

THE EFFECTS OF EDUCATION, INFRASTRUCTURE, AND DEMOGRAPHICS ON REGIONAL INCOME PERFORMANCE IN MISSOURI

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Abstract: The objective of this study is to examine the potential impacts of different levels of educational attainment and infrastructure investment on income performance within the state of Missouri. Data are collected for all of Missouri's 114 counties. Endogeneity testing is carried out and both ordinary least squares and two-stage least squares parameter estimates are presented. Results indicate that increased educational attainment levels and enhanced private capital stocks are associated with income gains. The effects of public capital stocks are not as clear-cut. Model simulations show the possible income gains from increasing educational attainment levels.

JEL Codes: I25 - Education and Economic Development; O18 - Urban, Rural, Regional, and Transportation Analysis; Housing; Infrastructure; R15 – Regional Econometrics

Keywords: Infrastructure, Education, Economic Development, Missouri

I. Introduction

The American Recovery and Reinvestment Act (ARRA) calls for greater investment in education and infrastructure (U.S. Department of Education, 2009; White House, 2009). ARRA is billed as a means of stimulating the economy in the short-term and improving the long-term economic health of the nation. Its expenditures are distributed across federal, state, and local governments. Proponents of ARRA anticipate that improvements in the public stock of physical capital and higher levels of educational attainment will boost productivity and enhance economic performance at the national, state, and local levels. To analyze this possibility at the state level, an empirical analysis of Missouri personal income is performed.

The potential impacts of infrastructure investment and educational attainment on income performance are examined for the 114 counties in the state of Missouri. Data on educational attainment, public infrastructure, private capital stocks, and demographic characteristics are collected for each county. Regression analysis is used to quantify the potential contributions of education and physical infrastructure to changes in personal income. Out of sample simulation analyses are also employed to examine whether higher levels of educational attainment will aid regional income performance.

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Acknowledgements: Financial support for this research was provided by Hunt Communities, El Paso Water Utilities, JPMorgan Chase Bank of El Paso, Texas Department of Transportation, UTEP Center for the Study of Western Hemispheric Trade, and a UTEP College of Business Administration Faculty Research Grant. Econometric research assistance was provided by Francisco Pallares. Helpful comments and suggestions were provided by Doyle Smith and Dennis Bixler-Marquez.

Subsequent sections of the study are as follows. The relevant literature is summarized in section II. Data sources and methodology are discussed next. Empirical results of the analysis are presented in section IV. A simulation exercise is subsequently undertaken to explore the potential impacts of increased educational attainment on county-level per capita income. This is followed by a discussion of policy implications and a conclusion.

2. Prior Research

An extensive literature addresses the relationship between education and economic development. Schultz (1988) views education as a public good with positive externalities which increases economic efficiency. Numerous empirical studies analyze the relationship between education and growth. Gottlieb and Fogarty (2003) report that higher educational attainment levels are associated with faster per capita income growth in metropolitan areas. Thompson (1998) finds a negative and statistically significant relationship between the share of the adult population without a high school education and per capita income levels across U.S. states. Evidence has also been documented that low incomes are related to below average levels of human capital within regions (de Young, 1985).

A number of empirical studies analyze the impacts of education at the county level in the United States. Domazlicky et al. (1996) provide evidence that an increase in a county's high school non-completion rate is associated with a decline in personal income. Similarly, Dodge (2003) employs two stage least squares to show that higher levels of educational performance are related to higher levels of income for 44 Indiana counties. Fullerton (2001) reports that educational attainment is correlated with higher income levels across Texas counties. Partridge and Rickman (2005) show that some nonmetropolitan counties that began the 1990s with high poverty rates had lower poverty rates by the end of the decade. The empirical results indicate that this was possible due to relatively high levels of education initially present in some of the nonmetropolitan counties.

Some studies distinguish the impact of each level of education individually while holding the effects of other levels of education constant. Almada et al. (2006) use time series and cross sectional data to demonstrate that each successive level of education completed raises county per capita incomes in Texas. Similar results are reported for Arkansas by Fullerton et al. (2010). Blöndal et al. (2002) find that the wage premium is higher for those with higher education than for those with only secondary education. Private and social rates of return to secondary and tertiary education are calculated for a group of developed countries. The average private internal rates of return are above 10 percent for both levels of educational attainment, indicating that the benefits of education outweigh the costs by a substantial margin.

Infrastructure has also been found to influence regional productivity (Thompson and Chandra, 1998). Aschauer (1989) reports that public infrastructure such as highways and streets enhance productivity. Similarly, Garcia-Mila and McGuire (1992) use panel data to provide evidence of positive effects of highway infrastructure and education on output. A logarithmic specification yields results that indicate that both variables influence output. Destefanis and Sena (2005) analyze the relationship between total factor productivity and public capital. In that study, public capital refers to roads,

airports, education, and public buildings. Empirical results demonstrate that, for various Italian administrative regions, public capital stocks have significant impacts on total factor productivity.

Bronzini and Piselli (2009) analyze regional growth due to the interaction of total factor productivity, research and development expenditures, human capital, and public infrastructure across Italian regions. New infrastructure is believed to add value to existing public capital and draw in even more investment. The results illustrate the positive relationship between the public capital stock and total productivity. Motorways are the type of infrastructure found to exercise the strongest positive effect on productivity.

This research attempts to quantify the potential benefits of greater infrastructure development and educational attainment for the 114 counties in Missouri. The study includes both public infrastructure and private capital stock variables. Additionally, various measures of educational attainment are included to measure the correlation between income and education. Several equation specifications are implemented to assess the possible gains, or shortfalls, associated with the explanatory variables. In the following section, data and methodology for the study are explained in greater detail.

3. Data and Methodology

Missouri covers 69,704 square miles, making it the 21st largest state in terms of land area. In the year 2000, the state's total population was 5,595,211 (US Census Bureau, 2000). Its four largest urban areas are St. Louis, Kansas City, Springfield and Columbia. Missouri is home to 67 postsecondary educational institutions (Carnegie Foundation for the Advancement of Teaching, 2012). Table 1 offers a brief profile of the state of Missouri. Maximum and minimum figures refer to county-level data.

Table 1: Missouri State Profile (2000)

Variable	State	Maximum	Minimum
Population	5,595,211	1,016,315	2,382
Area	69,704 sqm	-	-
Persons Per Square Mile	80.3	2,000.6	8.2
Per Capita Income	\$19,936	\$27,595	\$11,492
Total Centerline Highway Miles	32,333.14	504.52	138.99

This analysis utilizes data on educational attainment levels, capital stocks, and demographic characteristics to study regional income levels across the 114 counties in Missouri (the independent city of St. Louis is not included in the analysis). Data on all of the socioeconomic variables are collected from the U.S. Census Bureau for the year 2000. Table 2, below, provides a list of the variable names and descriptions. As with previous research, the dependent variable in the econometric model is per capita income. Potential explanatory variables are described next.

Table 2: Variables Names and Descriptions

Variable	Description
HSDR25	Percentage of adults 25 and older who have dropped out of high school
HSGR25	Percentage of adults 25 and older who graduated high school
COLSOM25	Percentage of adults 25 and older who attended college partially
BACHGRAD25	Percentage of adults 25 and older who hold at least a bachelor's degree
FLFPR	Female labor force participation rate
POPLT18	Percentage of population age 18 or less
POPGT65	Percentage of population age 65 or more
PCTENGL	Percentage of individuals who speak English only
PCTSPNH	Percentage of individuals who speak Spanish only
POP	County population
DENSITY	Population density per square mile
AIRPC	Commercial airport takeoffs and landings per capita
AIRMILES	Miles to nearest commercial airport
CENPC	Centerline highway miles per capita owned by the state
LANE	Per capita state highway lane miles
PROPC	Per capita private sector property tax valuation, market value
PCINC	County per capita income

Several educational attainment variables are collected. These variables measure the percentage of each county's adult population comprised by high school dropouts, high school graduates, holders of bachelor's and graduate degrees, and people who have some college education but who lack a degree from a four-year college. It is expected that educational achievement will be positively correlated with regional per capita income (Domazlicky et al., 1996).

Demographic variables are also included in the study. The first one is the female labor force participation rate. The study hypothesizes that, as the participation of females in the work force increases, income levels will rise. The second variable is the percentage of the population under the age of 18. As the representation of children and adolescents in the total population grows, income levels are likely to fall. Most young people do not work or do not hold a full time job. Lastly, changes in the percentage of the population over the age of 65 are anticipated to have ambiguous effects on income. Retirement may entail lower levels of income for people in this age category. It is also possible that, when an individual retires, income levels can increase due to transfer payments, pension payments, and other mechanisms (Fullerton, 2001).

In order to fully analyze per capita income levels, variables for public capital stocks are included in the study. Fan and Zhang (2004) provide evidence that increasing investment in rural infrastructure within China raises income levels for the rural area. Physical infrastructure variables include centerline highway miles owned by the state in each county and total state highway mileage by county. Data on air transportation

infrastructure include the number of air tower operations and the distance to the nearest airport. The counties that have a commercial service airport are Boone, Greene, Jasper, Platte, Pulaski, and St. Louis (Federal Aviation Administration, 2010). Figure 1 indicates the geographical location of each one. In addition, Figure 2 is a representation of Missouri's centerline highway miles owned by the state.

Prior research points to income gains associated with private capital stocks (Bronzini and Piselli, 2009). The inclusion of private capital stock data in the analysis may improve the understanding of factors affecting per capita income performance in each county. Private capital stocks are measured by property tax valuation for residential, commercial and industrial real estate across Missouri for 2000. The data on property tax valuation are from the State Tax Commission of Missouri.

As noted, the model attempts to quantify the potential impacts of infrastructure and educational attainment on per capita income. The association between the dependent variable and the independent variables is as follows:

$$PCINC_i = b_0 + \sum b_k x_{ki} + e_i,$$

where i ranges from 1 to 114 for each county in Missouri; k goes from 1 to K and represents the number of explanatory variables included; and e_i represents the error term.

The equation assumes that causality is from the right-hand side to the left-hand side. Increases in educational attainment and greater investment in public infrastructure and private capital stocks should increase per capita income. Simultaneity between income and education may exist if counties offering higher wages disproportionately attract migrants with higher levels of education. Individuals possessing advanced education have a strong incentive to live in places that provide relatively large returns to human capital, which may lead to their concentration in high income areas (Galor and Stark, 1994; Lucas, 2004). If the education variables are endogenous, ordinary least squares parameter estimation will be inconsistent. Davidson and MacKinnon (1989) address the issue of parameter consistency with an artificial regression test. The implementation of this test will shed light on the possibility that endogeneity exists between per capita income and its regressors. Recent evidence of this type of simultaneity has been reported for other regional economies (Trostel et al., 2002; Lillo and Casado-Díaz, 2010).

A variety of studies have documented strong correlation between education and regional incomes. This study also includes public infrastructure and private capital stocks for all Missouri counties as regressors. To allow for diminishing returns, the data are transformed prior to estimation using natural logarithms. Empirical results are discussed below.

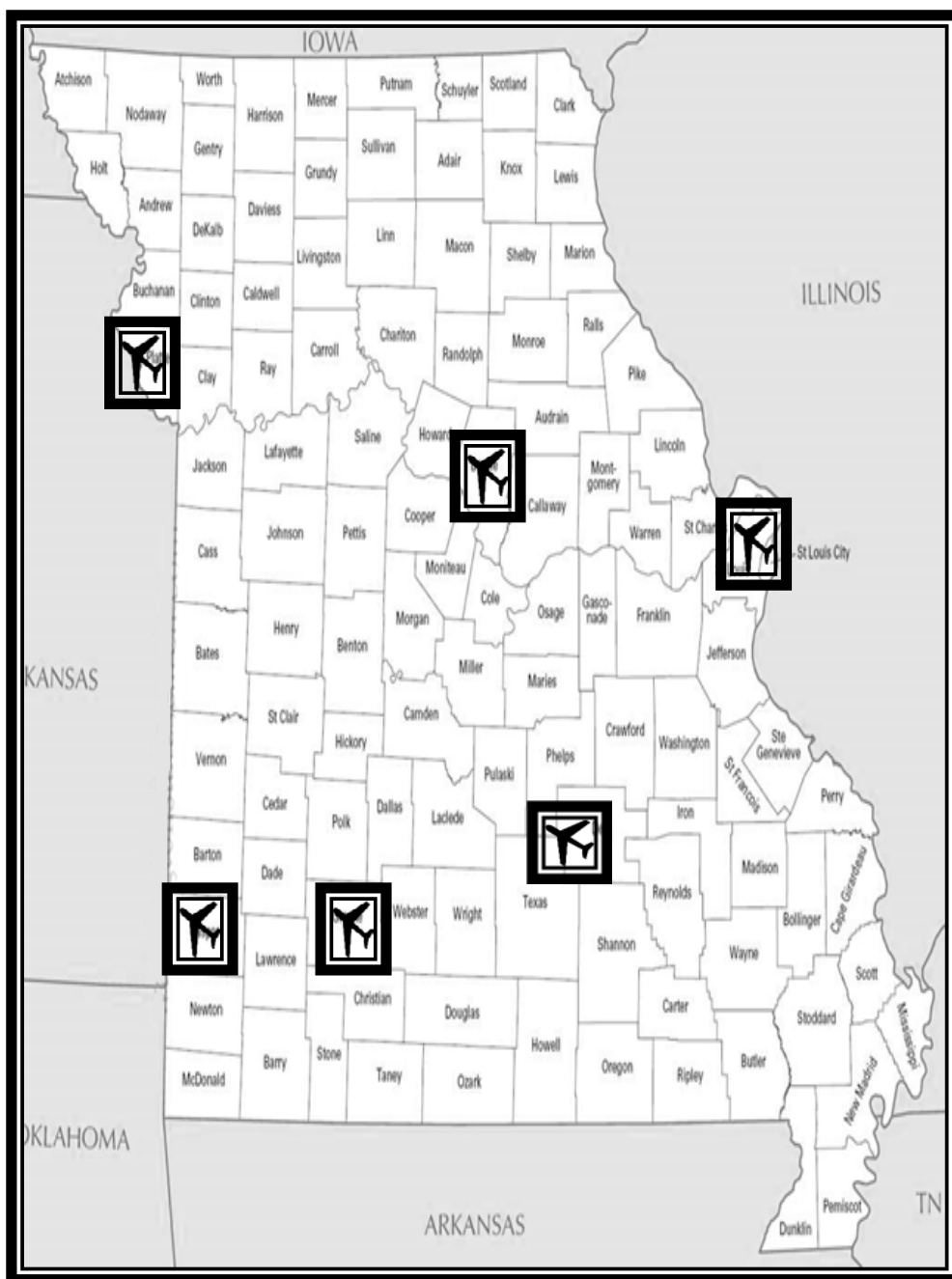


Figure 1: Commercial Service Airports.



Figure 2: Centerline Highway Miles.

4. Empirical Results

The results of the ordinary least squares regression are summarized in Table 3. As in previous studies, the covariance matrix is corrected for heteroscedasticity (Almada et al., 2006; Domazlicky et al., 1996). Per capita income for all Missouri counties is modeled as a function of educational attainment and infrastructure variables. Important explanatory variables in the equation are the regressors for education, HSGR25, COLSOM25, and BACHGRAD25. The coefficients for these variables are all positive, as hypothesized, and satisfy the 5-percent significance criterion.

Table 3: Ordinary Least Squares Regression Output

Dependent Variable: LOG(PCINC)				
Method: Least Squares				
Sample: 1 114				
Included observations: 114				
White heteroskedasticity-consistent standard errors & covariance				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	6.236964	1.379744	4.520377	0.0000
LOG(HSGR25)	0.203711	0.080226	2.539230	0.0126
LOG(COLSOM25)	0.140836	0.056665	2.485418	0.0145
LOG(BACHGRAD25)	0.183276	0.025841	7.092433	0.0000
LOG(POPLT18)	-0.631297	0.236069	-2.674211	0.0087
LOG(POPGT65)	0.040366	0.016438	2.455702	0.0157
LOG(PCTENGL)	0.572578	0.271733	2.107136	0.0375
LOG(DENSITY)	0.047934	0.052254	0.917334	0.3611
LOG(AIRPC)	0.089026	0.022433	3.968435	0.0001
LOG(CENPC)	-0.029961	0.056342	-0.531773	0.5960
LOG(PROPC)	0.155013	0.027501	5.636601	0.0000
R-squared	0.832375	Mean dependent var	9.668593	
Adjusted R-squared	0.816100	S.D. dependent var	0.152625	
			-	
S.E. of regression	0.065451	Akaike info criterion	2.523513	
			-	
Sum squared resid	0.441237	Schwarz criterion	2.259493	
			-	
Log likelihood	154.8402	Hannan-Quinn criter.	2.416362	
F-statistic	51.14650	Durbin-Watson stat	2.005627	
Prob(F-statistic)	0.000000			

The regression output in Table 3 indicates that an increase in secondary and tertiary educational attainment levels will increase per capita income. This confirms outcomes detailed in other studies for the region. Domazlicky et al. (1996) report that

increases in high school non-completion rates will lead to negative impacts on per capita income for southeastern Missouri. Across the state line, Fullerton et al. (2010) find that a one percent increase in high school graduation rates is associated with a \$2.03 increase in per capita income in Arkansas counties. For southern Illinois, Sloboda (1999) indicates a \$336.62 decline in per capita income for every one percentage point increase in the high school non-completion rate.

An increase of one percentage point in the number of people 25 and older with some college education raises county per capita income by \$118.19. Holding constant the share of the population that has completed some college coursework, an increase of one percentage point in the number of adults with a college degree increases per capita income by \$218.24. For southeastern Missouri, Domazlicky et al. (1996) provide evidence that obtaining a college degree will increase per capita income by \$203. Sloboda (1999) also reports similar results. For southern Illinois, a one percentage point increase in the proportion of the population that has attended some college will increase per capita income by \$205.29. Likewise, a one percentage point increase in the share of the population that possesses a bachelor's or graduate degree will increase per capita income by \$326.49.

In addition to educational attainment variables, several capital stock variables are included in the model. Exclusion of the LANE and AIRMILES variables from the specification increases the F-statistic for the equation. For this reason, AIRPC, CENPC, and PROPC are the only infrastructure variables included in the equation shown in Table 3. The AIRPC parameter estimate is statistically significant and has the expected positive sign. That result corroborates evidence obtained by Green (2007) regarding positive linkages between airport activity and regional economic growth.

Also included in the equation is CENPC, a measure of total centerline highway miles owned by the state in each county. Estimation results yield a slope coefficient for this variable that is statistically indistinguishable from zero. Several factors may contribute to this result. Baum-Snow (2007) finds that the expansion of highway infrastructure contributes to urban sprawl. Sprawl increases commuting distance and requires new infrastructure to service outlying areas while inner-city infrastructure must also be maintained (Burchell, 1997). Sprawl can lead to highway congestion, increasing travel costs, and it may also lead to productivity declines related to reduced density (Glaeser and Kohlhase, 2004; Glaeser, 2011). Given the potential costs imposed by sprawl on regional economies, it is possible that any positive impact of highway infrastructure on income may be obscured by the correlation between highways and urban sprawl. The private capital stock performs as expected. The slope coefficient is greater than zero and statistically significant as in prior studies (Garcia-Mila and McGuire, 1992; Bronzini and Piselli, 2009).

Right-hand regressors also include several demographic variables. The variable POPLT18 has the predicted sign and is statistically significant at the 5-percent level. An increment of a percentage point in POPLT18 leads to a decrease in per capita income by \$135.04. As the percentage of population age 18 or less increases, regional incomes tend

to decline (Fullerton, 2001). That may be because individuals 18 years old or less typically hold part-time employment or do not work. For POPGT65, the opposite is observed, possibly because persons over 65 years of age receive pension and other transfer payments. This result potentially confirms development strategies that recruit retired people as one means for increasing regional per capita incomes (Fullerton, 2001). As an additional verification exercise, the age variables are replaced by an indicator of labor force participation, namely the ratio of total employment to population. The parameter estimate for this variable is near zero and insignificant. This is not surprising if the share of the population under 18 and the proportion that is over 65 have opposite effects on income as indicated above.

Results in Table 3 further indicate that a unit increase in the percentage of individuals that speak English is associated with higher income levels. Because most business transactions in Missouri are executed in English, an increase in the percentage of English speakers may positively affect transactional efficiencies. It should be noted that a substantial proportion of the Missourians who speak languages other than English are monolingual in those languages (U.S. Census Bureau, 2000). The results should therefore not be interpreted as evidence that an increase in bilingualism reduces county income levels. Inclusion of the percentage of individuals that speak Spanish only does not improve model fit. Including the female labor force participation rate, FLFPR, reduces the F-statistic for the equation, so that variable is also excluded from the final specification.

The variable DENSITY does not satisfy the significance criterion, but the positive sign indicates that, as the number of people per square mile increases, per capita income will follow suit. This independent variable is utilized to attempt to capture agglomeration effects that positively influence regional economic performance (Glaeser and Maré, 2001). However, the coefficient on this variable may also capture negative effects associated with denser cities, such as higher rents, congestion, crime, and pollution (Cirilli and Veneri, 2011). This may explain why the density coefficient is statistically insignificant. Because it is possible that population density is not a reliable measure of urban agglomeration, the equation is re-specified using alternative indicators. These include a measure of the distance from each county to the nearest Metropolitan Statistical Area (MSA) and a dichotomous variable, METRO, which is equal to one for counties located in an MSA and zero for other counties. However, the estimated parameters for these two variables are also statistically insignificant and population density is, therefore, the only measure of agglomeration retained in the final specification.

As discussed in section III, it is possible that the educational variables are endogenous. To examine this possibility an artificial regression test is carried out (Davidson and MacKinnon, 1989). The instruments utilized include federal expenditures on higher education by county (EXPHIGH), the percentage of adults with a high school diploma in 1970 (HSGR_70), and the percentage having a bachelor's degree in 1970 (BACH_70). The METRO variable mentioned above is also used as an instrument because educational attainment may be conditioned by location in rural or urban areas (Andres and Looker, 2001). The instruments used have statistically significant impacts on the educational variables (see Appendix A).

The artificial regression test consists of evaluating whether the residuals from each of the reduced form equations shown in Appendix A are significant predictors of per capita income (see Appendix B). While the null hypothesis of exogeneity cannot be rejected for the high school completion and limited college attendance variables, the results are not clear-cut with respect to the variable for college completion. Both the individual t-statistic for the residuals from the BACHGRAD25 reduced form equation and a joint F-statistic for all three residual series are between the 5 percent and 10 percent critical values. Since there is some possibility that the college completion variable may be endogenous, two-stage least squares parameter estimates are computed using fitted values for BACHGRAD25 and actual values for all other variables. The results are presented in Table 4.

Table 4: Two-Stage Least Squares Regression Output

Dependent Variable: LOG(PCINC)				
Method: Least Squares				
Sample: 1 114				
Included observations: 114				
White heteroskedasticity-consistent standard errors & covariance				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	6.436300	1.858553	3.463070	0.0008
LOG(HSGR25)	0.127572	0.090722	1.406189	0.1627
LOG(COLSOM25)	0.221123	0.063807	3.465495	0.0008
LOG(FITTED_BACHGRAD25)	0.134877	0.039441	3.419729	0.0009
LOG(POPLT18)	-0.602187	0.297443	-2.024545	0.0455
LOG(POPGT65)	0.038159	0.028315	1.347647	0.1807
LOG(PCTENGL)	0.529110	0.368435	1.436100	0.1540
LOG(DENSITY)	0.074858	0.063850	1.172416	0.2437
LOG(AIRPC)	0.083102	0.028326	2.933786	0.0041
LOG(CENPC)	0.005345	0.067287	0.079437	0.9368
LOG(PROPC)	0.166930	0.031389	5.318094	0.0000
R-squared	0.782767	Mean dependent var		9.668593
Adjusted R-squared	0.761677	S.D. dependent var		0.152625
				-
S.E. of regression	0.074509	Akaike info criterion		2.264275
				-
Sum squared resid	0.571817	Schwarz criterion		2.000256
				-
Log likelihood	140.0637	Hannan-Quinn criter.		2.157125
F-statistic	37.11457	Durbin-Watson stat		1.998066
Prob(F-statistic)	0.000000			

In general, the signs and magnitudes of the coefficients in Table 4 are similar to those in Table 3. One noteworthy difference is the somewhat larger coefficient for partial college attendance in Table 4 and the somewhat smaller coefficients for the other educational attainment variables. The relatively large magnitude of the COLSOM25 coefficient implies that college coursework may increase earnings even if it does not ultimately lead to the granting of a bachelor's degree (Kane and Rouse, 1995). While the impacts of various levels of educational attainment differ in magnitude when estimated by two-stage least squares relative to the ordinary least squares results, the estimated elasticities are all positive and fall within the range of 0.12-0.22 regardless of which estimation procedure is employed.

The coefficient for centerline highway miles per capita is still statistically insignificant in Table 4, but now has a positive sign. This is consistent with the results of other studies that have found that highway infrastructure has a positive economic impact (Garcia-Mila and McGuire, 1992; Noriega and Fontenla, 2007). As mentioned above, the correlation of highway miles with low-density development may help explain why the measured impact on per capita income is not statistically significant.

5. Simulation Results

The parameter estimates shown in Table 3 can be used to estimate how improved educational attainment levels might affect county-level income performance. County per capita income levels estimated using the coefficients in Table 3 and observed values of the explanatory variables are compared with the income levels that are predicted to exist if local educational attainment levels rise to the state average but values for all other variables remain unchanged. The difference between these two figures is the estimated per capita income gain from improved educational performance for each county. The aggregate impact is equal to the per capita impact multiplied by the county's population. For the Missouri counties that exceed the average educational attainment rate of the state, no simulations are carried out. The ordinary least squares parameter estimates are used for this exercise because the artificial regression test indicates that the null hypothesis of exogeneity cannot be rejected for any of the educational attainment variables under the standard 5-percent significance threshold (Appendix B).

Table 5 reports the potential income gains related to increasing high school completion levels to the state average. The weighted per capita income gain for currently underperforming counties is \$1,177.53. That translates to a state aggregate income gain of over \$5 billion. Table 5 shows that increasing high school completion levels can yield impressive benefits.

Next, simulation estimates of increasing partial college attendance to the state average are presented in Table 6. New Madrid County exhibits the largest per capita income gain of \$811.02, followed by Mississippi and Pemiscot, with \$790.27 and \$702.48, respectively. In aggregate terms, an increase in partial college attendance has the biggest impact in Dunklin County with an increase of \$16,890,116, while New Madrid and Stoddard follow suit. On average, the state per capita gain is \$252.01, while the potential state aggregate income gain is approximately \$235 million.

Table 5: Income Gains from Increased High School Graduation Rates

COUNTY	Per Capita Impact	Aggregate Impact
St. Louis	\$2,417.56	\$2,457,002,094
Platte	\$1,910.53	\$140,960,569
Boone	\$1,862.82	\$252,326,296
St. Charles	\$1,363.06	\$386,950,132
Jackson	\$1,252.38	\$820,158,431
Clay	\$967.87	\$178,093,540
Greene	\$958.97	\$230,528,882
Cole	\$874.63	\$62,446,218
Johnson	\$689.46	\$33,271,795
Phelps	\$616.99	\$24,571,507
Cape Girardeau	\$616.74	\$42,365,782
Adair	\$560.58	\$14,001,492
Pettis	\$545.43	\$21,491,749
Newton	\$523.51	\$27,555,283
Pulaski	\$469.38	\$19,321,888
STATEWIDE	\$1,177.53	\$5,036,839,848

Table 6: Income Gains from Increased Some College Attendance Rates

COUNTY	Per Capita Impact	Aggregate Impact
New Madrid	\$811.02	\$16,025,770
Mississippi	\$790.27	\$10,610,923
Pemiscot	\$702.48	\$14,082,632
Perry	\$666.26	\$12,080,644
Dunklin	\$509.43	\$16,890,116
Osage	\$496.93	\$6,490,960
Stoddard	\$492.98	\$14,643,827
Shannon	\$434.34	\$3,615,450
St. Clair	\$401.15	\$3,871,887
Bollinger	\$393.98	\$4,739,179
Sullivan	\$383.48	\$2,768,371
Reynolds	\$372.94	\$2,494,584
Montgomery	\$356.80	\$4,330,121
Carroll	\$355.91	\$3,660,575
Audrain	\$348.00	\$8,996,815
STATEWIDE	\$252.01	\$235,041,897

The magnitudes associated with increasing bachelor and graduate degree completion to the state average are illustrated in Table 7. The largest per capita income gain is \$1,576.37, and corresponds to Bollinger County. McDonald County follows closely with \$1,566.92, and then Wayne County with \$1,495.34. In aggregate terms, Jefferson County could increase its income by \$62 million, the largest increase of all the counties. St. Francois and Lincoln counties have the second- and third-largest aggregate gains, respectively. The statewide per capita income gain is \$622.06 and the state aggregate gain is \$969 million.

Table 7: Income Gains from Increased Bachelor and Graduate Graduation Rates

County	Per Capita Impact	Aggregate Impact
Bollinger	\$1,576.37	\$18,962,195
McDonald	\$1,566.92	\$33,972,303
Wayne	\$1,495.34	\$19,826,768
Reynolds	\$1,419.48	\$9,494,894
Ste. Genevieve	\$1,386.87	\$24,744,479
Washington	\$1,362.43	\$31,804,523
Hickory	\$1,358.70	\$12,146,744
Madison	\$1,277.30	\$15,072,151
Shannon	\$1,247.30	\$10,382,540
Iron	\$1,236.77	\$13,229,739
Ripley	\$1,168.71	\$15,788,152
Crawford	\$1,167.63	\$26,626,593
Pemiscot	\$1,139.58	\$22,845,096
Sullivan	\$1,090.43	\$7,871,789
Ozark	\$1,086.17	\$10,364,196
STATEWIDE	\$622.06	\$969,428,735

The results presented in Tables 5 through 7 provide evidence of the key role education plays in Missouri's state economy. Increasing educational attainment levels will likely increase income levels and confirm estimates reported in other studies conducted for this geographic region of the United States (Fullerton et al., 2010). To capture these benefits, policies to reduce dropout rates and increase enrollments are not, of course, costless. However, some research suggests that such programs may be worth the costs. Levin et al. (2007) report that, for the United States in general, the benefits of intervention programs to increase high school graduation rates outweigh the costs. This remains true whether costs and benefits are measured exclusively by monetary variables or if they are expanded to include social costs and benefits as well. Estimates of the costs associated with those types of efforts in Missouri go beyond the scope of the paper, but are probably lower than the benefits they would generate.

6. Policy Implications

Results presented in Table 5 indicate that increasing the share of high school graduates in the general population will have a positive effect on regional per capita income. Policy analysts and administrators can take these findings into consideration when creating regional economic development strategies. As suggested by Domazlicky et al. (1996), a good step would be to provide additional resources to programs created to motivate students to stay in high school until they graduate. Increasing high school graduation rates is likely to increase the local stock of high school graduates over time. The simulation results indicate that counties that increase high school completion levels to the statewide average will benefit with better income performance.

Tables 6 and 7 illustrate the gains resulting from increased levels of tertiary education and highlight the importance of strategies aimed at increasing college completion levels. Increases in the number of people that attend college and, especially, the number that graduate, will generate growth in per capita income (Dodge, 2003). To increase the number of students in post-secondary institutions (universities, community colleges, and technical institutes), recruitment efforts should be increased across the state. Furthermore, to assure college completion and reduce attrition, additional scholarships, grants, and financial aid should be provided to new and currently enrolled students.

The model developed in this paper uses two measures of public infrastructure. Results indicate that increases in commercial air activities are correlated with higher income levels. As noted by Fan and Zhang (2004), investment in maintenance and improvement of this infrastructure will likely increase regional income levels. Green (2007) quantifies a relationship between airport activity and economic growth. Adequately maintained airport capacity will likely have a positive impact on economic development in the surrounding region. Continued maintenance and expansion of the existing commercial airports in Missouri is advisable. For those counties without airports, improved surface linkages to the nearest metropolitan areas that do have airports is probably a useful step to take.

Even though the results show that the presence of more highway miles does not exert a significant impact on regional income levels, it would be a mistake to neglect maintenance and improvements to roads across the state of Missouri. The positive coefficient obtained in Table 4 is in line with the conclusion of Destefanis and Sena (2005) that the presence of public capital stocks will increase economic performance. These results also concur with the findings Aschauer (1989) and Noriega and Fontenla (2007).

Finally, the empirical results indicate that private capital stocks are positively linked with income gains, which re-affirms results obtained by Bronzini and Piselli (2009). Investment in the development of private capital stocks will increase property tax valuation and lead to higher per capita income levels. This suggests that private capital investment should be encouraged across all Missouri counties. Downs (1997) states that local and regional governments sometimes impose complex rules and regulations on

businesses. Excessive red tape tends to discourage business expansion and sap growth. As an example, Burby et al. (2000) find that strict regulatory policies increase the cost of new construction and commercial rehabilitation. In an environment with more business-friendly regulatory policies, greater economic development can be achieved. One means to encourage private capital investment is to ensure that business licensing and permitting requirements are as streamlined and straightforward as possible.

7. Conclusion

This study attempts to quantify the impacts of education, infrastructure, and demographic variables on regional per capita income for all 114 counties in Missouri. The data are logarithmically transformed in order to allow for diminishing returns. Empirical results obtained are in line with findings previously reported in other studies. Findings show that educational attainment levels and regional income are very closely related. As the proportion of the population possessing secondary and tertiary education increases, regional income levels increase. Simulation results indicate that several counties will greatly benefit from increasing educational achievement to the state average. Policy makers should take this into consideration when designing economic development strategies.

The existence of public and private capital stocks also increases per capita incomes. Expanding commercial air activities and investing in such infrastructure also helps increase income levels in the region. Estimation results obtained using the two-stage least squares procedure indicate that highway infrastructure has a small positive effect on regional income, but the coefficient does not satisfy the 5-percent significance criterion. As property tax valuations increase, regional income also rises. To improve private capital stocks, business licensing and permitting processes should be clear and unambiguous.

A cost-benefit analysis of creating and implementing programs that increase educational attainment levels goes beyond the scope of this study, but these efforts are probably worth the expense. Moreover, additional research should be conducted to further clarify the role of physical infrastructure in this regional economy. Airport activity appears helpful, but the effect of the highway infrastructure variable is not as clear. Data permitting, a time series approach may help clarify the potential impacts of highway investments (Fullerton, González Monzón, and Walke, 2013). To further explore the importance of public and private capital stocks, data on additional variables (e.g. sewer systems, railroads, municipal street grids) may be useful in future efforts that analyze regional income performance in Missouri.

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Annex on line at the journal Website: <http://www.usc.es/economet/eaat.htm>