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THE DEMAND FOR GRADUATE EDUCATION IN THE U.S.A.

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INTRODUCTION

Graduate education is of considerable interest and a matter of much concern to laymen, policy makers, researchers and School administrators. The demand for graduate education increased substantially during the 1960's. For exemple, in the United States, in 1960, the number of new enrollees in master's and doctoral program was 197,000 and this figure reached 525,000 by 1971. During this period, new enrollments trended upward, except for the year 1971 when it dipped slightly.

If we measure the first year enrollments in graduate programs in the United States relative to the number of bacherol's degrees awarded, then the ratio for these years does not form any trend but shows fluctuations.

Within the past two decades, economic theorists and empirical researchers have dealt increasingly with the problems related to human capital. Most of the work is done to calculate the rate of return form four year college education. The literature on the demand for education estimation appears to begin in 1967 (2)

A search of the literature reveals that no attempt has been made either to calculate the rate of return or to estimate the effect of various economic variables on enrollment demand for graduate education. In view of the importance of the problem, we attempt to estimate the effect of various economic and social factors on enrollment demand for graduate education in the United States.

The purpose of this Study was:

1 To identify selected social and economic variables relating to demand determination for graduate education.
2. To develop an econometric model which allows determination of the influence of various economic variables on the demand for graduate education.
3. To test the relationship and significance of the exogenous variables on enrollment demand at the national level by using time-series data.

THE ANALYTICAL FRAMEWORK

It can be inferred form human capital theory that a college graduate (B.

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S. degree holder) will purchase a graduate education if the present value of the expected stream of benefits resulting form that graduate education is greater than its present cost.

The present value of an individuals graduate education (V) is equal to the discounted stream of gains, associated with graduate education, he or she expects over his or her working life.

$$V = \sum_{t=1}^{n} (V_t) / \quad 1 + r)^t$$

where n = expected number of years remaining in an individual's earning life

V_t = expected gains in year t

r = discount rate, it is assumed for simplicity that the discount rate remains the same in each year.

Graduate education also requires an investment. The present value of the private cost associated with graduate education is:

$$\text{II.} \quad C = \sum^{m} (C_t)/(1+r)^t$$

where m = number of years required to graduate

C_t = expenditures associated with graduate education in year t.

The net present value of gains from graduate education would be:

$$\text{III} \quad V_n = \sum_{t=1}^{n} (V_t)/(1+r)^t - \sum_{t=1}^{m} (C_t)/(1+r)^t$$

The private gains from graduate education is the sum of the additional lifetime earnings resulting from the graduate education and the additional psychic gains attained through broadened occupational opportunities, increased knowledge, prestige and social contacts made possible by the graduate education.

The relevant private cost of graduate education likewise are: 1. Direct monetary outlays such as tuition and fees, cost of books and supplies, and the living expenses attributable to going to school. 2. Opportunity cost; it will be influenced by the prevailing unemployment rate for college graduates. 3. Psych costs such as the burden and pressure of studying, examinations, and for some students the undersirability of being away from home will depend upon the type and quality of the graduate program offered by an institution and the individual's taste for graduate education.

The benefits from graduate education do not come with perfect certainty. Considerable uncertainty always exists about the length of an individuals working life, one of the most important determinants of the returns. Since the gains associated with graduate education will be realized in the future. Their value should be estimated on the basis of prevailing knowledge.

A college graduate, consciously or subconsciously, makes his or her decision to enter a graduate school on the basis of expected benefits and costs associated with graduate education. A college graduate will purchase the graduate education if the present value of gains is positive.

The aggregation of all college graduates for whom the present value of gains is positive will provide the total possible number of graduante enrollments demanded.

The Relation Between the Present Value of Gains and the Demand for Enrollments:

A reduction in the demand for master's and doctoral degree holders, ceteris paribus, would decrease the expected income of the individuals, this resulting in a decrease in their expected present value of gains. Due to the nonavailability of information on the present value of gains over time, one could incorporate variables in the model which, it is believed, affect the expected value of gains. A general rise in the expected money income from graduate education, ceteris paribus, should increase the present value of gains and therefore, increase the demand for graduate enrollments. An increase in the cost of graduate education, in the form of either increased direct outlays or an increase in the opportunity cost should descrease the demand for enrollments. The opportunity cost of graduate education depends, at least in part, upon the prevailing unemployment rate for college graduates. The higher unemployment rate for potential enrollees reduces the opportunity cost of graduate education and will encourage the college graduates to invest in graduate education. On the other hand, a higher unemployment rate for master's and doctoral degree holders will result in lowering the expected earnings of the potential enrollees and discourage them from entering the graduate school. We would expect an inverse relation between the unemployment rate for techinical and professional workers and the demand for enrollments.

Graduate Education as a Consumption Good:

Graduate education may be viewed as a consumption good providing current consumption benefits from social, cultural and athletic activities available to a graduate student. If consumption services from graduate education are a normal or superior good, then an increase in income will result in an increased demand for the number of enrollments.

The law of demand applies to all normal and superior goods. Unless graduate education is a Giffen good, an increase in it's cost (price) will decrease the number of enrollments demanded (5).

The Demand Function:

A formal statement of enrollment demand is given by the following equation:

IV. $E_t = f((RI)_t, T_t, V_t, S_t, U_t, F_t, P_t)$

where:

E_t is the number of new students enrolled in the graduate program in calendar year t. T_t is the average real tuition cost of graduate education incurred by new enrollees. V_t represents the expected real monetary gains associated with graduate education in year t. S_t is the expected economic value from the direct consumption benefits resulting form graduate education as viewed by the potential enrollee in year t. U_t is the unemployment rate for technical and professional workers in the United States in year t.[1]

F_t represents the number of assistentships and fellowships available to new graduate students in year t, and P_t is the number of persons graduating from college during the fall term of year t-1, and winter, spring and summer of year t.

The majority of the graduate students recieve financial support in the form of assistentships (teaching or research assistantships), fellowships, and tuition scholarships. Then tuition (price) is not an important factor determining the enrollment demand for graduate education.

If we assume that psychic gains (S) associated with graduate education do

(1) The majority of the bachelor's degree holders join the graduate school at the end of september of year t. The information on the unemployment rate is released by the federal administration at the begining of the next year. However, we assume that a potential enrollee has some feeling of that unemployment rate at the time he makes his decision regarding graduate education. Information on monetary gains over time is not available. However, the unemployment rate for technical and professional workers will embody the effect of monetary gains variable on enrollment demand.

not change over time, then we can eliminate this variable from the model.

New enrollment data provide the most obvious source of information on demand. Such data are available for only 12 years (1960-71) at the national level. The small number of observations on the endogenous variable limits the number of exogenous variables which can be used in the estimation process. A large number of explanatory variables in the equation would reduce the confidence in our parameter estimates by reducing the number of degrees of freedom. Then the formal statement of the model is given in equation V.

$$\text{V. } E_t = f(U_t, (RI)_t, P_t), \quad t = 1960, 61, \quad 71$$

For equation V to provide a test of our demand model, we assumed that every recent college graduate can find some public or private institution in the United States that will accept him or her, if he or she is willing and can afford to enroll.[2]

There is no *a priori* evidence to justify the contention that a multiplication relation exist between the "potential enrollees" variable and all other explanatory variables as assumed in the previous investigations. (2,3,3,4,4,6).

However, in this study the new graduate enrollment was deflated by the number of college graduates to reduce the expected severe multicollinearity.

The demand function of equation V may be written as:

$$\text{VI. } E_t/P_t = Y_t = F(U_t, (RI)_t) \quad \text{where}$$

Y_t is the first year enrollment ratio and U_t and $(RI)_t$ are unemployment rate mean family income variables as defined earlier.

(2) For supporting views see Blaug(1), Osthiemer (11) and Hopkin(6).

The Econometric Model

The model is specified as:

$$\text{VII. } E_t/P_t = Y_t = \alpha + \beta_1 U_t + \beta_2 (RI)_t + e_t$$

The null hypotheses are that the coefficients (β_1, β_2) are equal to zero. The alternative hypotheses are that β_2 is greater than zero and β_1 is less than zero.

Sources and Nature of the Data:

The data on first year graduate enrollment and the number of bachelor's degrees awarded in various years were obtained from various publications of the U.S. Department of Health, Education and Welfare. (14)

Figures on annual average real family income were calculated form data on mean family income appearing in the publications of the U.S. Department of Commerce (13). These data were deflated by the Consmer Price Index.

The information on the unemployment rate for technical and professional workers was obtained from the Manpower Report of the President (15).

Estimation of the Model.

Using the 12 observations on the new graduate enrollment ratio (Y), the unemployment rate for technical and professional workers (U) and real mean family income (RI), equation VIII was estimated.[3]

$$\text{VIII. } E_t/P_t = \hat{Y} = 0.474 - 0.076U_t + 0.0000381\,(RI)_t$$

$$(3.777) \quad (-2.645) \quad (2.77752)$$

$$R^2 = .6109 \quad F = 7.0665 \quad N = 12$$

(3) A linear relationship was specified between the endogenous and exogenous variables. The analysis was limited to the 1960-71 period because information on the first year graduate enrollments was available for unly that period.

Autoregressive structure of the disturbance term, $\hat{p}$ = 0.29095.[4] The number in the prentheses are t – statistics. The Durbin-Watson d statistics was computed to be 1.09[5].

In the demand equation, both of the coefficients have the expected signs and were significantly different from zero (one tailed test at the .025 level). The F – Value indicates that the overall regresion equation is significant. Plots of the residuals against the endogenous variable and each of the exogenous variables suggested the absence of bias from specification error and heteroskedasticity. A check of the simple correlation matrix (r_{23} + 0.031) did not reveal any evidence of severe multicollinearity. The low value of the Durbin-Watson statistics (d = 1.09348) may create suspicions in one's mind about the violation of one of the important assumptions that successive disturbances are drawn independently of the previous values[6]. If the assumption that the error terms are independent is violated, the least square estimators of the regression coefficients are unbiased and consistant but they are not efficient. KMENTA (9) has pointed out that the estimated variance of the coefficients obtained through least square (O.L.S.) are biased when the disturbances are autoregressive.

To avoid the problem of autocorrelation, a generalized least square (G. L.S.) procedure was used and the estimated equation was:

$$\text{IX. } \hat{Y} - 0.465^7 - 0.062\,U + .000015\,(RI)_t$$
$$(5.252) \quad (-3.030) \quad (1.062)$$
$$R^2 = .523, \quad F = 4.9419, \quad N = 12$$

(4) $\hat{p} = \Sigma\ \hat{e}_t\ \hat{e}_{t-1} / \Sigma\ \hat{e}^2_{t-1}$ (t = 2, 3, n)

(5) $d = \sum_{t=2}^{n} (e_t - e_{t-1})^2 / \sum_{t=1}^{n} e_t^2$

(6) At the .05 level the $d_L < d < d_u$, the test is inconclusive and the researcher is not in a position to acept or to reject the hyphotesis of no autocorrelation.

(7) $a^* = (1 - \hat{p})\ \hat{a}, \hat{a} = \hat{a}^* / (1 - \hat{p}) = 0.6563$

Autoregressive structure of the disturbance term, $\hat{p}$ ü 0.086.

The t-statistics are given in the parentheses below their respective coefficients.

A comparison of equations VIII and IX indicates that there was only a slight change in the value of the regression coefficient for the "unemployment rate" variable. However, the estimated coefficient associated with the "mean family income" variable which was significant (one-tailed test at the .05 level) in equation VIII, became insignificant in equation IX. Care must be taken in interpreting the results because of the questionable validity of the F and t statistics pertaining equation VIII and because of the sensitivity of the coefficients of equation IX to small changes in the data [8].

CONCLUSIONS

When estimating a demand function, economists usually use the least square procedure, which assumes the disturbances from the regression equation to be independent. The ordinary least square (O.L.S.) regression coefficients of variables representing mean family income and the unemployment rate had the expected signs and also were significant. However, the Durbin-Watson test was inconclusive. The method used to corrected for autocorrelated observations is the one suggested by PRAIS and WINSTON (12). Basically, the corrected method used was the generalized least square (G. L.S.) procedure for eliminating the first order autoregressive error term structure.

The estimated coefficient of the family income variable was significant in the O.L.S. equation. The estimated coefficient of the unemployment rate variable in both of the equations was significant.

SUMMARY

The objective of this study was to identify and estimate the effect of va-

(8) See appendix.

rious economic variables on the demand for graduate education in the United States.

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SINOPSE

O objetivo deste estudo foi identificar e estimar o efeito de diferentes variáveis econômicas sobre a demanda para pós-graduação nos Estados Unidos.

Quando se estima a função, em economia se usa o método dos Mínimos Quadrados, assume-se que os erros da equação de regressão são ondependentes.

Os coeficientes da regressão obtidos através do método dos Mínimos Quadrados Ordinários (M.Q.O.) representaram em forma significativa que a renda familiar e a taxa de desemprego tiveram sinais esperados e foram também estatisticamente significativos. Contudo, o teste Durbin-Watson foi inconclusivo. O método usado para corrigir a autocorrelação das observações é o sugerido por PRAIS e WINSTON [12]. Basicamente, o método usado foi o de Mínimos Quadrados Generalizado (M.Q.G.) para eliminar o erro autoregressivo de primeira ordem do termo estrutural.

O coeficiente estimado da variável, "renda-familiar" foi significativo na equação (M.Q.O.). O coeficiente estimado da variável "taxa de desemprego" em ambas equações foi significante.

Policy Implications:

It should, perhaps, be noted that the above conclusions are drawn form the results of a model which, of necessity, could not consider all of the factors potentially important to graduate demand. The specification of the model was constraint by data availability. Nonetheless, despite possible weaknesses in the model the results do support some old hypotheses and generate new ones regarding the demand for graduate education.

The ordinary least square regression coefficient of the mean family income variable supports the general contention that family income is important for in determining who enrolls in graduate education. However, the estimated coefficient of the income variable from the generalized least square suggests that family income is not an important factor influencing the decision of a college graduate to enroll in a graduate school. Thus one should be very cautions in recommending some kind of income enhancing program as vehicles for increasing the enrollment ratio. However because it was not possible to measure the effect of direct financial assistence on enrollment demand, one can not infer that increasing the availability of financial assistence for graduate study would not increase the enrollment demand.

Both of the equations indicate that unemployment rate for technical and professional workers is an important factor in explaining the variation in the enrollment ratio. Improved employment opportunities for master's and doctoral degree holders may be considered a stimulus for increasing graduate school enrollments.

APPENDIX

A comparison between the O.L.S. and G.L.S. estimating procedures will give the readers some idea of the extent of underestimation by O.L.S., as the G.L.S. estimates provide unbiased estimates of variances [20].

Table 4 shows the bias introduced in the variance of the estimated coefficients due to the underestimation of the diagonal elements (C_{ii}) of the $(X'X)^{-1}$ matrix by O.L.S. The value of the total sum of squares (Σy_i^2) for O.L.S. in Table 5 is almost three times larger than that of the Σy_i^2 for the G. L.S. in Table 6.

The critical F-value for (2,9) degrees of freedom at the .05 level is 4.26. The calculated F-values in Table 5 and 6 are significant. The over-all F statistics using O.L.S. is 1.42 times larger than that under the G.L.S. procedure. The value of F from the O.L.S. regression overestimated the real F value by 3.39 times[21]. This suggests that when disturbances are autoregressive and O.L.S. procedures are used, the analysis of variance may be misleading and F and t statistics are not statistical valid.

The residual sum of squares, $\Sigma(Y-\hat{Y})^2$, for the O.L.S. regression equation is 2.37 times higher than that for G.L.S. equation, indicating a much better fit of the data by the G.L.S. equation. Murphy has pointed out that, in the presence of positive autocorrelation, the estimated variance of residuals (σ_e^2) assertion of underestimation by O.L.S. does not hold.

From the previous discussion we saw that the σ_e^2 for the O.L.S equation was 2.37 times larger than the σ_e^2 for the G.L.S. equation. In the case of O.L.S. the real F value was overestimated by 3.39 times. On the other hand, the estimated regression coefficient of the "family income" variable was reduced significantly, suggesting that this coefficient is very sensitive to small changes in the data.

For these reasons one should be very careful in choosing one estimated equation over the other, because these estimated equations may lead to different policy implications.

TABLE 4. C_{ii} Values from the Inverted Matrices and Bias in the O.L.S. Estimation of Variance of $\hat{\beta}_i$.

Elements	O.L.S. (C_{ii})	G.L.S. (C_{ii})	Ratio of the main diagonal elements O.L.S./G.L.S.	Underestimation of O.L.S. variance due to $(X'X)^{-1}$
C_{11}	0.4170656	0.5046495	0.8264	1.22
C_{22}	$9.619793.10^{-8}$	$23.89344.10^{-8}$	0.4026	2.48

TABLE 5. Analysis of Variance: O.L.S. Regression

Source	Degrees of freedom	Sum of Squares	Mean sum of squares	F
Total	1	$4.60838270.10^{-2}$	$4.1894388.10^{-3}$	
Regression	2	$2.81746723.10^{-2}$	$14.0773362.10^{-3}$	
Residual	9	$1.79291547.10^{-2}$	$.9921283.10^{-3}$	7.0665

TABLE 6 Analysis of Variance: G.L.S. Regression

Source	Degrees of freedom	Sum of squares	Mean sum of squares	F
Total	1	$.586\ 3931.10^{-2}$	$1.44194483.10^{-3}$	
Regression	2	$0.83018348.10^{-2}$	$4.15091740.10^{-3}$	
Residual	9	$0.75595583.10^{-2}$	$0.830050922.10^{-3}$	4.9419

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