Econometric Evidence Regarding Education and Border Income Performance

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2006

ECONOMETRIC EVIDENCE REGARDING EDUCATION AND BORDER INCOME PERFORMANCE

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ABSTRACT

This study examines the relationship between education and income in Texas counties that are located along the border with Mexico. Estimation results confirm earlier research for this region. Parameter heterogeneity underscores the increased importance of education in the service-oriented labor that has emerged in recent years in the United States. Simulation results quantify the income gains that could potentially be observed if drop out rates were lowered in the border counties included in the sample.

ACKNOWLEDGEMENTS

Partial funding support for this research was provided by Partial financial support for this research was provided by National Science Foundation Grant SES-0332001, Southwest Consortium for Environmental Research and Policy Grant W-04-03, El Paso Electric Company, and Wells Fargo Bank of El Paso. Helpful comments were provided by Roberto Tinajero, Martha Patricia Barraza, and Cesar Olivas. Econometric research assistance was provided by Brian Kelley and Marycruz De Leon.

INTRODUCTION

Substantial research effort has been directed toward answering questions regarding how educational attainment and earnings are related. For impoverished regions and low-income groups in society, this question is important. Mora and Dávila (1998) present evidence for Hispanic immigrants that additional years of formal schooling enhance earnings at a decreasing rate. For Texas counties along the border with Mexico, Fullerton (2001) estimates fairly strong linkages between education and per capita earnings. The latter study relies on data from the 1990 census of the United States.

Empirical results obtained in those articles form part of a larger literature that indicates that educational attainment increases earnings potential and helps reduce poverty. There exist numerous studies published at different points in time for widely variant data sets that reach this basic conclusion (Becker, 1964; Welch, 1970; Orley & Krueger, 1994; Jones, 2001; Partirdge & Rickman, 2005). At the microeconomic level, the evidence that human capital increases productivity and, therefore, output is particularly strong (Sianesi & Reenen, 2003). The behavior of this relationship over time has not been addressed quite as often in regional contexts.

Several studies report rates of return estimates that oscillate between 6 and 11 percent for each additional year of formal schooling (Sianesi & Reenen, 2003). This paper attempts to shed additional light on the relationship between education and earnings in Texas border counties using United States census data from 1990 and 2000. Additional data on the 254 counties contained in Texas from the United States Bureau of Economic Analysis Regional Economic Information System (REIS) are also employed. Subsequent sections include a review of the literature, data and methodology, and empirical results. Conclusions and suggestions for future research are presented in the final section.

LITERATURE REVIEW

Texas is the second largest state in the United States. It has 261,914 square miles divided into 254 counties. In 2000, the United States Census Bureau reported a Texas population of 20,851,820. Data from the United States Bureau of Economic Analysis (2001) indicate that Texas ranks twenty-seventh in per capita personal income at $28,472. Educational attainment in Texas falls slightly below the national average. There is a narrow gap of 70 basis points between the state and the national averages for the percentage of people who dropped out of high school in 2000 (12.8 and 12.1 percent, respectively). However, for the percentage of people 25 and over who attended college partially, there is a wider gap. The national average is 27.4 percent while that for Texas is only 22.3 percent (U.S. Census Bureau, 2000). Many border counties lag further behind the national averages than the state taken as a whole.

A variety of empirical studies confirm that higher levels of education increase the likelihood for higher earnings through productivity improvements (Rosenzweig, 1995; Jones, 2001; Psacharopoulos & Patrinos, 2002). Accordingly, if income performance is to improve in Texas, educational attainment levels in the state will have to increase. This objective is especially important in low-income Texas counties. Among the latter, border counties exhibit some of the lowest regional earnings and education performances (Peach & Adkisson, 2000; Levernier, Partridge & Rickman, 2000; Fullerton, 2001).

Schultz (1971) encourages the use of human capital measures to explain growth. In the United States during the 1929-1956 periods, sustained economic growth was attained despite a reduction in the capital to income ratio. Schultz (1971) argues that such a pattern can only be explained by increases in the productivity of workers. Such improvements in productivity, it is argued, are realized through gains in formal education and other human capital investments. Education, approximated by median years of schooling, has also been found to exert a similarly favorable impact on aggregate output using regional state data in both the United States and Mexico (García-Mila & McGuire, 1992; Arellano & Fullerton, 2005).

Several studies have also been completed using city and county level data to allow completion of sub-state regional analyses. In addition to Texas border counties, sections of other states that have been examined include southern Missouri (Domazlicky, Benne, McMahon, Myers, & Skinner, 1996), southern Illinois (Sloboda, 1999), and southern Georgia (Rickman, 1993). Estimation results in those papers are further employed to simulate the per capita and countywide income gains that would be associated with greater educational attainment. Given the shift in labor market demands across the country in recent years, it is reasonable to expect that real potential earnings improvements calculated in those papers to understate those currently available in most regional markets (Rauch, 1993).

This study examines that possibility by taking advantage of new county level data reported for Texas in the 2000 census. For many border areas, below-average educational attainment continued to be observed in 2000 (Fernández, Amastae, & Howard, 2003). In addition, the analysis tests whether pooling with the 1990 census data should be utilized. Once parameter estimation is complete, per capita and countywide simulations of the potential income impacts of additional schooling are calculated.

DATA AND METHODOLOGY

A large number of research efforts have estimated the returns to higher levels of education. The majority of these studies use either time-series or cross-sectional data. For the study at hand, a pooled cross-section and time series data set for the 254 counties in Texas is collected to determine how schooling affects earnings. Industrial change has affected regional economies and the demand for labor throughout the United States (Levernier, Partridge, & Rickman, 2000; Morrill, 2000; Gottlieb & Fogarty, 2003). As a result, structural changes in the Texas economy may rule against pooling both sets of census data. Parameter heterogeneity testing is used to see whether the sample data can be pooled for modeling purposes. A Chow F-test will be used to consider whether that step would be statistically sound (Wooldridge, 2003).

Data collected are primarily the same as those analyzed in Fullerton (2001). The left-hand side variable is per capita income. Independent variables include four that describe educational attainment. These are the percentage of adults who are 25 and over and dropped out of high school, the percentage who are 25 and over and graduated from high school, the percentage who are 25 and over and attended some college, and the percentage who are 25 and over and graduated from college. Several additional socioeconomic variables were initially included in the sample, but are excluded from the results discussed below due to statistical insignificance and economic irrelevance (McCloskey & Ziliak, 1996).

Two dummy variables are also included. One reflects the size of the population of the county under observation, and the other identifies Texas counties along the border with Mexico. Larger counties are likely to exhibit agglomeration and other externalities. Consequently, they generally observe above average incomes than do smaller areas (Glaeser & Mare, 2001). Because the United States is a higher income labor market than Mexico, labor migration effects are likely to depress wages on the north side of the international boundary and raise them on the southern side due to labor supply effects (Harris & Todaro, 1970). Migrants from Mexico generally exhibit relatively low educational achievement profiles, also impacting border county labor productivity (Gottlieb & Fogarty, 2003). Accordingly, the Texas border counties in the sample may exhibit lower incomes than their non-border counterparts.

Texas is a large state with wide ranging socioeconomic characteristics. Consequently, the sample includes heavily populated counties such as Harris, 3.4 million persons in 2000, and Dallas, 2.2 million persons in 2000. It also includes lightly populated counties such as Loving, 67 people in 2000, and King, 356 inhabitants in 2000. Given those extremes, heteroscedasticity is likely to be present in the residuals of any equation that is estimated. This possibility will be examined using a chi-square test. If the residuals are heteroscedastic, the covariance matrix will be re-estimated using the White (1980) procedure.

Least squares regression has been shown to provide realistic estimates of the returns associated with educational attainment and is utilized herein (Angrist & Krueger, 1991). Once parameter estimation is complete, the resulting coefficients are used to examine the impacts of educational shortfalls on personal income performance in border counties. For counties in which educational attainment is below the state average, per capita income gains are calculated by taking the percentage point increase required to raise reach the state figure and then multiplying it by the corresponding regression coefficient. For aggregate income improvements, each per capita gain is multiplied by the respective county population totals.

EMPIRICAL RESULTS

The basic pooled cross section equation initially tested can be expressed as follows:

1. $$PCINC_{it} = b_0 + \sum_k b_k x_{kit} + e_{it} ,$$

where $i = 1, 2, 3, \ldots, 254$ for each of the counties in Texas; $t = 1990$ or 2000 for the two census years; $k = 1, 2, 3, \ldots, K$ depending on the number of independent variables included; and the e_{it} error term is assumed to be homoscedastic. Testing with several specifications resulted in the selection of three educational achievement variables and two dummy variables. They include the percentage of adults 25 and over that graduated from high school in each county (HSGR25), the percentage of adults 25 and over that attended some college (COLSOM25), and the percentage of adults 25 and over that graduated from college (COGR25). Readers should note that the fourth educational variable, adults 25 and over who did not graduate from high school, is excluded in order to avoid perfect collinearity. Given that, the signs of remaining three educational slope coefficients are expected to be positive.

Two dummy variables are also included in the model specification. Using the definition introduced by Fullerton (2001), the first dummy is for urban counties (URBAN) with populations in excess of 600,000. As previously discussed, the sign for the parameter estimated for this variable is expected to be greater than zero. The second dummy (BORDER) is defined for counties that are adjacent to Mexico. The sign for coefficient associated with the second qualitative regressor is expected to be negative. Definitions for all of the variables are provided in Table 1.

If parameter heterogeneity is indicated by the Chow F-test, then Equation 1 will simplify to the expression shown here:

2. $$PCINC_i = b_0 + \sum_k b_k x_{ki} + e_i ,$$

where $i = 1, 2, 3, \ldots, 254$ for each of the counties in Texas; $k = 1, 2, 3, \ldots, K$ depending on the number of independent variables included; and the e_{it} error term is assumed to be homoscedastic. If the reduced sample estimate is required, only data from 2000 will be employed for this version of the model. The hypothesized coefficient signs are the same as for Equation 1.

TABLE 1
VARIABLE NAMES AND DEFINITIONS

Mnemonic	Definition
PCINC	County per capita personal income level in 2000
HSDR25	Percentage of adults 25 and over that did not finish high school
HSGR25	Percentage of adults 25 and over that graduated from high school
COLSOM25	Percentage of adults 25 and over that attended some college
COGR25	Percentage of adults 25 and over that graduated from college
URBAN	Dummy = 1 if 1990 population exceeds 599,999; 0 otherwise
BORDER	Dummy = 1 if county is adjacent to Mexico; 0 otherwise

Estimation results using the pooled data are shown in Table 2. At first glance, these results exhibit good econometric traits. All parameter signs conform with their respective null hypotheses. Further, the computed t-statistics for each of the explanatory variables are significant at the 5-percent level. Once the sample is split between 1990 and 2000 observations, the F-test for parameter heterogeneity shown in Table 3 indicates that parameter instability exists. Consequently, pooling the 1990 and 2000 data would incorrectly impose parameter homogeneity (Wooldridge, 2003). Given that outcome, only the equation estimated using the 2000 sample observations is used for the simulation exercises.

A chi-square test (White, 1980) performed on residuals estimated using the 2000 data indicates that heteroscedasticity is present in the sample (see Table 4). Given that result, the estimation outputs shown in Tables 5 and 6 are calculated using corrected covariance matrices. Utilization of the latter does not change the values of the regression coefficients, but insures that the computed t-statistics can be reliably used for hypothesis testing (Wooldridge, 2003).

Comparison of the 1990 and 2000 estimation results highlights differences between the regression coefficients. The dependent variable in both sets of results is per capita income measured in 2000 dollars. In 2000, the premium paid to high school graduates is substantially lower than that observed for the 1990 data. Similarly, the additional income that a person receives after attending at least some college, or from graduating from college, is higher in 2000 than in 1990. Also shown in Tables 5 and 6, the urban county income premium is more than double of what it was in 1990, and the border counties in Texas are more economically penalized in 2000.

Those coefficient magnitude differences potentially reflect structural changes that have changed the demand for labor in the Texas economy at large and the border region in particular (Petersen & Caputo, 2004; Cañas, 2002). Although many jobs have been lost in Texas manufacturing sectors, large gains have simultaneously been tallied in tertiary segments of the state economy. Examples of the latter include education, health care, business services, and information technology activities. As a result, the Texas economy may have paid higher premiums for educational attainment in 2000 than was the case ten years earlier.

TABLE 2

POOLED ORDINARY LEAST SQUARES ESTIMATION RESULTS

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Constant	3582.748	1699.782	2.107769	0.0355
HSGR25	147.6071	47.02596	3.138843	0.0018
COLSOM25	412.3607	51.06984	8.074447	0.0000
COGR25	291.4581	41.95433	6.947031	0.0000
URBAN	4629.224	1333.915	3.470404	0.0006
BORDER	-3330.080	880.0061	-3.784156	0.0002

R-squared	0.420718	Mean dependent variable	20014.84
Adjusted R-squared	0.414949	Std.Dvn. dependent variable	5216.184
S.E. of Regression	3989.788	Akaike info criterion	19.43260
Sum Squared Resid.	7.99E+09	Schwarz info. criterion	19.48257
Log Likelihood	-4929.882	F-statistic	72.91812
Durbin-Watson stat.	1.977007	Prob. (F-statistic)	0.000000

Notes:
Dependent Variable, PCINC
Sample, 1990 and 2000 Census Data, 254 Texas Counties
Included Observations, 508

TABLE 3
F-TEST FOR PARAMETER HETEROGENEITY

Chow Breakpoint at Observation 255

F-statistic	5.024775	Probability	0.000051
Log Likelihood Ratio	29.97599	Probability	0.000040

Overall statistical traits for the equation shown in Table 6 are good. The adjusted R-square coefficient of determination is 37.7 percent, fairly high for heterogeneous cross section data. All but one of the t-statistics are statistically significant at the 5-percent confidence level and all of the coefficients exhibit plausible signs and magnitudes. Furthermore, the F-statistic for joint significance surpasses its 1-percent critical value.

TABLE 4
CHI-SQUARE HETEROSCEDASTICITY TEST

White Heteroscedasticity Test			
F-statistic	16.85792	Probability	0.000000
Obs*R-squared	143.1432	Probability	0.000000

The main hypothesis tested is that per capita personal income in Texas benefits from greater educational achievement. Parameter estimates in Table 6 depict such a pattern as each successive level of education raises county per capita incomes. As is the case in Fullerton (2001), counties with larger populations exhibit higher incomes than do their smaller counterparts. Reflective of well-known earnings differential migration patterns between high and low wage markets, border counties adjacent to Mexico exhibit lower incomes (Harris & Todaro, 1970).

TABLE 5
HETEROSCEDASTICITY CONSISTENT REGRESSION OUTPUT, 1990 DATA

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Constant	2539.304	1868.345	1.359119	0.1753
HSGR25	190.5578	50.05117	3.807260	0.0002
COLSOM25	217.4538	77.52722	2.804871	0.0054
COGR25	218.8657	65.83716	3.324349	0.0010
URBAN	2542.586	1234.340	2.059874	0.0405
BORDER	-2763.392	627.7881	-4.401791	0.0000

R-squared	0.400664	Mean dependent var.	14711.18
Adjusted R-squared	0.388580	Std. Dvn. dependent var.	3385.411
Std. Err. Regression	2647.165	Akaike info. criterion	18.62370
Sum Squared Resid.	1.74E+09	Schwarz info. criterion	18.70726
Log Likelihood	-2359.210	F-statistic	33.15823
Durbin-Watson stat.	2.042666	Prob. (F-statistic)	0.000000

Notes:
Dependent Variable, PCINC
Included observations, 254

TABLE 6
HETEROSCEDASTICITY CONSISTENT REGRESSION OUTPUT, 2000 DATA

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Constant	7261.917	3627.321	2.002006	0.0464
HSGR25	26.89789	55.34949	0.485965	0.6274
COLSOM25	456.7534	221.1108	2.065722	0.0399
COGR25	272.2920	107.4147	2.534960	0.0119
URBAN	5500.033	2060.172	2.669697	0.0081
BORDER	-3857.339	1416.995	-2.722196	0.0069

R-squared	0.376719	Mean dependent var.	21754.02
Adjusted R-squared	0.364153	Std.Dvn. dependent var.	5546.473
Std. Err. Regression	4422.760	Akaike info. criterion	19.65025
Sum Squared Resid.	4.85E+09	Schwarz criterion	19.73381
Log Likelihood	-2489.582	F-statistic	29.97884
Durbin-Watson stat.	2.000351	Prob. (F-statistic)	0.000000

Notes:
Dependent Variable, PCINC
Included observations, 254

One problem facing most Texas border counties is below-average educational attainment. The regression equation in Table 6 can be used to calculate potential gains associated with improved educational achievement. Three sets of those calculations are summarized in Tables 7, 8, and 9. In several instances, border counties exhibit educational achievement rates that exceed the state average. In such cases, no calculations are performed.

The potential income gains from greater educational achievement are substantial. As shown in Table 7, raising border county high school graduation rates to the state average leads to several notable improvements. The estimated largest income per capita gain, $215, is realized by Starr County. Nearby Hidalgo County experiences the largest aggregate increase at just over $70 million. For the border region as a whole, the total improvement for increased high school graduation rates surpasses $213 million. As noted above, estimated gains are calculated by raising the county's school attainment rate to the state's average for per capita gains. For aggregate gains, the per capita gain is multiplied times the county's population.

The impact of increasing the percentage of adults 25 and over who attended at least some college in border counties is shown in Table 8. A $5,938 per capita gain is estimated for Starr County, followed closely by Presidio County with an additional $5,618 income per capita. The aggregated gains for Hidalgo County alone exceed $2.0 billion. For the entire border area, the implied income loss resulting from below average participation in partial college attendance is estimated to be greater than $4.3 billion.

TABLE 7
INCOME GAINS FROM INCREASED HIGH SCHOOL GRADUATION RATES

County	Per Capita Impact	Aggregate Impact
Brewster	$102	$906,211
Cameron	$129	$43,281,115
El Paso	$62	$42,044,915
Hidalgo	$124	$70,459,824
Hudspeth	$116	$386,770
Jeff Davis	$159	$350,245
Kinney	NC	NC
Maverick	$164	$7,760,356
Presidio	$134	$982,311
Starr	$215	$11,533,170
Terrell	NC	NC
Val Verde	$3	$120,653
Webb	$186	$35,841,635
Zapata	NC	NC
Border Zone	$110	$213,667,206

Notes:
Texas state high school graduation rate among adults 25 or over in 2000 was 24.9 percent.
All impacts are calculated in 2000 dollars for 2000 schooling rates relative to the Texas average.
Border Zone per capita estimate is a weighted average net of Kinney, Terrell, and Zapata Counties.

Table 9 examines the impact of increased college graduation rates for the border counties in Texas. Once again, the greatest potential per capita increase is available in Starr County, an additional $4,438 per person. That is followed by Zapata County with a potential $3,948 increase. Total county income gains of more that $1.2 billion are tallied for El Paso County and Hidalgo County. For the border zone as a whole, matching the state average for college graduation results in more than $4.8 billion in higher personal incomes.

It seems clear that increased educational achievement rates in the border counties provide beneficial economic result. For the region as a whole, raising performance to the state average is estimated to increase personal income by a total of slightly more than $9.4 billion. That figure represents 30.5 percent of total personal income in this 14 county region in Texas. Income growth of that magnitude would help expand local tax bases in each of the individual counties by large amounts. An accurate estimate of the net economic gains that increased schooling rates offers would require a fairly extensive cost-benefit analysis. A large-scale study of that nature, however, falls beyond the scope of this study. Nevertheless, it is probably safe to argue that such increases in educational achievement rates will yield a positive net present value for the border area as a whole in Texas. Failure to do so will potentially lead to long-run negative consequences for regional labor market performance and standards of living (Simon, 1998; Partridge & Rickman, 2005).

TABLE 8
IMPLIED INCOME GAINS FROM INCREASED LIMITED COLLEGE ATTENDANCE

County	Per Capita Impact	Aggregate Impact
Brewster	NC	NC
Cameron	$2,192	$734,957,146
El Paso	$320	$217,293,761
Hidalgo	$3,608	$2,054,822,875
Hudspeth	$4,248	$14,204,665
Jeff Davis	$2,878	$6,350,745
Kinney	$2,055	$6,945,164
Maverick	$5,253	$248,435,254
Presidio	$5,618	$41,034,360
Starr	$5,938	$318,247,956
Terrell	NC	NC
Val Verde	$2,786	$124,977,596
Webb	$2,923	$564,523,817
Zapata	$3,289	$40,062,023
Border Zone	$2,240	$4,371,855,362

Notes:
Texas state limited college attendance rate among adults 25 and over in 2000 was 22.3 percent.
All impacts are calculated in 2000 dollars for 2000 schooling rates relative to the Texas average.
Border Zone per capita estimate is a weighted average net of Brewster and Terrell Counties.

TABLE 9
IMPLIED INCOME GAINS FROM INCREASED COLLEGE GRADUATION RATES

County	Per Capita Impact	Aggregate Impact
Brewster	NC	NC
Cameron	$2,668	$894,540,377
El Paso	$1,797	$1,221,367,182
Hidalgo	$2,805	$1,597,120,258
Hudspeth	$3,676	$12,292,350
Jeff Davis	NC	NC
Kinney	$1,498	$5,060,411
Maverick	$3,839	$181,588,186
Presidio	$3,131	$22,871,439
Starr	$4,438	$237,882,759
Terrell	$1,144	$1,236,260
Val Verde	$2,478	$111,146,763
Webb	$2,532	$489,033,192
Zapata	$3,948	$48,097,387
Border Zone	$2,472	$4,822,236,562

Notes:
Texas state college graduation rate among adults 25 and over in 2000 was 23.2 percent.
All impacts are calculated in 2000 dollars for 2000 schooling rates relative to the Texas average.
Border Region per capita estimate is a weighted average net of Brewster and Jeff Davis Counties.

CONCLUSION

This study attempts to quantify the relationships that various levels of educational attainment share with personal income in Texas border counties. Various efforts to explain and quantify the relationship of such variables using times series or cross sectional data have been completed. However, the use of pooled cross sectional and time series data is rarely found in this branch of the regional economics literature. For the study at hand, a pooled cross-section and time series data set for the 254 counties in Texas is used to determine how schooling affects earnings in the border area. Census data for Texas from both 1990 and 2000 are utilized.

To examine the earnings-education relationship, a model is specified similar to those estimated for other regional economies in the United States and Mexico. An F-test for parameter heterogeneity indicates that the data should not be pooled. Empirical results obtained from OLS parameter estimation using 2000 data point to significant positive correlations between income and education in Texas counties. Simulations with the model further indicate that counties along the border with Mexico can garner substantial income improvements by increasing educational attainment performance among the members of their adult labor forces.

Additional research regarding the net economic costs of increasing graduation rates may prove beneficial. However, it is arguable that increasing graduation rates will consistently yield net positive social returns. While the results for Texas border counties are consistent with Fullerton (2001), they may not be representative for other regional economies with different socio-economic characteristics. Replication for other geographic areas, therefore, would also be useful.

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