regions, there are two components to be separated out: the level of the salary schedule and the placement of teachers on the schedule. Examination of salary schedules indicates that they are somewhat higher in both the large urban areas and the North than in the rest of the province. Looking at the placement or distribution of teachers on the salary schedule across regions, the evidence from Part 2 of Chapter II suggests that the large city districts and the districts in the smaller urban centers tend to hire teachers with relatively large amounts of formal training, while districts in the northern region tend to hire teachers with relatively small amounts of formal training. Taking this information in conjunction with what we know about the level of salary schedules by region, the implication is that unit costs will tend to be relatively high in both the large and small cities. In the northern region, the two components of expenditures on teachers' salaries have their effects in opposite directions -- hence, the net effect is indeterminate.

G, the percentage rate of growth from the preceding year to the current year of the number of pupils in the district. The thrust of Part 1 of Chapter II was that school districts do not adjust their stocks of teachers fully from year to year in response to changes in desired stock -- and in fact, districts make up only a fraction of the discrepancy between desired stock and previous actual stock. If we accept the growth rate of numbers of pupils as a proxy for the discrepancy between desired stock and previous actual stock, it follows that G should be inversely related to C_n . Let us consider two districts identical in size and other independent characteristics, except that one had 10 percent fewer and the other 10 percent more pupils last year. The implication of the stock-adjustment model is that the former district will employ fewer teachers this year than the latter district and hence unit costs will be lower in the district that experienced growth.[4]

An additional case may be made for a negative relationship between growth and unit costs of education. To the extent that tenure provisions impair a district's ability to pare down its teaching staff in the case of a reduction in district size, low (i.e., negative) values of G will be associated with relatively high values of C_n . More generally, it seems plausible to suggest that growth imparts a certain flexibility which can be utilized to lower the unit costs of education.[5]

<u>D , a dummy variable taking the value of one for school divisions and counties, and zero for all other school districts.</u> This variable is included to take account of the broad geographic area of the divisions and counties, as compared to other districts, and the consequent high expenditures by the divisions and counties for conveyance and maintenance of pupils. The estimated sign on D

should be positive, and the value of the coefficient should give a general notion of the additional cost of conveyance and maintenance of pupils for divisions and counties as compared with other school districts.[6]

The variables discussed above should account for a good portion of the variance in the unit costs of education across school districts. In addition, of course, district size is included as a variable.[7] In order to allow for curves similar to those in Fig. 4.1, district size is introduced as a quadratic term -- with both P and P^2 . Hence, we shall estimate:

$$C_n = a_0 + a_1 P + a_2 P^2 + a_3 D + a_4 V + a_5 E + a_6 C + + a_7 R1 + a_8 R2 + a_9 R3 + a_{10} R5 + a_{11} G , \qquad (4.1)$$

where

C_n = per-pupil expenditure on education, net of debt charges and contributions to building and loan fund, expressed in dollars ;

P = hundreds of pupils;

D = dummy variable for school divisions and counties;

V = equalized assessed property value per pupil, expressed in tens of thousands of dollars;

E = median years of education of adults;

C = dummy variable for Catholic districts;

R1 = dummy variable for districts in Edmonton and Calgary;

R2 = dummy variable for school districts in the smaller cities;

R3 = dummy variable for northern Alberta;

R5 = dummy variable for southern Alberta;

G = percentage rate of growth of pupils.

We expect to find

$$a_2, a_3, a_4, a_5, a_7, a_8 > 0 \quad \text{and} \quad a_1, a_6, a_{11} < 0 \ .$$

IV.2. EMPIRICAL RESULTS

Equation (4.1) was estimated across all school districts in Alberta[8] for the 1967-68 school year.[9] In addition, since we are concerned largely with the curve relating unit costs to district size, the equation was re-estimated without the four districts from Edmonton and Calgary, in order to see if these districts -- with very large values for P -- were unduly affecting the regression. Finally, the equation was estimated without very small districts (i.e., those with less than 100 pupils). These districts usually cover just the elementary grades; hence, the structure of costs may be somewhat different for them than for larger districts.

In looking at these three estimated forms of equation (4.1), it was readily apparent that the omission of the four districts from Edmonton and Calgary made a substantial difference in the estimated partial relationship between per-pupil costs and district size. In addition, the estimated values of the coefficients on several of the other variables differed as well, depending on whether or not the four largest districts were included. To surmount this problem, an alternate specification of the district size variable was used -- viz., the natural logarithm of the number of pupils. Hence, in the context of equation (4.1) as presented above, the estimated equations substitute the term

$$a_1 \ell nP \quad \text{for} \quad a_1 P + a_2 P^2 \qquad \text{and}$$

we expect

$$a_1' < 0.$$

In comparison with the quadratic term for district size --which yields a curve similar to AC of Fig. 4.1, the logarithmic specification results in a curve similar to AB of Fig. 4.1 (except that the curve will continue to decline as size increases, but at an ever-decreasing rate). This specification is the one used to generate equations (4.1a), (4.1b), and (4.1c) of Table 4.1, and these three forms are for all districts, all districts except those in Calgary and Edmonton, and all districts with over one hundred pupils, respectively.[10]

In general, the three equations in Table 4.1 suggest that the framework developed above is a fairly good one. Between 57 and 62 percent of the variance in unit costs across districts can be explained by the dependent variables. With but one exception, those variables for which there was an <u>a priori</u> expectation as to the sign of the coefficient had the expected sign, and the coefficients were significant as well. Also, it is clear that the logarithmic specification of district size results in equations (4.1a) and 4.1b) being virtually identical. Thus, the partial relationship between per-pupil costs and district size and those between costs and each of the other independent variables are unaffected by the omission of the four large districts. This, in turn, is one reason why the logarithmic specification is favored

TABLE 4.1

COEFFICIENTS OF THE COST EQUATION (4.1)

Dependent Variable = C_n (mean = $\begin{Bmatrix} 554.4 \\ 555.6 \\ 551.2 \end{Bmatrix}$ for Equation $\begin{Bmatrix} 4.1a \\ 4.1b \\ 4.1c \end{Bmatrix}$)

Independent Variables (t values in parentheses)

Equation* (number of observations)												
4.1a (143)	755.8 (9.2)	-39.7 (-4.0)	146.2 (5.7)	43.8 (2.2)	-0.69 (-0.1)	-94.4 (-4.3)	220.2 (3.2)	70.7 (2.4)	13.3 (0.6)	20.0 (1.1)	-2.22 (-2.5)	0.575
4.1b (139)	755.9 (9.1)	-39.7 (-3.9)	146.1 (5.6)	43.7 (2.1)	-0.65 (-0.1)	-94.7 (-4.2)	--- ---	70.7 (2.4)	13.3 (0.6)	19.9 (1.1)	-2.22 (-2.4)	0.572
4.1c (131)	628.5 (7.1)	-29.5 (-2.6)	126.9 (5.4)	114.1 (4.6)	.98 (0.3)	-63.1 (-2.6)	146.3 (2.1)	46.3 (1.7)	24.6 (1.2)	8.0 (0.5)	-1.11 (-1.2)	0.620
mean of variable for 4.1a		6.68	0.41	0.57	7.9	0.35	0.03	0.11	0.16	0.27	2.20	---

C_n = per-pupil expenditures on education, net of debt charges and contributions to building and loan fund, expressed in dollars;

P = natural logarithm of the number of pupils;

D = dummy variable for school divisions and counties;

V = equalized assessed property value per pupil, in tens of thousands of dollars;

E = median years of education of adults;

C = dummy variable for Catholic districts;

R1 = dummy variable for districts in Edmonton and Calgary;

R2 = dummy variable for districts in the smaller cities;

R3 = dummy variable for districts in southern Alberta; and

G = percentage rate of growth of pupi

*Equation 4.1a covers all districts, 4.1b covers all except those in Calgary and Edmonton and 4.1c covers all with over one hundred pupils.

over the quadratic specification for district size.[11]

The coefficients on V suggest that wealthier districts do indeed spend more on education than their less wealthy neighbors. In addition, the increase in both the size and significance of the coefficient when the very small districts are omitted from the regression is noteworthy; however, the quantitative impact of V on C_n is still quite small, the elasticity in this case being just over .11.

The coefficients on E, education of adults, had the wrong sign in two of the three equations, and were not significantly different from zero in any case. The hypothesis that the amount of education of the adults in a district will be positively related to per-pupil expenditures on education by the district is thus not borne out by the data.[12]

The dummy variable for Catholic districts has a highly significant coefficient, indicating (for all districts) that Catholic districts spend almost a hundred dollars less per pupil than do non-Catholic districts, *ceteris paribus*. When the extremely small districts are omitted, both the size and significance of the estimated coefficient on C decline in absolute value, suggesting that differences in expenditure levels between Catholic and non-Catholic districts are most pronounced among small districts.

The coefficients on the regional dummy variables are significant and in the expected direction for the two cases where there was an *a priori* expectation and insignificant in the other two cases. Taking school districts in central Alberta as the base group, we find that districts in the urban areas spend more per pupil on education, with the differential being greater for the two large cities than for the smaller urban areas. It would appear that the effect on unit costs of high salary schedules in the North is mostly offset by the relatively low levels of teacher training.

The growth variable has the expected negative coefficient. However, the small size of the coefficient, taken in conjunction with the mean of G(2.1) and the mean of C_n(554), results in an elasticity of the order of .01. Thus, while there does appear to be a relationship between the rate of growth of the number of pupils and unit costs of education, the quantitative impact of growth on costs is extremely small.

The dummy variable for school divisions and counties has a highly significant coefficient, indicating that these geographically broad school units spend almost one hundred and fifty dollars more per pupil than do the rest of the school districts in the province, ceteris paribus. When the very small school districts are omitted from the regression, the size of the estimated coefficient declines, suggesting (not surprisingly) that the small districts have very low per-pupil expenditures on conveyance and maintenance of pupils and on any other factors affected by geographic dispersion of the district.[13]

As noted above, the logarithmic specification for district size seems preferable to the quadratic specification on two counts; its use results in a greater proportion of the variance of C_n being explained, and the equations generated by the two different samples represented by (4.1a) and (4.1b) in Table 4.1 are virtually identical with the logarithmic specification, while being considerably different with the quadratic specification. The estimated partial relationship between unit costs of education and district size thus is similar to curve AB of Fig. 4.1. More precisely, estimated unit cost continuously declines as district size increases, but at a declining rate. Hence, the curve relating cost to size flattens out as size increases.

In addition to noting the shape of the curve relating unit costs to district size, we can also note the responsiveness of cost to changes in size -- i.e., the elasticity. The elasticity of cost with respect to district size is given by the coefficient of $\ln P$ divided by C_n. Evaluated at the mean of C_n, the elasticity is just under .1. Thus, while the relationship between cost and size is highly significant, the responsiveness of cost to changes in district size is relatively limited.

Before going on to consider the implications of the estimated equations, it should be noted that, as Part 2 of Chapter II indicated, larger districts tend to hire teachers with greater amounts of formal training. Hence, the inverse relationship between unit costs and district size exists in spite of the fact that there is a generally positive relationship between teacher training and district size.

IV.3. SUMMARY AND IMPLICATIONS

Using variables that attempted to account for differences across school districts in attractiveness to teachers, demand for education, and structural factors affecting per-pupil expenditures, we were able to explain roughly sixty percent of the variance of per-pupil costs of education. In addition to ascertaining the direction and quantitative impact on unit cost of each of the other variables, we noted that a good specification for the district size variable was one which implied that unit costs decline continuously (although at a declining rate) as district size increases, ceteris paribus.

Returning to the original question -- is there a cost-minimizing district size, other things equal? -- the three estimated equations might seem at first glance to suggest that the cost-minimizing district size is one which would encompass all of the students in Alberta. Aside from the problems attendant on projecting a curve substantially beyond the range of points over which it was fitted, however, the one-district answer also runs into other problems. The most noticeable of these is that, given the spatial distribution of the population, consolidation of school districts to achieve greater district size has cost-increasing consequences.

That is, consolidation would ultimately result in many cases in geographically disperse districts and presumably, the higher costs of education currently borne by dispersed districts would also fall on new consolidated districts. Hence, the decline in per-pupil costs of education associated with increases in district size would be offset by cost increases associated with geographic dispersion of districts. On the basis of the estimated coefficients on P and D , one might make some estimates of the net effect of consolidation. However, since cost increases concomitant with consolidation are likely to vary substantially according to the geographic distribution of pupils in the particular area, such estimates would not be especially useful.

The thrust of the above two paragraphs, then, is that consolidation of school districts, if begun with proximate and compact districts, will result in lower per-pupil costs of education, but as consolidation begins to take in more distant districts, the increased costs associated with operating a very dispersed district will probably outweigh the economies of scale attributable to the increase in district size. Hence, there is no single "optimal" district size -- the "optimal" size district for an area depends considerably on the density of population for the area.[14]

Finally, there is one additional but very significant point to be made -- viz., that one must take account of the quality of education associated with district size. In order to argue for consolidation of school districts as a way to reduce the costs of education, one must assume that the quality of education is either invariant or positively related to district size.[15] Indeed, there is conceivably a district size which maximizes educational "benefits" per pupil and there is no reason to assume that this size will also be that which minimizes educational costs per pupil.

If the amount of formal training which teachers have is viewed as an important factor in determining the quality of education offered by a district, the evidence from Part II of the first essay suggests that quality and size are positively related. However, there are a number of factors -- both quantitative and, perhaps even more important, qualitative -- which go into making up the "quality" of education offered by a school district, and an adequate discussion of these factors and the relationship between quality and district size is beyond the scope of this essay. Suffice it to say that consolidation of school districts in order to achieve economies of scale and thereby lower unit costs must necessarily be preceded by consideration of the impact of consolidation on the quality of education that is offered.

FOOTNOTES FOR CHAPTER IV

[1]In addition, the small-sized school buildings that such districts would require would probably cost more to construct per unit of area than larger buildings; but since the data used refer to costs net of capital servicing and construction costs, arguments reflected in these costs will not be developed in the text.

[2]In the discussion below of variables affecting components of unit cost, much emphasis is placed on factors affecting the demand for and supply of teachers. This emphasis is due to the fact that expenditures on teachers' salaries and expenses amounted to almost 70 percent of net costs for the school year studied (1967-68).

[3]That is, costs and expenditures are identical. Hence, explanation of variations in this measure must account for factors affecting each aspect.

[4]A point is suggested here that is implied above and that will be discussed more fully below -- viz., that lower unit costs may simply signify a lower quality of education being offered by the district. If one views the student-teacher ratio as an important element of the quality of education, then it can be argued that the growing district in the example above is enjoying lower unit costs only at the expense of some quality in the education which it offers.

[5]For example, a growing district making new hires has the option of hiring teachers whose training and experience levels make their salaries lower than the average salary paid to experienced teachers in the district. Hence, a growing district may -- if it chooses to do so -- lower the average cost of a teacher from one year to the next, while a non-growing district may not have this option open to it.

[6]Ideally, an explicit measure of population density would be more desirable here, but practical problems make this unfeasible.

[7]One might argue that the salary level and average training of teachers should be included in the equation. The endogenous aspects of these variables would undercut their usefulness in explaining variations in costs, however. Instead, the exogenous variables used may be seen as serving also as instruments for these omitted variables.

[8]With the exception of six districts operated by the Department of National Defense, for which cost figures were not available.

[9]Cost figures were available on a calendar year basis; the figures for 1967 and 1968 were weighted in a 1:2 ratio to arrive at figures for the school year.

[10]The estimated equations with the quadratic specification are presented in Appendix C for purposes of comparison.

[11]The other reason is that more of the variance of unit costs is explained with the logarithmic specification than with the quadratic specification, ceteris paribus.

[12]As was the case at times in the previous chapters, the measurement error in this variable may well tend to bias the coefficient toward zero (see footnote 8, Chapter II). In this connection, it is interesting to note that the estimated coefficient moves in the right direction when the extremely small districts are omitted from the regression -- and these districts are where the measurement error is greatest. Hence, it may be that if the regression only consisted of observations of sufficiently large districts, the expected sign on E would be obtained.

[13]That is, the value of the estimated coefficient on D will reflect not only the differential that school divisions and counties pay for conveyance and maintenance of pupils, but also it will reflect any other differentials in expenditure levels associated with the geographic dispersion of these districts. For example, if dispersed districts have to pay higher salaries than other districts in order to attract teachers of given quality, then their per-pupil expenditures will be higher, ceteris paribus. Examination of expenditure figures on a disaggregated basis suggests that roughly two-thirds of the coefficient on D is attributable to differences in conveyance and maintenance of pupils, so presumably, the remainder reflects differences in expenditure levels attributable to dispersion, but due to other factors.

[14]Before it seems as though we are backing away from drawing any substantive conclusions, it should be noted that it seems quite likely that substantial economies in terms of costs would be made by consolidation of many of the small districts in Alberta, and it is quite likely that economies could be gained as well through consolidation of a number of the larger districts as well. However, the important point to note is that attention to specific conditions in

each individual case is crucial in determining the desirability of consolidation.

[15]In this regard, it is of interest to note Kiesling's study, in which there was empirical evidence indicating that size of school district was negatively related to performance of students on achievement tests. Herbert J. Kiesling, "Measuring a Local Government Service: A Study of School Districts in New York State", The Review of Economics and Statistics, August, 1967, Vol. XLIX, No. 3, pp. 356-367.

CHAPTER V

CONCLUSIONS AND IMPLICATIONS

The empirical work of the preceding three chapters has considered three distinct aspects of the economics of education in Alberta. In Chapter II, the demand for teachers was examined, using an analogy between the school district and the firm. This examination led to the conclusion that in order to understand this demand, one must take account of both the determinants of the desired stock of teachers and the lag of adjustment of the actual stock to the desired stock.

The estimates of this lag suggest that roughly half the difference between desired stock and (previous) actual stock will be made up in any one year. Hence, several years will be required to make up 95 percent of such a difference generated by a once-and-for-all change in desired stock away from an equilibrium position. In addition, the desired-stock demand functions implied by the empirical work indicate that the sole factor with considerable impact on the desired stock of teachers is pupil enrollment. The salary level of teachers is generally significantly related to the desired stock of teachers, but the partial elasticity is equal to only about -.10, and the per-pupil wealth of school districts -- which was expected to be positively related to desired stock -- was not significant at all.

The second part of Chapter II looked at some aspects of the demand for teacher quality. In particular, an attempt was made to explore the relationship between the structure of the salary schedule and the distribution by years of training of newly hired teachers. This attempt failed, however, when it proved impossible to specify an appropriate equation which was identified in practice. Alternatively, a reduced-form equation was estimated, with average training of newly hired teachers as the dependent variable. This equation indicates that average training of new teachers increases with district size (although at a declining rate), is positively related to the education of adults in the school district, is lower for Catholic districts, and is not affected by variations in per-pupil wealth.

Taking the chapter as a whole, an interesting point emerges: contrary to our initial expectations, per-pupil wealth (i.e., equalized assessed property value) was not significantly related to either the quantitative demand for teachers or to the training of newly hired teachers. One is tempted to infer that the Alberta School Foundation Program has been successful in its efforts to compensate relatively poor school districts. In the absence of a more well-defined test of this hypothesis, such a conclusion can not be firmly drawn; however, the evidence does at least provide primae facie support for this contention.

In Chapter III, the mobility of teachers across school districts was examined. The analysis was based on a human capital approach, with pecuniary and non-pecuniary returns of current and alternative employments viewed as determining mobility. Observations of turnover are available on a school district, rather than an individual, basis; consequently, the variables describing pecuniary and non-pecuniary returns consisted of characteristics of the district's teaching force and of the district itself.

Among the characteristics of the teaching force, three factors stand out: experience, age, and training distributions of teachers. The greater the proportion of teachers who have little experience in the district and/or who are young, the higher will be the turnover of teachers. The relationship between turnover and training of teachers is slightly more complex: districts with relatively high or relatively low levels of average training of teachers experience lower turnover than districts with intermediate levels of average training. Two district characteristics related to turnover are size and growth of the teaching force. Up to a substantial district size, turnover declines as size increases, at a declining rate. The greater the rate of growth (and consequent creation of new positions) in a district, the less will be the turnover of teachers.

The results of Chapter III lend support to the use of a human capital approach in attempting to ascertain the determinants of the mobility of teachers. Somewhat surprisingly, however, the salary variable was insignificant. In addition, there is no support in the data for the "industrial feudalism" hypothesis applied to Alberta teachers.

In Part I of Chapter II, both the desired-stock demand functions and the equations with the teacher-pupil ratio as the dependent variable implied that there are economies of scale in the operations of school districts. That is, both desired and actual teacher-pupil ratios tended to decline as district size increased. This implication is developed more fully in Chapter

IV. Examination of variations in operating costs/expenditures across school districts must take account of expenditures on teaching services, since these expenditures are a majority of total costs. Part 2 of Chapter II provides some information in this regard, and making use of this information enabled us to explain roughly 60 percent of the variance in operating costs/expenditures across districts.

There do indeed appear to be economies of scale in the operation of school districts, in spite of the fact that larger school districts tend to hire teachers with more training than do smaller districts. It is not possible, however, to describe a (cost-minimizing) "optimal" school district size, since costs will be influenced by the density of population. At the same time, it is quite likely that given the distribution of the population in Alberta, consolidation of some of the very small and some of the not-so-small school districts currently in existence would result in a lowering of the per-pupil costs of education.

The analysis of this study has been at the microeconomic level, with the school district as the focus of analysis. This has been done, at least in part, to provide a fuller understanding of the structure underlying various aggregates pertaining to Alberta education. We may at this point inquire into the implications of the above analysis for some of these aggregative considerations.

Much discussion has taken place concerning the "end" of the teacher shortage in Alberta.[1] This "end" is coincident with the levelling off of provincial school enrollments in conjunction with continued increases in numbers of university students preparing for careers in teaching. One implication of the stock-adjustment model of Chapter II is that the demand for teachers will not level off as rapidly as enrollment does. That is, even as desired stocks of teachers stabilize, the dynamic lag of adjustment of actual stocks to desired stocks will result in additional hirings for several years. Consequently, projections of "required" numbers of new teachers are likely to be biased downward. Aside from this bias, however, the implied desired-stock demand functions of Chapter II suggest that projections of future demand for teachers in Alberta based primarily on projected enrollments should be fairly accurate. This is due to the dominant role of enrollment in determining desired stock.

In addition, one would ordinarily anticipate that the end of a longstanding shortage of teachers would ultimately result in a substantial decline in the rate of growth of salaries offered to teachers. The desired-stock demand functions estimated in Chapter II suggest that this need not be the case, however, since the elasticity of demand with respect to the salary level of teachers is quite low. In such a case, teachers' organizations will be able to continue to push for substantial salary increases without having to worry about consequent declines in employment. School boards in this situation may well be tempted to substitute cheaper (i.e., less well-trained) teachers for more expensive teachers, but this will become increasingly difficult in the face of actual and anticipated increases in the minimum training required of new teachers. The implication of the demand function, then, is that teachers will be able to retain a strong bargaining position in spite of the end of the teacher shortage.

Consideration of the gross demand for teachers must take account of teacher turnover; and we may ask in turn what is likely to happen to turnover in the future.[2] Three of the determinants of turnover seem to be most likely to change: the proportion of teachers who are new to the district, the net growth in numbers of teachers, and the average training of teachers. As enrollments -- and consequently, desired stocks of teachers -- level off, rates of growth will do the same. This decline in the creation of new positions will result in an increase in turnover, <u>ceteris paribus</u>. At the same time, the decline in growth will also result in more experienced teaching forces, which will lead to lower turnover. Average training of teachers will no doubt continue to increase, ultimately with dampening effects on turnover. The net impact of these changes on the mobility of teachers is indeterminate in the absence of more detailed analysis; but the view here is that as the professionalism of the Alberta teaching force increases, it is most likely that teacher turnover will decline. If this is indeed the case, it means that the gross demand for new teachers will be lower than that anticipated by those who project constancy of turnover.

In summary, we have examined the determinants of three aspects of education in Alberta: the demand for teachers, the mobility of teachers, and costs/expenditures on education. There are aggregate implications of the analysis, but in the main, the information generated was of a micro-economic nature. Hopefully, this information will provide us with a greater understanding of the structure of these aspects of education in Alberta.

In addition, the methods of analysis used -- in which the analogy is made between the school board and the business firm, and implications for school board behavior are drawn from the theory of the firm -- appear to be quite useful. Hence, while the parameters obtained are specific to Alberta, the analytical approach is seen here as a useful one in examining how school boards in general function.

FOOTNOTES FOR CHAPTER V

[1] For a good general summary of the evidence and description of future prospects, see G. Loken, "Quantitative and Qualitative Aspects of Teacher Demand and Supply", (mimeo), Alberta Universities Commission, Staff Study No. 5, December, 1969. The discussion here will attempt to supplement rather than duplicate that of Dr. Loken.

[2] Since the use of cross-section results to predict time trends is a tenuous procedure, the predictions which follow must be viewed as tentative, at best.

APPENDICES

APPENDIX A

A TEST OF THE ADVISABILITY OF POOLING TIME-SERIES AND CROSS-SECTION DATA[1]

Implicit in the practice of pooling time-series and cross-section data is the assumption that the structure of the estimated relationship is invariant both over time and across school districts. Pooling of the data was done in both Chapter II and Chapter III; consequently, it was felt advisable to test this assumption explicitly.

A residual from a pooled equation will be denoted as ε_{ij}, where i denotes the district and j denotes the year. Consider

$$\frac{\sum_{i=1}^{n} \varepsilon_{ij}}{n} = \bar{\varepsilon}_{\cdot j} ,$$

the average residual for the j^{th} year. By our hypothesis that the year makes no difference, $\bar{\varepsilon}_{\cdot j}$ should have an expected value of zero. Similarly, the term

$$\frac{\bar{\varepsilon}_{\cdot j}}{\sigma_{\bar{\varepsilon}_{\cdot j}}}$$

will be distributed normally with mean of zero and variance of one. The term $\sigma_{\bar{\varepsilon}_{\cdot j}}$ is given by $\frac{SEE}{\sqrt{n}}$, where SEE is the standard error of estimate of the pooled regression.

The sum over all years of squared deviations of $\bar{\varepsilon}_{\cdot j}$ from its expected value divided by its standard error will be distributed as a chi square, with t-1 degrees of freedom (where t=the number of years). Since the expected value of $\bar{\varepsilon}_{\cdot j}$ is zero, this term reduces to

$$\sum_{j=1}^{t} \left(\frac{\bar{\varepsilon}_{\cdot j}}{\sigma_{\bar{\varepsilon}_{\cdot j}}} \right)^2$$

Here lies the basis for our test: if the term above is significantly different from zero, then we must reject the hypothesis that the expected value of $\bar{\varepsilon}_{\cdot j}$ is zero. That is, we are hypothesizing that the year that an observation is from should make no difference, and consequently, the value of the average residual for a given year should equal the value of the "average" residual for the equation as a whole -- viz., zero. If it does not, this means that the year does indeed make a difference and this will be reflected in an increased size of the term to be tested.

To apply the test across districts rather than years, we compute

$$\frac{\sum_{j=1}^{t} \varepsilon_{ij}}{t} = \bar{\varepsilon}_{i\cdot} \quad .$$

$$\frac{\bar{\varepsilon}_{i\cdot}}{\sigma_{\bar{\varepsilon}_{i\cdot}}} \sim N(0,1) \ , \quad \text{and}$$

$$\sum_{i=1}^{n} \left(\frac{\varepsilon_{i\cdot}}{\sigma_{\bar{\varepsilon}_{i\cdot}}} \right)^2 \sim \chi^2(n-1) \quad .$$

These two terms were each computed for one equation from Chapter II and one from Chapter III, and tested for their significance. The terms were insignificant across districts but significant across years in both cases. The implication, then, is that the estimated relationships are invariant across districts, but that there may be some change over time.

Examination of $\bar{\varepsilon}_{\cdot j}$ reveals no particular pattern -- e.g., alternating positive and negative, or half the period positive and the other half negative -- and in fact, the significance of the test in each case was due to high values of $\bar{\varepsilon}_{\cdot j}$ in the last two years covered by the equations. We attempted to ascertain whether there were any factors which distinguished these years from the other years in the sample, but we could not do so.

FOOTNOTES FOR APPENDIX A

[1]This test was originally suggested and subsequently formulated and developed by Dan Hamermesh. I thank him.

APPENDIX B

METHODOLOGY USED IN DERIVING OBSERVATIONS ON TURNOVER

The data used to compute turnover rates are those obtained in the annual DBS survey of Alberta school teachers. For a given district, the turnover rate, K , is determined as follows: let

T_t = the actual number of teachers in the district this year·

T_{t-1} = the actual number of teachers in the district last year;

T_t^o = the number of teachers in the survey who are new to the district;

T_t^x = the number of teachers in the survey who have experience teaching in the district.

To determine the turnover rate from last year to this year, we must know how many of this year's teachers were teaching in the district last year. If the survey covered every single teacher, this figure would simply be T_t^x , for all practical purposes. Since the survey is not so complete, the figure had to be estimated. Assuming that responses to the survey are not biased on the basis of experience of the teacher in the district, then $\frac{T_t^x}{T_t^x + T_t^o}$ would give us the proportion of experienced teachers in the district and multiplying this by T_t would give us an unbiased estimate of how many of this year's teachers were teaching in the district last year. Subtracting this figure from T_{t-1} gives us the turnover, and dividing by T_{t-1} yields the turnover rate. Hence,

$$K = \frac{T_{t-1} - T_t\left(\dfrac{T_t^x}{T_t^x + T_t^o}\right)}{T_{t-1}} \quad . \tag{B.1}$$

K, then, is estimated indirectly, rather than observed directly. This produces some problems, however, since, as can be seen in equation (B.1), the probability that K will accurately reflect the true turnover rate is positively related to the fraction $\dfrac{T_t^x + T_t^o}{T_t}$. That is, as the sample size converges toward the full number of teachers, the likelihood of the sample representing the true proportion of experienced teachers increases. Hence, the reliability of K is closely related to the fullness of coverage of the DBS sample.

In estimating equations with K as the dependent variable, therefore, a certain amount of the variance of K will be due to differences in the representativeness of the sample across districts. As the discussion above suggests, this "excess variance" may be reduced by imposing a constraint such that observations would not be included in the equation unless the relevant sample was some specified percentage of the actual number of teachers in the district. In the limit, we would make the percentage 100, and presumably the excess variance would be completely eliminated. However, this would leave us with so few observations as to make the resulting equations of doubtful validity. To balance off the competing demands for accuracy of K on the one hand and a sufficient number of observations on the other, we have set the constraint at 90 percent. Thus, in order to be included in the estimated equations, a district must satisfy the condition:

$$\frac{T_t^x + T_c^o}{T_t} \geq .90 \quad . \qquad (B.2)$$

Imposition of this constraint reduced the number of observations in the estimated equations by almost 40 percent, yet still left us with almost 500 observations. The concomitant reduction in the excess variance associated with the dependent variable K is felt to be sufficient to justify this procedure.

APPENDIX C

COST EQUATIONS WITH QUADRATIC SPECIFICATION OF THE DISTRICT SIZE VARIABLE*

The equations below correspond to equations (4.1a), (4.1b), and (4.1c) of Chapter IV

Independent Variables (t values in parentheses)

Equation	Constant	P	P^2	D	V	E	C	R1	R2	R3	R5	C	R2
(4.1a')	517.3 (9.9)	-1.84 (-2.5)	0.0019 (2.3)	101.0 (4.6)	67.2 (3.4)	0.37 (0.1)	-76.7 (-3.4)	351.2 (2.4)	35.6 (1.3)	23.0 (1.1)	18.8 (1.0)	-3.35 (-3.9)	0.545
(4.1b')	561.6 (10.2)	-6.93 (-3.0)	0.078 (2.3)	147.7 (5.0)	53.9 (2.7)	-1.3 (-0.2)	-92.0 (-4.0)	--- ---	59.7 (2.0)	18.0 (0.8)	18.6 (1.0)	-2.92 (-3.3)	0.562
(4.1c')	452.3 (9.7)	-1.52 (-2.3)	0.0016 (2.2)	107.5 (5.3)	124.9 (5.2)	1.66 (0.3)	-46.5 (-2.2)	274.3 (2.2)	30.8 (1.2)	26.8 (1.3)	9.9 (0.6)	-1.38 (-1.6)	0.617

* For explanatory notes to this table, please see Table 4.1

APPENDIX D

R^2 FOR EQUATION (1.11'), FOR VARIOUS VALUES OF γ

	SAMPLE			
γ	A	B	C	D
-5.0	0.063	0.072	0.055	0.063
-2.0	0.307	0.311	0.316	0.314
-1.0	0.402	0.401	0.412	0.403
-0.75	0.421	0.418	0.432	0.422
-0.50	0.437	0.433	0.451	0.439
-0.25	0.451	0.445	0.468	0.455
0	0.463	0.456	0.482	0.469
+0.25	0.473	0.464	0.495	0.480
+0.50	0.480	0.469	0.503	0.487
+0.75	0.483	0.471	0.507	0.490
+1.0	0.481	0.468	0.504	0.487
+2.0	0.397	0.377	0.401	0.378
+5.0	0.102	0.096	0.124	0.103

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