WORKING PAPER #313
INDUSTRIAL RELATIONS SECTION
PRINCETON UNIVERSITY
MARCH 1993

Comments Welcome

DEMOCRATIZATION OR DIVERSION?
THE EFFECT OF COMMUNITY COLLEGES ON EDUCATIONAL ATTAINMENT

Cecilia Elena Rouse
Princeton University

February 1993

I thank Joshua Angrist, Susanto Basu, Michael Boozer, David Card, Brad DeLong, Gary Engelhardt, Jonathan Gruber, Tom Kane, and Boris Simkovich for helpful conversations, and members of the Harvard Labor/Public Finance lunch group, and seminar participants at Columbia University, Harvard University, the J. F. Kennedy School of Government, MIT, Princeton University, RAND, UC Berkeley, UCLA, UC Santa Barbara, the University of Michigan, and the University of Virginia for useful comments. I especially thank Gary Chamberlain, Claudia Goldin, Guido Imbens, Larry Katz, and Alan Krueger for help and guidance.

ABSTRACT

Throughout the late 1970s and the early 1980s, over 50% of all first-time first-year college students started in a junior college. Despite such a large role in higher education, we know relatively little about how well they serve their role of providing an education for all who want to attend college. Junior colleges affect educational attainment in two ways. First, the schools provide a place in higher education for those who might not have otherwise attended college, the *democratization effect*; however, they also draw away some students who might otherwise have attended a four-year college, the *diversion effect*. The democratization effect is nonnegative; however the effect of diversion on educational attainment is unclear, *a priori*, as some students might be better off starting in a four-year school.

This paper attempts to sort out the overall impact of junior colleges on educational attainment. I use the natural experiment arising from variation in access to junior colleges across cities and states to address the problem of self-selection into types of colleges. This approach is implemented by an instrumental variables strategy in which distance to junior college and average state two-year college tuition are used to instrument for junior college attendance in an educational attainment equation. The results suggest that on net junior colleges increase total years of schooling, but do not change the likelihood of attaining a BA.

Cecilia Elena Rouse
Robertson Hall
Woodrow Wilson School
Princeton University
Princeton, NJ 08544

I. Introduction

Junior colleges were first designed in the late 19th century as local, relatively easy access schools allowing all who wanted to attend college the opportunity to do so without over-burdening the four-year colleges. Students could complete their first two years in a junior college and earn a two-year degree (an associate's degree); those who chose to do so could continue in a four-year institution and complete their last two years.¹ The junior college model has survived and is thriving. During the late 1970s and early 1980s, more than 50% of all first-time, first-year college students started in a two-year school. In 1987, 35% of 18-19 year old college students and 30% of full-time equivalent college students attended junior college.² But has the junior college been a success?

The presence of a junior college may affect educational patterns in two, opposing, ways. The college may provide a place in higher education for those who otherwise might not attend college either for financial reasons or because they were not yet ready to attend four-year college. Brint and Karabel (1989) term this the *democratization effect*. But a local community college may also draw away students who might otherwise have attended a four-year college, the *diversion effect*.³ The democratization effect is nonnegative, however the effect of diversion on educational attainment is unclear, *a priori*. Some students may be better off starting in a junior college either to improve their basic skills before transferring to a four-year school, or to finish with the associate's as their terminal

¹ In *The American Junior, College* Cohen and Brawer define junior colleges as, "...any institution accredited to award the associate's degree in arts or science as its highest degree." (pp. 5-6) This definition includes comprehensive two-year colleges and many technical institutes (both private and public), and it excludes publicly funded vocational schools, adult education centers, and most proprietary schools. Although there are nuances in definitions, in this chapter I use the terms "junior college", "two-year college", and "community college" interchangeably.

² *Digest of Education Statistics* 1989, pp. 171, 178, and 180.

³ See Brint and Karabel (1989).

degree. On the other hand, others might be better off starting in a four-year school where a greater fraction of the students attend full-time keeping students focused on attaining a bachelor's degree. Educators have appeal to the raw statistics on the educational attainment of those who begin in a community college in their critique of community colleges. For example, 47% of those starting in four-year school report having a BA within five years of high school however only 17% of those who started in a junior college finished an associate's degree and 11% had a BA. Similarly, almost 40% of those starting in a community college have not completed one year of college within five years of high school compared with only 12% of those starting in a four-year college.⁴

This paper helps to sort out the overall impact of junior colleges on educational attainment. I ask whether starting in a junior college increases one's probability of attaining a bachelor's degree or increases the number of years of education earned. Previous studies of the impact of junior colleges on educational attainment conclude that the schools do more harm than good. The authors, however, do not adequately address the problem of self-selection into types of colleges. Velez (1985), for example, using the *National Longitudinal Survey of the High School Class of 1972* (NLS-72) compares the attainment of those in two-year colleges with those in other colleges. Not surprisingly, those starting in a junior college were 0.19 less likely to receive a BA within 7 years of high school than the base group. (See also Breneman and Nelson (1981), and Anderson (1981).) Because these studies evaluate the effect of starting in a junior college on attainment by comparing two-year students to four-year students, they find that junior college students receive less education. Given their experimental design, such results are not surprising.

Although their interest was in isolating the diversion effect, the authors observe only those

⁴ Author's calculations using the *High School and Beyond*. See Rouse (1992) for more information about who attends junior college and their eventual educational attainment.

who did attend junior college, a group that includes some who would otherwise have attended no college at all. If those diverted from a four-year college differ from those who would not have attended college in the absence of a junior college, then their results are inconsistent due to both self-selection into college and self-selection into type of college.⁵ By not explicitly accounting for the democratization effect, the authors may have biased their estimates of the diversion effect, and underestimated the net effect of junior colleges on educational attainment. A numerical example in Appendix I illustrates that even if the diversion effect has no impact on educational attainment, conditioning on college attendance can result in a negative estimate of the educational impact of junior colleges.

What is needed to evaluate the impact of junior colleges is a statistical experiment akin to random assignment. Alba and Lavin (1981) attempted one in their study of applicants to four-year schools in the City University of New York (CUNY) system. They tracked applicants admitted to the four-year system and those assigned to a two-year school and found an 0.11 point difference in the probability of attaining a BA between students starting in the both types of schools. But, the students starting in two-year schools were not randomly assigned, and there was likely unobserved heterogeneity in students attending the two types of colleges. In a similar vein, Grubb (1989) utilizes a state-level cross-section from 1980 to examine the effects of two-year enrollments on aggregate levels of educational attainment. He finds that states with more extensive junior college systems have larger proportions of men with 13-15 years of college (some college) and not lower proportions of male college graduates. On the other hand, women in states with more junior colleges have

⁵ Manski and Wise (1983) find evidence of substantial self-selection of individuals into college. Modelling college persistence and the application decision, they conclude that those who do not apply to college would most likely have dropped out anyway.

relatively higher proportions with "some college", although it occurs by decreasing the number of college graduates. Thus community colleges appear to help men, but not women.

I improve upon this literature by exploiting the natural experiment arising from variation in access to junior colleges across cities and states to address the problem of self-selection into types of colleges. This approach is implemented by a strategy in which distance to junior college and average state two-year college tuition are used to instrument for junior college attendance in an educational attainment equation. Because proximity and cost are not likely to be correlated with unobserved factors that affect educational attainment, conditional on college type and other observable covariates, I am able to estimate a consistent net effect of junior colleges on educational attainment. The natural experiment simulates the following thought experiment. If a community college is built it will attract students by virtue of its proximity and lower relative price. Of these, some will have been diverted from a four-year college track which might lower their educational attainment by the diversion effect. Others, however, who would otherwise not have continued their education, will be drawn into the college system. They will increase their educational attainment through the democratization effect. I measure the net "treatment" effect of junior colleges by considering not just those who attend college at all, but rather by considering the entire set of potential students. The results suggest that, on net, junior colleges increase aggregate years of schooling, but do not change the likelihood of attaining a BA.

II. Correcting for Self-Selection

The ideal manner in which to evaluate the effect of starting in a two-year college on educational attainment is by conducting a random experiment. Some fraction of the population would be randomly assigned to start in a junior college and the others could either attend four-year college

or not attend any college. After some period of time, educational attainment would be measured and a *treatment effect*, the difference in mean outcomes between the control group and the treatment group would be evaluated. In the absence of random assignment, my task is to employ an estimation strategy that allows for identification of the treatment effect.

Previous authors have interpreted OLS results as identifying the treatment effect by assuming that conditional on the included covariates, there are no additional factors related to both attending junior college and educational attainment. However, such an assumption is fairly implausible. Test scores and other observable measures of "ability", usually included to address self-selection, are unlikely to fully capture one's determination to achieve, nor do they perfectly capture academic ability. An alternative strategy, and the one I employ here, is to employ an IV strategy that simulates a random experiment by imposing exclusion restrictions that determine the assignment of treatment.

States vary dramatically in their provision of a community college education. For example, 85% of Arizona's institutions of higher education are community colleges compared to 19% for West Virginia. Similarly states vary in their tuition rates. In 1990, Vermont charged \$2424 in two-year college tuition compared to California which charged only \$114.⁶ The primary instrument is distance from the respondent's high school to the nearest junior college (see Kane and Rouse (1993)). As an additional instrument, I use average two-year college tuition in the respondent's high school state of residence. These instrumental variables simulate the experiment of improving the accessibility of junior colleges by building more campuses or lowering tuition, and observing the effect on educational attainment. To see how the strategy works, suppose that people either live in towns with junior colleges, or they do not. Instrumental variables compares the mean attainment of

⁶ *Digest of Education Statistics*, 1992, Tables 227 and 302.

those who live in towns with junior colleges to the mean attainment of those who do not. The critical assumption is that the only effect of the presence of the junior college on educational attainment is through the probability of attending a junior college, as opposed to some other factor correlated with the presence of junior colleges.

The success of the instrumental variables strategy hinges on the validity of the instruments. Equation (1) represents the first-stage equation:

$$A_{2YR} = Z\theta + \gamma_{2YR}D_{2YR} + \delta_{2YR}T_{2YR} + \mu \quad (1)$$

A_{2YR} is starting in a two-year school, Z is a row vector of exogenous variables, D_{2YR} represents the number of miles from the respondent's high school to the nearest two-year colleges, T_{2YR} the average tuition at junior colleges in the high school's state in 1980, and μ an error term.⁷ If people who value education move to areas in which there are more junior colleges, making residence correlated with unobservable variables that determine educational attainment, then the instruments are not valid. I control for this to some extent by conditioning on measures of family background as well as urban status. Such a correlation is also mitigated by the fact that both instruments are based on residence when respondents were seniors in high school so that residence and college attendance were not contemporaneously determined and primarily reflect the decisions of the parents.

Table 1 shows results from linear probability models on the first-stage specification.⁸

⁷ The tuition data for both two-year and four-year colleges are from the State of Washington Higher Education Coordinating Board.

⁸ Table 1 also includes estimates of the decision to attend four-year college which is relevant for a later section in which I control for both two-year and four-year college attendance. The coefficients from the full specification are available from the author upon request. I get similar effects on the probability of attending two-year and four-year using a probit.

TABLE 1
FIRST STAGE RESULTS
(Linear Probability)

Independent Variables	Dependent Variable: Two-year College	Dependent Variable: Four-year College
	Coefficient (Std. Error)	Coefficient (Std. Error)
Miles to Two-year College (x10)	-0.036 (0.004)	0.013 (0.004)
Miles to Two-year College Squared (x1000)	0.011 (0.002)	-0.003 (0.002)
Miles to Four-year College (x10)	0.017 (0.005)	-0.026 (0.005)
Miles to Four-year College Squared (x1000)	-0.010 (0.004)	0.013 (0.004)
Two-year Tuition in State (\$82) (x1000)	-0.094 (0.043)	0.106 (0.044)
Four-year Tuition in State (\$82) (x1000)	0.051 (0.033)	-0.121 (0.034)
R ²	0.106	0.270

NOTES: There are 6808 observations. Also included are a constant, female, race, the HS&B test score, parents' education, family income, whether family owns home, % of high school enrollment that is White, four-year college tuition in state of residence when in high school, high school in urban area, high school's city unemployment rate in 1980, census region dummies, and state income per capita in 1980 in state of residence when in high school.

Conditioning on family background and state variables, those living closer to a junior college are more likely to begin in one and the relationship is not linear. The effect of distance to a two-year school has an opposite and significant effect on four-year college attendance. The own-price and cross-price effects of tuition on college attendance also have the right signs and are significantly different from zero. Those facing lower two-year tuition are more likely to attend two-year school, as are those facing higher four-year college tuition.

I identify a *net* treatment effect by estimating the following second-stage equation:

$$BA = X\beta + \alpha_{NET}A_{2YR} + \varepsilon \quad (2)$$

where BA represents educational attainment, X is a row vector of exogenous variables, A_{2YR} signifies starting at a junior college and α_{NET} the net treatment effect of starting at a junior college; ε is an error term. The control group contains both those who never attended college, those who started in vocational/technical school, and those who started in four-year college.⁹

III. The Sample

The sample consists of 6808 individuals from the *High School and Beyond* (HS&B) senior cohort who participated in all four rounds of the survey.¹⁰ Junior colleges typically have open

⁹ I indirectly control for four-year college attendance in these equations by including four-year college tuition and distance from the respondent's high school to the nearest four-year college among the covariates.

¹⁰ *High School and Beyond* (HS&B) is a survey conducted by the Department of Education to complement the *National Longitudinal Survey of the High School Class of 1972*. Employing a two-stage sampling design in which high schools were randomly chosen in the first stage, and in which students were randomly sampled from within each high school in the second, HS&B included about 12,000 seniors from the high school class of 1980 from about 1,100 schools. Schools with relatively more minority and low-income students were over-sampled. Follow-up surveys were conducted in February 1982, 1984, and 1986, and by 1986 the survey retains 88% of the original base sample.

admissions, requiring either a high school diploma or an "ability to benefit" from attendance.¹¹ All members of the high school class of 1980 were, thus, eligible to attend. I categorize respondents according to the first post-secondary institution attended after high school: vocational/technical school, two-year college, or four-year college.¹²

I include measures of gender, race (Black, Hispanic, and Other), and socio-economic status - parents' education, family income, and whether the family owns their own home. To provide another socio-economic indicator, I include the percentage of the high school's enrollment that is White. Measured ability is captured by the composite score from a battery of tests, similar to the SAT, administered during the spring of the senior year in high school to all respondents. Local labor market indicators proxy for the opportunity cost of staying in college. I include the city unemployment rate and state average manufacturing wage (\$1982) in the respondent's state in 1980. Finally, census region, urbanization of the high school, and income per capita (\$1982) in the respondent's high school state of residence control for location effects which may be correlated with the proposed instrumental variables.

Two measures of "educational attainment" are used. The first is attainment of a bachelor's degree since the traditional mission of junior colleges is to allow students to transfer to four-year schools, and since there are clear economic gains associated with graduating from a four-year college. Because Kane and Rouse (1993) find similar economic returns to community college credits

¹¹ Many high school dropouts attend junior colleges in order to receive a high school equivalency diploma (GED). Since all participants in the survey reached the spring of their senior year in high school, this study is likely to underestimate the overall value of junior colleges in increasing educational attainment.

¹² There were about 316 people who started in schools that were "unclassifiable". I exclude them from the sample with the result that the treatment effect for junior colleges increases slightly.

and four-year college credits, I also use total (completed) years of college education.¹³ The means and standard deviations of the variables are in Appendix II.

IV. Treatment Effects: Results

A Treatment Effect: Linear Instrumental Variables (IV) Results

Table 2 presents linear IV estimates of the net treatment effect of community colleges.¹⁴ OLS estimates of the effects of college type on attainment that have not been corrected for self-selection are shown in the top row. Using both definitions of attainment, these results suggest a negative, and significant, effect of starting in junior college on educational attainment; the results found by others. The instrumental variables results occupy the bottom four rows of the table.

The treatment effect of starting in a junior college is marginally statistically significant when distance to the nearest community college is represented as five dummy variables in the years of education equation. However, the effect is not precisely estimated in any of the other specifications, although the standard errors on the years of education equations are a bit smaller than those in the BA equation. Thus, it appears that starting in a junior college has a positive effect on total years of

¹³ To calculate completed years of education I started by assigning 12 years of education to all members of the survey since the survey was conducted during the spring of their senior year in high school. Each additional year in a post-secondary institution counted as one year. I assigned a vocational degree 13 years, an AA 14 years, and a BA 16 years (even if it took the respondent five years to complete). Those who have enrolled in a graduate program were given 17 years and a graduate degree corresponded to 18 years of education.

¹⁴ The effects of the other, non-college type, covariates on educational attainment are presented in Appendix III. The signs of the coefficients are as one might expect and their statistical significance and magnitudes indicate that they are important components of educational attainment. In addition, the results presented below are unweighted. Weighting appears to make little difference for the results.

TABLE 2
THE NET EFFECT OF TWO-YEAR COLLEGES ON EDUCATIONAL ATTAINMENT
Instrumental Variables Results

	Dependent Variable: Years of Education	Dependent Variable: 1 = BA/0 = No BA
OLS/Linear Probability Results		
Two-year College	-0.089 (0.044)	-0.094 (0.010)
Instruments: Miles to Two-year College and Miles Squared		
Two-year College	0.484 (0.340)	0.016 (0.077)
GMM χ^2 (dof)	0.015 (1)	0.127 (1)
Instruments: Miles to Two-year College and Miles Squared/Two-year College Tuition		
Two-year College	0.401 (0.332)	-0.003 (0.075)
GMM χ^2 (dof)	1.362 (2)	1.389 (2)
Instruments: Miles to Two-year College as Five Dummy Variables		
Two-year College	0.676 (0.322)	0.026 (0.073)
GMM χ^2 (dof)	13.62 (4)	7.720 (4)
Instruments: Miles to Two-year College as Five Dummy Variables/Two-year College Tuition		
Two-year College	0.609 (0.314)	0.011 (0.071)
GMM χ^2 (dof)	14.98 (5)	8.721 (5)

NOTES: There are 6808 observations. These estimates are from IV with a linear probability model in the first stage and OLS/Linear Probability in the second. Standard errors are in parentheses. The linear probability (BA) standard errors are also corrected for heteroskedasticity using White's (1980) method. Other exogenous variables include: a constant, female, race, the HS&B test score, parent's education, family income, whether family owns home, % of high school enrollment that is White, four-year college tuition in state of residence when in high school, miles from high school to nearest four-year college, high school in urban area, high school's city unemployment rate in 1980, and state income per capita in 1980 in state of residence when in high school. The distance groupings are <20 miles, 20-39 miles, 40-59 miles, 60-79 miles, 80-99 miles, and 100+ miles. The GMM test of orthogonality of the instruments is distributed as a χ^2 with k-1 degrees of freedom where k is the number of instruments. The critical values (at the 0.05 level) are: 3.84 for one degree of freedom, 5.99 for two degrees of freedom, 9.49 for four degrees of freedom, and 11.07 for five degrees of freedom.

education attained, but at most a small negative effect on the attainment of a bachelor's degree. The primary function of junior colleges may not be to facilitate earning a bachelor's degree, but rather to increase other forms of educational achievement.

The test statistics from the Generalized Method of Moments (GMM) error-orthogonality test are reported for each equation. The test involves regressing the residuals from the second-stage equation on all of the exogenous variables. The R^2 of this regression times the number of observations is asymptotically distributed as a χ^2 with $k-1$ degrees of freedom, where k is the number of instruments, see Newey (1985). The weaker the association between the instruments and the second-stage residuals, the less likely one is to reject the null hypothesis that the equations are properly specified.

In the equations explaining probability of attaining a BA, the test statistics do not reject the null at the 0.05 level. However, the results of the tests of over-identifying restrictions are sensitive to the functional form of the distance variable in the years of education equations. The results with distance as five dummy variables suggest that the instruments are not completely valid, although the null hypothesis is not rejected at the 0.05 level when distance and distance squared are used. One interpretation is that those who live near junior colleges receive more education for reasons other than the presence of a junior college. On the other hand, by dividing the distance (and by using the distance squared as the second instrument) the equation is only over-identified from a nonlinear functional form. Although the coefficients are within a standard error of one another, the differences in the results of the over-identifying restrictions, advise that one should interpret the results, particularly the magnitudes of the treatment effect, with caution. It is worth noting, however, that the net effect of junior colleges is always positive providing evidence that they may increase overall years of education.

The positive net treatment effect of starting in a junior college on years of schooling suggests that overall either democratization outweighs a negative diversion effect, or that the diversion effect is nonnegative. On the other hand, the small gain made by those who would otherwise not have attended college may be marginally outweighed by a decrease in likelihood of attaining a BA experienced by those who were diverted from four-year school.

A Treatment Effect: Bivariate Probit Results

The instrumental variables coefficients in Table 2 were generated from a linear instrumental variables estimation, even though the models have a dummy endogenous variable. Because the BA equation is nonlinear in the second-stage as well, it is possible that I can improve upon the results in Table 2 by implementing a bivariate probit with maximum likelihood estimation. In this case, the structural equation is identified through the exclusion restrictions as well as the functional form. On the other hand, Angrist (1991) shows using Monte Carlo evidence that in nonlinear models, the linear IV strategy performs nearly as well as a bivariate probit. Table 3 compares the linear instrumental variable results in Table 2 to those obtained from a bivariate probit. The signs change in three of the four specifications, however, the estimates in all cases are essentially zero due to large standard errors. The magnitudes of the estimated net treatment effects are also quite small. Thus the qualitative conclusion that community colleges do not substantially change one's likelihood of receiving a bachelor's degree is derived from either the linear IV or the bivariate probit. Given that the linear IV strategy has the advantage that it is often easier to implement and the source of the identification is more easily understood, it may be the preferable estimation procedure. This comparison is particularly important for more complicated models with more than one dummy endogenous variable and a binary outcome given that higher order normal distributions, such as a

Table 3
Instrumental Variables vs. Bivariate Probit
The Net Effect of Two-year Colleges on Educational Attainment

		Dependent Variable: 1 = BA / 0 = No BA			
		Linear IV	Bivariate Probit		
		Coefficient/ Treatment Effect	Coefficient	Treatment Effect	rho
Instruments: Miles to Two-year College and Miles Squared					
Two-year College		0.016 (0.077)	-0.020 (0.348)	-0.005	-0.206 (0.193)
					12,363
Instruments: Miles to Two-year College and Miles Squared/ Two-year College Tuition					
Two-year College		-0.003 (0.075)	-0.041 (0.350)	-0.009	-0.195 (0.195)
					12,359
Instruments: Miles to Two-year College as Five Dummy Variables					
Two-year College		0.026 (0.073)	-0.044 (0.334)	-0.010	-0.193 (0.185)
					12,343
Instruments: Miles to Two-year College as Five Dummy Variables/ Two-year College Tuition					
Two-year College		0.011 (0.071)	-0.045 (0.334)	-0.010	-0.193 (0.185)
					12,343

Notes: There are 6808 observations. See notes to Table 2 for other covariates. Linear IV results are the same as in Table 2. "Rho" is the correlation between the error terms in the first- and second-stage equations. The bivariate treatment effect is:

$$\alpha_{\text{NET}} = \Phi[X\beta + \alpha] - \Phi[X\beta]$$

where Φ is the standard cumulative normal, β is the vector of standardized coefficients from the bivariate probit and α is the estimated coefficient on whether one has started in a two-year college. This treatment effect is estimated by calculating the difference for each member of the sample using the individual data. The average difference is reported.

trivariate normal (see below), are currently difficult to implement.

Identifying Democratization and Diversion Effects

One problem with the above specification is that it does not identify the separate two-year and four-year treatment effects, nor does it tell us the relative sizes of the two groups of people affected by the presence of a junior college. We cannot distinguish whether democratization outweighs diversion due to a large marginal effect or because of the relative sizes of the groups of students, or whether both effects are positive. To try to distinguish the two effects, I estimate the following first-stage equations:

$$A_k = Z\theta' + \gamma_j'D_j + \delta_k'T_k + \mu' \quad (3)$$

where A_k represents either two-year or four-year college attendance, Z is a row vector of exogenous variables, D_j represents the distance from the respondent's high school to the nearest two-year or four-year college, T_k is the average state two-year or four-year college tuition, and μ' an error term.

To instrument for the decision to attend four-year college, I use measures analogous to those used to model the decision to start in a two-year college: the number of miles from the respondent's high school to the nearest four-year college and average tuition at comprehensive four-year schools in the high school's state in 1980. Using this strategy I identify the democratization and diversion effects by estimating attainment equations of the form:

$$BA = X\beta' + \alpha A_{2YR} + \alpha' A_{4YR} + \epsilon' \quad (4)$$

where X is a row vector of exogenous variables, A_{2YR} signifies starting at a junior college and α the average treatment effect of starting at a junior college, A_{4YR} and α' the average treatment effect of

starting at a four-year school, and ε' is an error term. The control group consists of those who have not attended any college.

I interpret α , the gain in attainment for those randomly assigned to a junior college compared to those with no college, as the democratization effect. The difference, $\alpha' - \alpha$, is the diversion effect because it shows the change in attainment, if there is one, of starting in a junior college instead of a four-year college. Table 4 presents the results.

The treatment effects are positive and significant in all of the equations explaining years of education. On the other hand, the point estimates in the BA equation, though positive, have large standard errors such that the values could be interpreted as zero. Slightly smaller standard errors in all equations suggest that distance performs better as an instrument once it is allowed a very nonlinear functional form. Unlike in the estimation of the net effect, all of the specifications pass the tests of over-identifying restrictions.

The magnitudes of the coefficients on starting in a two-year college suggest a positive democratization effect on years of schooling that is statistically significant. Those who start in community college receive one to one-and-one-half more years of education than those who do not attend college. The democratization effect of starting in a junior college in the BA equation appears quite small although the coefficients are much less precisely estimated than those estimating years of education.

A diversion effect is identified by subtracting the two-year treatment effect from the four-year treatment effect. The coefficients suggest a negative, although generally insignificant, diversion effect on years of education. Focusing on the largest coefficient, starting in a two-year college, instead of a four-year college, leads to at most one less year of education. The diversion effect is negative, but not significant, in the BA equation as a result of large standard errors on both

TABLE 4
DIVERSION VS. DEMOCRATIZATION: INSTRUMENTAL VARIABLES RESULTS

	Dependent Variable: Years of Education	Dependent Variable: 1 = BA/0 = No BA
OLS/Linear Probability Results		
Two-year College (α) (Democratization Effect)	0.940 (0.044)	0.060 (0.008)
Four-year College (α')	2.021 (0.043)	0.302 (0.011)
Diversion Effect ($\alpha' - \alpha$)	1.081 (0.043)	0.242 (0.013)
Instruments: Miles to Two-year and Four-year College, and Miles Squared		
Two-year College (α) (Democratization Effect)	1.185 (0.444)	0.096 (0.112)
Four-year College (α')	1.854 (0.725)	0.181 (0.188)
Diversion Effect ($\alpha' - \alpha$)	0.669 (0.478)	0.085 (0.125)
GMM χ^2 (dof)	0.108 (3)	0.366 (3)
Instruments: Miles to Two-year and Four-year College, and Miles Squared/ Two-year and Four-year College Tuition		
Two-year College (α) (Democratization Effect)	1.428 (0.411)	0.065 (0.103)
Four-year College (α')	2.410 (0.601)	0.141 (0.157)
Diversion Effect ($\alpha' - \alpha$)	0.982 (0.411)	0.076 (0.109)
GMM χ^2 (dof)	2.063 (5)	1.935 (5)
Instruments: Miles to Two-year and Four-year College as Five Dummy Variables		
Two-year College (α) (Democratization Effect)	1.532 (0.387)	0.173 (0.098)
Four-year College (α')	2.137 (0.636)	0.256 (0.165)
Diversion Effect ($\alpha' - \alpha$)	0.605 (0.428)	0.083 (0.112)
GMM χ^2 (dof)	13.88 (9)	9.860 (9)
Instruments: Miles to Two-year and Four-year College as Five Dummy Variables Two-year and Four-year Tuition		
Two-year College (α) (Democratization Effect)	1.686 (0.366)	0.131 (0.092)
Four-year College (α')	2.487 (0.560)	0.188 (0.145)
Diversion Effect ($\alpha' - \alpha$)	0.801 (0.386)	0.057 (0.101)
GMM χ^2 (dof)	15.05 (11)	11.90 (11)

NOTES: See Table 2. The χ^2 critical values (at the 0.05 level) are: 7.81 for three degrees of freedom, 11.07 for five degrees of freedom, 16.92 for nine degrees of freedom, and 19.68 for eleven degrees of freedom.

coefficients. Taken at fact value, a T-test indicates that there is no change in the probability of attaining a BA from starting at a junior college; those who start in a junior college probably would not have finished a BA anyway.

These results call into question earlier findings on the diversion effect. Students who were diverted from four-year college may have lost a year of education, but it is not clear that they would have completed a BA anyway. It is important to remember that the outcome variable I consider here is total years of schooling. However, because Kane and Rouse (1993) find that two-year and four-year college credits have similar economic value, the treatment effects on years of schooling translate directly into individual and social tradeoffs of two-year and four-year college. Overall, it appears that the benefits of providing the two-year college as a port-of-entry to higher education outweigh the small diversion cost. Given that current fund expenditures per full-time equivalent student in public four-year institutions were twice that of public two-year schools, the results here suggest that community colleges are a viable and effective way of increasing overall educational attainment.¹⁵

¹⁵ *Digest of Education Statistics* 1990, p. 301.

V. Conclusion

Distance can serve as a natural experiment in a variety of applications. Nonetheless this research highlights two potential limitations. The large standard errors in Tables 2 and 4 in the BA equation suggest the need for a lot of data in order to isolate treatment effects with precision. In addition, this paper cautions that location decisions are potentially endogenous. In the HS&B, the location decisions were made by the respondents' parents, not the respondents, which increases the validity of the instruments. Nonetheless, the case for exogeneity can only be made conditional on family background and location effects.

This paper derives estimates of the effect of junior colleges on educational attainment from a strategy that isolates a true treatment effect by simulating the relevant policy question. Using city and state variation in proximity to community colleges, I find that a new local community college will divert some students from four-year schools who might have achieved more years of schooling in a four-year college, but that this effect is outweighed by the gains of those who otherwise would not have attended college at all. I also find that those diverted from four-year college probably would not have finished a BA anyway. Given similar economic returns to two-year and four-year college, this paper provides evidence that the junior college has been a success.

REFERENCES

- Alba, Richard D., and David E. Lavin. "Community Colleges and Tracking in Higher Education." *Sociology of Education* 54 (1981): 223-237.
- Angrist, Joshua D. "Linear Instrumental Variables Estimation of Average Treatment Effects in Nonlinear Models." *Harvard Institute of Economic Research Discussion Paper* 1542 (1991).
- Angrist, J.D., and G.W. Imbens. "Sources of Identifying Information in Evaluation Models." *Harvard Institute of Economic Research Discussion Paper* 1568 (1991).
- Anderson, Kristine L. "Post-High School Experiences and College Attrition." *Sociology of Education* 54 (1981): 1-15.
- Breneman, David W., and Susan C. Nelson. *Financing Community Colleges: An Economic Perspective*. Washington, D.C.: The Brookings Institution, 1981.
- Brint, Steven, and Jerome Karabel. *The Diverted Dream: Community Colleges and the Promise of Educational Opportunity in America, 1900-1985*. New York: Oxford University Press, 1989.
- Clark, Burton R. "The 'Cooling-Out' Function in Higher Education." *The American Journal of Sociology* 65, no. 6 (1960): 569-576.
- Cohen, Arthur M., and Florence B. Brawer. *The American Community College*. San Francisco: Jossey-Bass Publishers, 1982.
- Digest of Education Statistics*. Washington, D.C.: U.S. Department of Health, Education, and Welfare, Education Division, National Center for Education Statistics, 1989, 1990, and 1992.
- Dougherty, Kevin. "The Effects of Community Colleges: Aid or Hindrance to Socioeconomic Attainment?" *Sociology of Education* 60 (1987): 86-103.
- Grubb, W. Norton. "The Effects of Differentiation on Educational Attainment: The Case of Community Colleges." *The Review of Higher Education* 12 (1989): 349-374.
- Grubb, W. Norton. "The Varied Economic Returns to Post-secondary Education: New Evidence from the National Longitudinal Study of the Class of 1972." *forthcoming, The Journal of Human Resources* (1993).
- Heckman, James J. "Dummy Endogenous Variables in a Simultaneous Equation System." *Econometrica* 46, no. 6 (1978): 931-959.

- Imbens G.W., and J.D. Angrist. "Identification and Estimation of Local Average Treatment Effects." Unpublished paper, Harvard University (1991).
- Kane, Thomas J., and Cecilia Elena Rouse. "Is a Credit a Credit?: Labor Market Returns to Two-year and Four-year College." Unpublished paper, Harvard University and Princeton University (1993).
- LaLonde, Robert J. "Evaluating the Econometric Evaluations of Training Programs with Experimental Data." *The American Economic Review* 76,no.4 (1986): 604-620.
- Maddala, G.S. *Limited Dependent and Qualitative Variables in Econometrics*. Cambridge: Cambridge University Press, 1983.
- Manski, Charles F., and David A. Wise. *College Choice in America*. Cambridge: The Harvard University Press, 1983.
- Murphy, Kevin M., and Finis Welch. "Wage Premia for College Graduates: Recent Growth and Possible Explanations." *Educational Researcher* 18,no.4 (1989): 17-26.
- Newey, Whitney. "Generalized Method of Moments Specification Testing." *Journal of Econometrics* 29 (1985): 229-256.
- Pincus, Fred L. "The False Promises of Community Colleges: Class Conflict and Vocational Education." *Harvard Educational Review*. 50,no.3 (1980): 332-361.
- Rouse, Cecilia Elena. *The Other College: The Economic Benefits of Community Colleges*. Doctoral Dissertation, Harvard University, 1992.
- Tinto, Vincent. "College Proximity and Rates of College Attendance." *American Educational Research Journal* 10 (1973): 277-293.
- Tinto, Vincent. *Leaving College: Rethinking the Causes and Cures of Student Attrition*. Chicago: The University of Chicago Press, 1987.
- Velez, William. "Finishing College: The Effects of College Type." *Sociology of Education* 58 (1985): 191-200.
- White, Halbert. "A Heteroskedasticity-Consistent Covariance Matrix Estimator and Direct Test of Heteroskedasticity." *Econometrica* 48 (1980): 817-838.

APPENDIX I

A NUMERICAL EXAMPLE OF THE IMPORTANCE OF THE RIGHT CONTROL GROUP

In this example I show that even if there were no negative diversion effect, OLS, and especially OLS conditional on the having attended college, can generate a negative estimate of the effect of starting in a junior college on educational attainment. Suppose there are two states of the world, one with a junior college and one without one, and that they occur with equal probability. Also suppose there are four groups of people: those who would never attend college whether there is a junior college or not, those who would not attend college if there is not a junior college, but attend if there is one, those who would attend four-year college if there were no junior college but attend junior college if there is one, and finally those who attend four-year college whether or not a junior college is near. Note that the second group represents the democratizing function of junior colleges, and the third the diverting effect. The proportions of these groups in the population are 40%, 10%, 10%, 40%. Similarly, their probabilities of finishing a BA are 0%, 0%, 28%, and 50% if there is no junior college, and 0%, 5%, 28%, and 50% if there is a junior college. The example is presented below:

A Numerical Example			
Four Groups of People	% in Population	Probability of BA	
		No JC	JC
No College	40%	0	0
Two-year if Available; No College Otherwise	10%	0	5%
Two-year if Available; Four-year College Otherwise	10%	28%	28%
Four-year College	40%	50%	50%

The fact that the probability of earning a BA for those who attend junior college instead of a four-year college is unchanged means that the diversion effect is neutral. The true treatment effect is the change in probability of attaining a BA conditional on attending the junior college. Here it is +2.5%. Note that we cannot empirically distinguish the two competing effects (democratization and diversion) due to heterogeneity in treatment, therefore the treatment effect will represent a weighted average of the outcomes. In this example, the democratizing function

outweighs the diversion effect generating a positive treatment effect.

Estimates from four possible strategies are presented below and can be derived using standard formulas for treatment effects (see Angrist and Imbens (1991)). The first is the true treatment effect. The second and third are from OLS; the first on the whole sample of eligible students and the second is conditional on attending college. The fourth and fifth are IV estimates, also with and without conditioning on college attendance.

Method of Estimation	Estimated Treatment Effect
α_{TRUE}	+2.5 %
α_{OLS}	-7.3 %
$\alpha_{\text{OLS} \text{COLLEGE}}$	-31.0 %
α_{IV}	+2.5 %
$\alpha_{\text{IV} \text{COLLEGE}}$	-20.4 %

The table shows that unless one can identify individuals being in each of the four groups, the unobserved heterogeneity will lead to biased estimates of the treatment effect. In addition, even if there is no diversion effect, as in this example, estimates that condition on those who attend college will generate a negative estimate of the treatment effect. The problem is that such an experimental design excludes those who would have attended college but did not because there was not one available. With individual heterogeneity the exclusion downward biases the treatment effects.

APPENDIX II
SAMPLE MEANS AND STANDARD DEVIATIONS

Variable	STARTED IN TWO-YEAR COLLEGE		STARTED IN FOUR-YEAR COLLEGE		CONTROL GROUP	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Female	0.57	0.49	0.56	0.50	0.55	0.50
Black	0.17	0.37	0.22	0.41	0.25	0.43
Hispanic	0.25	0.43	0.14	0.35	0.19	0.40
Test Score	48.87	8.01	54.39	7.99	44.85	7.63
Father's Education:						
Missing	0.19	0.39	0.15	0.36	0.25	0.43
Vocational School	0.08	0.27	0.07	0.25	0.07	0.25
Some College	0.12	0.32	0.11	0.31	0.05	0.23
Has BA	0.15	0.35	0.27	0.44	0.05	0.22
Mother's Education:						
Missing	0.11	0.32	0.07	0.25	0.16	0.37
Vocational School	0.09	0.29	0.10	0.29	0.06	0.24
Some College	0.13	0.34	0.15	0.35	0.06	0.23
Has BA	0.09	0.29	0.20	0.40	0.04	0.19
Family Income (\$80)	20126	15617	23481	18358	15965	13804
Family Income Missing	0.08	0.27	0.08	0.27	0.13	0.33
Own Home	0.79	0.41	0.80	0.40	0.73	0.44
% High School Enrollment that is White	64.62	32.23	68.84	33.06	66.95	34.18
Urban	0.26	0.44	0.27	0.44	0.25	0.43
City Unemployment Rate	7.42	2.64	7.52	2.68	7.74	2.78
State Income per Capita (\$82)	11347	1201	11039	1210	10731	1259
State Avg. Manufacturing Wage (\$82)	9.30	1.29	9.59	1.32	9.46	1.41
Northeast	0.14	0.35	0.26	0.44	0.19	0.39
Midwest	0.19	0.39	0.28	0.45	0.26	0.44
South	0.35	0.47	0.31	0.46	0.39	0.49
West	0.33	0.47	0.15	0.35	0.16	0.37
Completed BA by 1986	0.11	0.32	0.42	0.49	0.01	0.08
Years of Education	13.51	1.49	14.89	1.60	12.30	0.87
Miles to Two-year College	10.82	16.69	17.36	28.79	21.71	30.07
Miles to Four-year College	18.17	23.65	14.67	20.44	21.26	25.67
Two-year Tuition in State (\$82)	389.80	295.83	547.00	280.90	515.20	262.16
Four-year Tuition in State (\$82)	710.73	355.55	864.09	319.69	832.27	321.23
Vocational/Technical School	NA		NA		0.25	0.43
Number of Observations	1695		2755		2358	

APPENDIX III
EDUCATIONAL ATTAINMENT: THE IMPORTANCE OF THE OTHER VARIABLES
Instrumental Variables Results

Independent Variables	Dependent Variable: Years of Education	Dependent Variable: 1=BA/0=No BA
Female	0.109 (0.037)	0.026 (0.009)
Black	0.310 (0.062)	0.010 (0.015)
Hispanic	0.189 (0.061)	0.011 (0.014)
Test Score	0.087 (0.003)	0.015 (0.001)
Father's Education:		
Missing	0.001 (0.054)	-0.010 (0.011)
Vocational School	0.007 (0.075)	-0.005 (0.018)
Some College	0.214 (0.071)	0.036 (0.019)
Has BA	0.571 (0.063)	0.102 (0.018)
Mother's Education:		
Missing	-0.023 (0.065)	0.014 (0.013)
Vocational School	0.235 (0.069)	0.033 (0.018)
Some College	0.395 (0.064)	0.037 (0.017)
Has BA	0.535 (0.067)	0.121 (0.019)
Family Income (\$80) (x10000)	0.102 (0.014)	0.020 (0.004)
Family Income Missing	0.137 (0.073)	0.032 (0.016)
Family Owns Home	0.138 (0.047)	0.023 (0.010)
% of High School Enrollment is White (x10)	-0.046 (0.008)	-0.070 (0.019)
City Unemployment Rate	0.025 (0.008)	0.003 (0.002)
State Avg. Mfg. wage (\$80)	-0.031 (0.024)	-0.008 (0.005)

NOTES: There are 6808 observations. Standard errors are in parentheses. The coefficients are from instrumental variables with miles from the respondent's high school and the number of miles squared as instruments; they are from the same estimation as the second row of coefficients in Table 2. The equation explaining attainment of a BA is uses a linear probability model in the second-stage and the standard errors are corrected for heteroskedasticity using White's (1980) method. Also included in the specifications: a constant, whether the respondent started in a two-year college, average four-year college tuition in state of residence, miles from respondent's high school to the nearest four-year college, average income per capita in high school state of residence, urban status of high school, and region dummies.