Junior Colleges and the Demand for Undergraduate Education: Theory and Evidence

DONALD FREY* and ELMORE ALEXANDER**

The demand for undergraduate higher education has been a subject of continuing interest in recent economic literature [4, 5, 6, 7]. These studies have largely ignored the impact of a growing system of junior (two-year) colleges upon the demand for education at four-year colleges and universities. Given the significant growth of the two-year college system, their omission from econometric studies of the demand for college education represents an important, untapped source of knowledge and a potential source of bias. It may well be that the observed demand for undergraduate enrollment in four-year colleges and universities has been vastly different from what it would have been in the absence of an expanding system of junior colleges.

I. Theory

The theory of demand for higher education, unmodified to account for junior colleges, has been developed at length in several articles [2, 4, 5, 6, 11]. The main elements of that theory may be briefly summarized. If higher education is an investment in a productive skill, then an income-maximizing individual would enroll if the present value of the stream of social benefits is greater than the present value of the stream of social costs.

Consequently, the demand for higher education is a function of the rate of interest, the expected earnings differential attributable to college enrollment, the tuition and opportunity costs of college attendance. Hence, interest, the capital market is imperfect so that gifts and loans from relatives, rather than borrowing in the market, are the dominant sources of funds for education [5, 6, 7]. Therefore, ability of families to pay for college is a determinant of the demand for higher education, replacing the rate of interest. (That higher education is simultaneously a consumer good also suggests that the income constraints of families are important determinants of the demand for higher education.)

The functional form of the enrollment equation has varied substantially among published studies. Linear [6], log-linear [2], and first differences of lagged variables [5] have been employed in regression estimates. We prefer the following specification:

\[ R = \alpha R + \gamma R^2 \] (1)

where \( R \) is the per-capita demand for higher education (the ratio of undergraduates at four-year institutions to the total population of potential undergraduates), \( \alpha \) is a constant negative, the \( R \) are coefficients, and the \( R \) are variables. Since \( R \) is a per-capita demand (or "enrollment ratio"), must assume values between zero and one, even when the \( R \) assume extreme values, equation (1), which places asymptotic limits on

\[ R_0 = R_1 + R_2 = R(1 + \gamma) = R^1 \] (2)

where \( R_0 \) is the observed enrollment ratio for four-year colleges, and \( R_2 \) is the enrollment ratio that would have occurred in the absence of any impact by junior colleges on enrollment. The multiplier \( \gamma \) represents the proportion by which the observed enrollment ratio differs from the ratio that would have occurred if junior colleges were completely neutral in their impact. The multiplier \( \gamma \) may be either positive or negative. If junior colleges are substitutes for four-year colleges (or for part of a four-year education), the multiplier \( \gamma \) is negative (\( R_2 < R_0 \)). On the other hand, two years at a junior college are complementary to the last two years offered at four-year colleges. That is, junior colleges may recruit some transfer students for the four-year schools. If junior colleges are complements in this sense, then the multiplier \( \gamma \) should be positive (\( R_2 > R_0 \)). Only if the impact of junior colleges was neutral (\( \gamma = 0 \) due to exactly offsetting substitutionary and complementary effects) would \( R = R_0 \) and only then could equation (1) be estimated as it stands. That \( \gamma = 0 \), of course, would be mere coincidence.

The multiplier \( \gamma \) is itself a function of several

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college enrollment is relatively low, the proportion of junior college students who would have attended four-year colleges in the absence of junior colleges is high. Conversely, when junior college enrollment is relatively high, proportionately more junior college students will be high school graduates who would not have attended a four-year college in the absence of junior colleges. That is, junior colleges have a "core" of students who would have attended a four-year college if not given the option of attending a junior college. In order to expand enrollment beyond this core requires enrolling less capable students, most of whom would not have enrolled in a four-year college under existing circumstances. The tentative implication is that junior colleges are not substitutes to four-year colleges when junior college enrollment is relatively small, and not complements when their enrollment is relatively large. Stated in another way, the multiplier $\gamma$ should be positively related to junior college tuition rates when enrollment at junior colleges is small and negatively related to junior college tuition rates when junior college enrollment is relatively large. Thus,

$$\gamma = k + G_1 Z_1 + G_2 Z_1 + G_3 Z_2$$

where $k$ is a constant, $Z_2$ is the tuition of junior colleges, and $Z_2$ is the relative size of enrollment at junior colleges. The hypothesis predicts that $G_1$ is positive, and $G_2$ is negative. The coefficient $G_2$ is of less interest, but must be positive, since the hypothesis requires $\gamma$ to vary directly with $Z_2$. The equation ultimately to be estimated therefore is:

$$Z_2 = C + e Z_1 Y_1 Z_2 Y_1 Z_2 + G_2 Z_2 Y_1 Z_2 Y_1 Z_2,$$

where $C$ is the sum of the constants $c$ and $k$.

We note that at some value of $Z_2$, the derivative of the enrollment ratio with respect to $Z_1$, the tuition at junior colleges, is zero. When $Z_2$ takes this particular value, whatever it may be, junior colleges have a neutral impact on enrollment at four-year colleges. Otherwise, they either depress or bolster enrollment at four-year colleges. To estimate equation (4), we take the logarithms of both sides.

II. Sources of Data

The denominator of the enrollment ratio, $Z_2$, for a given year is the sum of all high school graduates for the preceding seven academic years, adjusted for deaths and for those serving in the armed forces. The numerator is defined as all resident undergraduates in four-year colleges and universities. Data were obtained from various issues of Projections of Educational Statistics, published by the United States Office of Education.

Our proxy for the tuition variable was an average of tuition at public and private universities, weighted by enrollment each year in each type of institution. The average tuition was then deflated by the consumer price index. The source, again, was Projections of Educational Statistics. In order to determine whether weighting by enrollments had a substantial impact on our empirical results, regressions were repeated with fixed-weight averages on tuition. The difference in results was not statistically significant.

A proxy for the opportunity cost of attending college that was not simultaneously a proxy for another determinant of college enrollment, namely household income, was not easily found. The unemployment rate of 16 to 19-year-olds was used as a proxy for opportunity costs. High unemployment among youth should lower the real opportunity cost of attending college since greater job-search costs during periods of high unemployment effectively mean a lower real wage. The unemployment variable proved to be statistically insignificant in preliminary regressions.

Household disposable income is a proxy for both opportunity cost and parents' ability to finance the education of their children. Aggregate disposable personal income, as reported in the Economic Report of the President, was divided by the number of households, and the result for each year deflated by the consumer price index.

Since household disposable income is positively related both to opportunity cost and parents' ability to pay for college, its coefficient reflects the impact of these two underlying variables. From previous studies, we expect the net effect to be positive. A rationalization of this result is as follows. Greater parental income, of course, unambiguously increases college enrollment via a pure income effect. On the other hand, greater opportunity cost for the high school graduate, as measured by greater household income, itself generates both income and substitution effects. Greater potential earnings imply that enrollment is costlier to the student, but greater potential earnings mean that a student earns more from a given amount of work (during summers, part-time, and even upon graduation from college), allowing him to indulge greater educational expenditures. Unless the substitution effect of increased opportunity costs is very large, the weight of this argument tends to rationalize the positive coefficient of household disposable income on college enrollment.

The tuition of junior colleges was computed as a weighted average in the same manner that tuition was computed for four-year colleges. To measure enrollment in junior colleges, we employed the enrollment ratio of junior colleges, computed as for four-year colleges. The source of data was also Projections of Educational Statistics.

A proxy for the anticipated differential in earnings due to college enrollment could not be found. We tested the hypothesis that anticipations of the earnings differential might be based upon the ratio of incomes of college and high school graduates prevailing at the time of the decision to enroll. This simple hypothesis was not confirmed by preliminary regressions. Galper and Dunn [5, 766] also reported difficulty in finding a proxy for the expected payoff to college enrollment.

We tested the hypothesis that the thrust of conscription during the Vietnam war may have temporarily increased college enrollment. In preliminary regressions, a dummy variable for the period of the Vietnam war proved to be insignificant.

In a preliminary regression, the tuition at four-year colleges and universities, lagged one year, was introduced as an explanatory variable. The coefficient of this variable was not significant. Furthermore, the sum of the coefficients of the tuition variable and the tuition variable lagged did not differ from the coefficient of the tuition variable when the tuition variable appeared without the lagged variable in the enrollment regression. Thus the coefficient of the tuition variable alone detects the long-run impact of changes in tuition, without resort to lagged variables.

III. Empirical Results

The estimated enrollment functions appear in Table 1. In regression (1) the impact of junior colleges upon enrollment in four-year colleges has been ignored. This will serve as a benchmark in attempting to measure the biases created by a failure to account for the effects of an expanding system of two-year colleges. The coefficients of the independent variables are all of the expected signs, and are statistically significant. The Durbin-Watson statistic of

The regression for the coefficient of $X_1$ is, of course, due to the fact that $X_1$ is the inverse of household disposable income.

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### TABLE 1

**Demand for Undergraduate Education Dependent Variable: Ln R₀**

<table>
<thead>
<tr>
<th>Regression</th>
<th>Intercept</th>
<th>X₁</th>
<th>X₂</th>
<th>Z₁</th>
<th>Z₂</th>
<th>Z₃</th>
<th>R²</th>
<th>F</th>
<th>d</th>
<th>Type</th>
</tr>
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<tr>
<td>i.</td>
<td>-321</td>
<td>-5016.4*</td>
<td>-2006.9**</td>
<td>.845</td>
<td>35.6</td>
<td>1.21</td>
<td>OLS</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td>(6)</td>
<td>(13.8)</td>
<td></td>
<td></td>
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<tr>
<td>ii.</td>
<td>.277</td>
<td>-6340.1*</td>
<td>-801.1*</td>
<td>.883</td>
<td>45.3</td>
<td>1.44</td>
<td>OLS</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>(3.8)</td>
<td>(3.1)</td>
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<td></td>
<td>.033</td>
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<td>.88</td>
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<td>iii.</td>
<td>-371</td>
<td>-496.4*</td>
<td>-3005.1*</td>
<td>.847</td>
<td>33.8</td>
<td>1.34</td>
<td>OLS</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>(3.3)</td>
<td>(23.5)</td>
<td></td>
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<td>iv.</td>
<td>-389</td>
<td>-305.5**</td>
<td>-2010.6*</td>
<td>.876</td>
<td>30.6</td>
<td>1.79</td>
<td>OLS</td>
<td></td>
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<td></td>
<td></td>
<td>(2.4)</td>
<td>(2.2)</td>
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<td>.019</td>
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<td>.19</td>
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<tr>
<td>v.</td>
<td>-494</td>
<td>-161.4**</td>
<td>-3050.6**</td>
<td>.912</td>
<td>18.6</td>
<td>1.38</td>
<td>OLS</td>
<td></td>
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<td></td>
<td></td>
<td>(2.5)</td>
<td>(4.2)</td>
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<td>.14</td>
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<td>.14</td>
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</table>

**Definitions:**
- X₁ = Income of disposable income of households (real term)
- X₂ = tuition at four-year colleges (real term)
- Z₁ = tuition at four-year colleges (ratio)
- Z₂ = enrollment in four-year colleges (proportion of potential students)

**Notes:**
- * indicates significant at 1% level, one-tail test
- ** indicates significant at 5% level, one-tail test
- *** indicates significant at 10% level, one-tail test

Linear estimation of equation (4) is possible by taking natural logarithms of both sides.

### TABLE 2

**Estimated Values of the Term γ (%) 1956-1971**

<table>
<thead>
<tr>
<th>Year</th>
<th>γ (%)</th>
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<tbody>
<tr>
<td>1956</td>
<td>-17.1</td>
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<tr>
<td>1957</td>
<td>-14.6</td>
</tr>
<tr>
<td>1958</td>
<td>-11.6</td>
</tr>
<tr>
<td>1959</td>
<td>-11.4</td>
</tr>
<tr>
<td>1960</td>
<td>-10.5</td>
</tr>
</tbody>
</table>

**Notes:**
- The values of γ are obtained from the relationship R₀ = R₀(γ)

**R₀ = R₀(γ)**

Where the method of estimating R₀, the per-capita enrollment at four-year colleges, in the absence of any impact by enrollment by junior colleges, is explained in the text. Thus:

γ = \ln(R₀/R₀)

Since R₀ = R₀(γ), the multiplier γ is simply the natural logarithm of the ratio R₀/R₀. For values of γ close to zero, γ may be interpreted as a proportion (or percent).

Table II is very revealing. It shows that over the period covered by the sample, junior colleges depressed enrollment at four-year colleges, with the exception of one or two years. However, this depressing effect was of relatively small magnitude, at least during the nineteen-sixties. Of more interest is the tendency for the values of γ to become smaller (less negative) over time. The diminution over time of the value of γ represents a stimulus to the enrollment ratio observed for four-year colleges.

This last observation is of some importance. While four-year colleges' enrollment grew greatly in absolute terms during the sixties, due to large demographic changes, the observed enrollment ratio R₀ grew only modestly, from 29.7 percent of potential students enrolled in 1956, to 30.4 percent in 1971. In fact, there is no strong trend in the series. This small increase in the observed enrollment ratio is overexplained by changes in the value of γ alone. Apparently in the absence of the diminution of the multiplier, γ, the observed enroll-
References


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Measuring the Values of Interrelated Commodities: A Note on the Generalization of Consumer's Surplus

Richard J. Anderson*  

Introduction

Recently there have been several additions to the already lengthy literature on consumer's surplus. [See Silberberg (1972), Burns (1973), and Glanzer (1974)]. This paper simplifies and expands upon these recent contributions investigating the concept in a general equilibrium framework. Special emphasis is given to the mathematical generalization of consumer's surplus to commodities, and the integrability assumption necessary to preserve its interpretation as areas under demand curves. The relationship between linear integrals and ordinary integrals is clarified. In addition, an approximate benefit measure from the availability of an additional commodity is presented which is especially useful for obtaining an ex ante measure of welfare changes in empirical analyses.

Consumer's surplus receives much attention in economics based on the desire to obtain a money measure of utility changes brought about by changes in prices, programs or policies. Marshall formally defines the concept as "... the excess of the price which the consumer would be willing to pay rather than go without the thing, over that which he actually does pay." [1920, p. 124]. There exists an extensive literature on the demotion, rehabilitation, and re-examination of consumer's surplus as a valid welfare measure. The uniqueness of the concept of consumer's surplus comes under attack by Samuelson who states that "the Marshallian concept of consumer's surplus does not refer to any one thing, but to at least a half dozen interrelated expressions" [1947, p. 397]. Hicks rehabilitates consumer's surplus by defining variations in money income which measure a consumer's willingness to pay for a price reduction thus avoiding some of the complications of utility measurement and comparisons [1946, 1966]. More recently the literature further investigates the validity of consumer's surplus as a unique measure of welfare changes. Silberberg argues that although there are many consumer's surpluses (equilibrating variations) which represent areas under ordinary demand curves (money income constant), Hicks' concept of "compensating variation" is unique and has empirical usefulness [1972, pp. 947-960]. Similarly, Burns argues that consumer's surplus although not unique remains a useful construct and has a wide range of application in economic analysis and policy [1973, pp. 342-364].

In partial equilibrium analysis the value of a commodity is commonly measured as the area under its demand curve with that portion of the

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The "price equilibrating variation" is the amount of money needed to compensate the consumer if the price were to return to the former level, and the "price compensating variation" is the amount of money the consumer is willing to pay to retain the price reduction [1956, p. 81].