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ABSTRACT

This study attempted to determine whether or not the location of states' public universities makes a difference in state population growth and by inference, in state economic growth. Specifically the study examined the effect of the size of the host community relative to the state population or the proportion of the state's population that resides in the university host community. The study included state public universities established before 1940, listed in "World Almanac," and found in the 48 contiguous states. The Bureau of the Census provided data for the analysis. That analysis employed statistical analysis and visualization of relationships in scatterplots. These showed that for every 10 percent increase of state's population residing in university communities, a state's population growth rate will increase by 2.6 percentage points. The study concluded that states have a higher return on their public investment if their universities are located in large metropolitan areas. Includes extensive tables and figures and a 22-item bibliography. (JB)

The Effect on State Growth of the Location of Public Universities

Richard Phelps

Introduction

State governments disperse most of their transfers and investments throughout their geographic domain. Welfare and Medicaid checks go to the poor wherever they may reside - scattered throughout in city and country alike. Paychecks to state police troopers are likewise dispersed. State aid to local schools are sent throughout the state to every school district.

The state does, however, concentrate some large and "lumpy" public investments in particular localities with some discretion. The communities in which large public facilities are sited may be profoundly affected. Often, communities lobby to receive (or to fend off) these public investments, knowing that state resources (or state problems) will be transferred into their local economy. State prisons, hospitals, parks, forests, regional offices, and research stations come to mind as examples of large public investments.

Two state "sitings," however, dwarf all others in size and effect - the capital, with its accompanying state central offices, and state universities. Most of these institutions had already been sited by the turn of the century.

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This study attempts to determine whether or not the location of the states' public universities makes a difference in state population growth and, by inference, in state economic growth. Specifically, this study examines the effect of one aspect of institutional location - the size of the host community relative to the state population - that is, the proportion of the state's population that resides in the communities host to its universities.

There is quite a large variation in host community sizes. Think of the virtually nonexistent town of Storrs, home of the University of Connecticut, or the very large metropolitan area of Minneapolis-St. Paul, home to the University of Minnesota, gargantuan by comparison (please see Table 1).

Table 1

Northeast	South	Midwest	West
States With Public Universities in Big Cities (by region)			
Vermont	Georgia	Ohio	New Mexico
Pennsylvania	Tennessee	Minnesota	Arizona
Delaware	Kentucky	North Dakota	Nevada
Maryland			California
New York			Washington
			Utah
States With Their Public Universities in Small Cities (by region)			
Maine	Virginia	Indiana	Montana
Connecticut	Florida	Illinois	Wyoming
Rhode Island	Alabama	South Dakota	Oklahoma
Massachusetts	Mississippi	Iowa	Oregon
West Virginia		Kansas	Idaho
			Texas

If the interaction between universities and their host communities produce positive externalities or agglomeration economies that increase as host community size increases, then the state as a whole benefits by having its largest institutions located in its largest metro areas. If the benefits are large enough they will accelerate state growth.

Could the benefits be large enough? Perhaps they could be. Comparing higher education expenditures to those in other "industries" according to their relative proportions of our country's gross national product, higher education ranks larger than the combined category of agriculture, forestry, and fisheries (please see Table 2). And, unlike in agriculture, forestry, or fishing, where the economic activity is widely dispersed, higher education activity is greatly concentrated in certain local areas.

Table 2

Sector of the Economy	Percent of Gross National Product
Agriculture, Forestry, & Fisheries	2.4
Higher Education	**2.7**
Mining	4.3
Construction	5.1
All Education	**6.3**
Non-Durable Goods	8.3
Transport & Utilities	8.3

Sources: Economic Report of the President, 1989
UNESCO, Statistical Yearbook, 1988
Economic Policy Institute

Theoretical Background

The hypothesis to be tested is that those states can grow faster that have their universities in larger cities because interactions between these institutions and their host communities take advantage of greater positive externalities and agglomeration economies.

It is conventional wisdom that large research universities produce positive "spillovers" - of research-generated knowledge, expertise, educational opportunities, and cultural enrichment - that are largely geographically localized. Localized positive spillovers from universities are explicit in the calculation of quality-of-life ratings of cities in publications like the Places-Rated Almanac. State governments attempt to capture localized positive spillovers from universities in establishing industry-university consortia in places such as the Research Triangle in North Carolina and the Austin-San Antonio axis in Texas.

Some of the arguments for beneficial university-community interaction are fairly straightforward and obvious; some are not:

(1) The marginal cost of attending a university is lower for residents of the university's host community - students can live at home and commute to school or can attend school part-time. So, the larger the host community, the more state residents who can benefit.

(2) University communities often produce positive spillovers, like low-cost cultural amenities, thus making their

communities more attractive to non-university-related in-migrants. Herzog and Schlottman (1986), moreover, find that some job changers prefer new employment in communities with higher education available for themselves as well, for further training and the like. So, cities with universities should be able to attract more productive employees.

(3) A university job changer may prefer to work for a university in a larger city in order that her spouse may more easily find employment. A university student may also prefer to attend school in a larger city in order to find part-time employment. So, universities in larger cities should be able to attract more productive employees and more students.

(4) Universities provide relatively stable employment. Thus, they can help their host communities weather economic storms through risk-spreading by business sector diversification. Communities with advantageous business mixes often experience employment gains in the face of recession and expand faster than the average during periods of prosperity (Noyelle and Starback, 1983). Communities dominated by firms in industries that are cyclically sensitive or subject to foreign competition experience more severe declines in their local employment during recessions (Bluestone and Harrison, 1982).

(5) Another argument for the economic benefits of university-community interaction concerns certain types of agglomeration economies - those of transfer, labor specialization, and professional interaction (or, networks).

Transfer economies are those savings in transport costs which accrue when organizations locate at common places. In information-based industries relevant transport costs could include transporting people to meetings and phone calls (for voice or data), which are less expensive over shorter distances.

Economies result from labor specialization because workers trained in specific skills can become very good at what they do and because specialization reduces the time that would be lost in moving from one task to another (and learning anew or starting up each time). Universities, of course, are full of specialists.

Economies of professional interaction accrue when new information and new ideas are transformed into new processes and products more quickly because of expeditious information transfer over a professional network. Professional interaction is particularly important in the early, uncertain period of a new good or service when businesses are reticent to commit themselves to specialized investments. Network information flows are facilitated when those generating and receiving the information know and trust one another. Close proximity helps generate familiarity and trust.

Bania, Eberts, and Fogarty (1987) found a significant relationship between university research spending and openings of new firms in a cross-section sample of SMSAs. With a sample of U.S. states, Jaffe (1989) used time-series data on corporate patents to discover a significant effect of university research on state-level corporate patent activity. Jaffe found weaker evidence that the spillovers were facilitated by local proximity of universities and corporate research centers. Jaffe also cited four case studies that confirm the important roles played by universities in the commercial innovation of Silicon Valley and Route 128.

All these theoretical arguments for how the size of university towns might affect state economic growth are summarized in table 3.

Table 3

How the Size of University Towns Might Accelerate State Economic Growth

- Theoretical Arguments -

(1) Lower Marginal Cost to Student Attendance

(2) University and its Amenities Attract Urban In-Migrants

(3) City and its Amenities Attract University In-Migrants

(4) A-Cyclical or Counter-Cyclical Economic Effect

(5) Agglomeration Economies:

   (a) Transfer Economies
   (b) Labor Specialization
   (c) Network Economies

Evidence from Private Universities

There already exists some **prima facie** evidence that universities will be more productive in larger urban areas and that colleges located in large cities have more potential for growth than those located in small cities.

A huge public university can exist in a small town or, for that matter, in no town at all (like the U. of Conn.). It can function, for better or worse, anywhere in a state because it has an assured source of funds and an assured supply of students. Private colleges and universities have no such assurances. If, then, there are no advantages to location in a population center, we could expect to find a good number of private universities located in small towns and cities. That is, the location of private universities should be randomly distributed among small cities and large cities. But outside the Ivy League, can you think of more than just a few? Cities the size of Rochester, N.Y. aren't small enough. In order to contradict the argument, one needs to find many large private universities located in cities the size of Iowa City, Iowa; Manhattan, Kansas; Corvallis, Oregon; Oxford, Mississippi; or State College, Pennsylvania.

One might rejoinder that there are many private colleges in small cities and towns. But, most universities - public and private - started out as small colleges. Some have grown into bigger universities as their host cities have grown into bigger cities. Others started out as small colleges in small cities and have remained small just as their host cities have remained small.

It may be that private colleges, even more than public colleges, depend on the benefits of interaction with a host community - and the larger the community the larger the benefits. In competition among colleges for students and faculty, those with economic advantages will do better and, in the long run, those economic advantages will decide which colleges get bigger and which ones survive.

Departure from Other Studies

A search through the academic literature reveals many studies on the local or regional economic impact of universities. These economic impact studies try to estimate the differential impact on local or regional income or spending caused by a university. Often, these researchers try to estimate the "multiplier effect" of having a university on a local or regional economy.

This study is very different and it is unique. It looks at state growth, not local or regional spending patterns. It tries to determine not the specific amount of economic impact in a local geographic area, but whether or not the location of public universities makes some difference on state growth on average and over many years.

Hypothesis

This study attempts to determine if the size of universities' host communities affects state economic growth. If there are no appreciable positive spillovers from universities or if the positive spillovers are diffused widely, and no agglomeration economies are shared with the host community, no significant effect will be found. If, however, some positive spillovers are only localized, needing a host community for capture, or universities do share agglomeration economies with their host community, and if these effects are large, one should find a significant effect on state economic growth.

Policy Implications

This research is significant for higher education facility planning. If evidence of a localized spillover effect or agglomeration economies is found, policy makers may wish to situate universities or university facilities in larger population centers. In a developed country like the United States, such changes could only be made at the margin - new programs or research centers could be placed at urban rather than rural campuses if the choice is available.

The implications are greater for developing countries where siting decisions for public institutions are still being made. Indeed, if there are no localized spillover effects or agglomeration economies, national leaders in developing countries may well prefer to make siting decisions based on political or equity criteria.

This research also has implications for organizing the implementation and dissemination of the knowledge that universities produce. In the United States, many are concerned that despite the creative talent, expertise, and prolific output of our academic centers, academic ideas are only slowly disseminated outside or put into practical use. Part of the problem may be proximate. If, say, a state treasurer or a corporation economist relies on the advice of an economics professor at the state university, she can call her on the phone anywhere in the state. But if the professor works nearby they can see each other more often and work together more closely.

Jaffe's research focused only on the dissemination and implementation of scientific and technical knowledge, measured by patent applications. The research here uses a more blunt instrument in an attempt to test the more general case. Is university expertise exploited more efficiently if the exploiters are located nearby? If it is, state governments may wish to encourage the proximate location of university experts and those who can use the expertise. The latter may be industry research and development labs, corporate headquarters, non-profit social action agencies, or state governments.

Unfortunately, the test in this research can not discriminate the effects among the different kinds of spillovers.

Data Description and Sources

The United States provides a good data set for this study. Because of the Morrill Act and the Jeffersonian ideal, or "country" ideology, in the early years of the Republic, many state universities were established in rural areas, giving a U.S. data set a more diverse character than one from Europe might have.

This study analyzes data from the 48 contiguous states over eight decades, from the 1900s through the 1980s.

The Universities

Only state universities are included in the calculations and only from the point in time when they appeared in the World Almanac's listing of universities. Most state teacher colleges, 2-year colleges, colleges exclusively for blacks, and vocational training schools were not counted. Only full universities were counted, and for most states there were just one or two. Most states did not commence "branching" their universities until the 1960s.

Universities were chosen, then, that met certain criteria, listed in table 4.

Table 4

Criteria for University Selection into Sample

(1) it was established before 1920 (1940 for some newer states out West);

(2) it was a complete research university, with graduate and professional schools, not simply a college;

(3) it was a full, public university, not a specialized college;

(4) it was a main, not a branch, campus; and

(5) it was included in the listings of the World Almanac.

Only these universities possess _all_ the characteristics alleged to produce all the positive spillovers at issue. If a significant effect on economic growth can not be detected with this sample of universities, it probably can not be detected at the state level of aggregation.

Population densities were extracted for the host county or MSA of each university for each decennial census (a rather tedious and time-consuming process). Population density or employment density from the succeeding decennial census are regressed onto the base year values for state population or employment, university county population and a vector of control variables. The eight decades' data were pooled.

The States

The sample consists of about 350 observations representing each of the 48 contiguous U.S. states in eight decades from the 1900s through the 1970s. State population and employment totals, from which the dependent variables are derived, and state percentage urban, are available from the population census.

Sixteen observations were deleted from the earliest two decades - the 1900s and the 1910s. This was done to reduce the "frontier effect" of population increases in new states which were extraordinarily large because of small population bases. Deletions were made according to the following rule: all observations with population changes greater than 800% (there were four in the decade of the 1900s) were eliminated; and observations were only included for states that had been states for at least eight years. Arizona and New Mexico, for example, became states only in 1912, Oklahoma only in 1907. Each of these states, however, as territories founded public universities in the nineteenth century.

The 800% limit on population increases was not chosen arbitrarily. Population increases in the "frontier" decades were not considered extraordinarily large if they were at levels found in later decades. Population increases of 787% and 736% occurred in Florida and in Arizona in the 1950s. Over a dozen states posted population increases of 400% and 500% in the 1940s and 1950s. Population increases of over 800%, however, occurred in only four western states in the 1900s.

Impact of University Towns

The impact of university towns can be measured in a variety of ways. Each way has its advantages and disadvantages.

The first, **population-proportion** method involves adding up the populations of the university-town counties and dividing by the state population. For very large cities, metro district populations were substituted for county populations if they were larger.

The second, **highest-rank** method employs the ordering of cities in a state by population size. To find a city's rank, all the cities in a state are ranked in order, from most populous to least populous. The rank of the university with the highest rank is selected. This method, however, may exaggerate the university-town impact in states with one very large university town, but one or more very small university towns.

The third, **average-rank** method averages the ranks of all the university towns in order to adjust for that potential problem.

These different measures of university-town impact are summarized in table 5:

Table 5

Measures of University-Town Impact

1) **Population Proportion** (in base year)--combined population of university-town counties, divided by state population in same decennial year.

2) **Highest Rank** (in 1980)--rank of the largest university town in the state, rank being determined by ordering all the cities in the state by population size, from largest to smallest.

3) **Average Rank** (in 1980)--mean of the ranks of all the university towns in the state.

Analysis

Exploratory Analysis

University Impact and the Number of University Students

Remember the first of the theoretical arguments that attempts to explain how the size of university towns might accelerate state growth. It maintains that the marginal cost of attending a university is lower for residents of the university's host community. So, the larger the host community; the more state residents who can benefit.

Calculating the simple Pearson correlation coefficient between the university impact variables and the number of public university students in each state supports the theoretical relationship. The correlations are all of the expected sign and two are highly statistically significant. See table 6.

Table 6

Correlations Between the Number of Public University Students and University Impact Variables

	Number of University Students	
University Impact Variables	Pearson r	significance level
University-Towns' Population Proportion	.227	.0001
University-Towns' Average Ranks	-.075	.1771
University-Towns' Highest Rank	-.146	.0001

T-Tests Between Small and Large Impact States

One simple way to see if states with larger university impacts have faster growth is to divide the states into two groups and compare their growth rates. One group of states has universities in small towns. The other group of states has one or more universities in bigger cities. Table 7 shows the results. States with larger university impacts do have faster growth rates. The mean rate of population growth, for example, is about 12 percent in the low university impact states and about 20 percent in the high university impact states. The mean rate of employment growth is about 14 percent in the low university impact states and about 23 percent in the high university impact states. The t-tests are highly statistically significant.

Table 7a

BIGUNI=0

Small-University-Impact States

N Obs	Variable	N	Minimum	Maximum	Mean	Std Dev
203	PPCTCHG Δ POP	174	-7.2781655	78.7080476	11.6081624	10.9120334
	EPCTCHG Δ EMPL	203	-20.4106280	79.3069307	14.4320163	14.3704177
	PPCTCHLG log(Δ Pop)	174	0.5433903	4.4740137	2.8883036	0.5681844
	EPCTCHLG log(Δ Empl)	203	1.7208669	4.6568792	3.6234713	0.4250093

BIGUNI=1

Large-University-Impact States

N Obs	Variable	N	Minimum	Maximum	Mean	Std Dev
105	PPCTCHG Δ Pop	90	-5.7268722	78.1250000	19.8652164	18.1170551
	EPCTCHG Δ EMPL	105	-16.6666667	89.9581590	22.8235310	22.1705417
	PPCTCHLG log(Δ Pop)	90	1.1857460	4.4673439	3.1817083	0.6170326
	EPCTCHLG log(Δ EmPL)	105	2.2335922	4.7532294	3.7755829	0.5028927

Table 7b

TTEST PROCEDURE

Variable: PPCTCHG ΔPop

BIGUNI	N	Mean	Std Dev	Std Error
0	174	11.60816241	10.91203336	0.82723911
1	90	19.86521644	18.11705514	1.90970529

Variances	T	DF	Prob>|T|
Unequal	-3.9675	123.3	0.0001
Equal	-4.6122	262.0	0.0000

For H0: Variances are equal, F' = 2.76 DF = (89,173) Prob>F' = 0.0000

Variable: EPCTCHG Δ EMPL

BIGUNI	N	Mean	Std Dev	Std Error
0	203	14.43201630	14.37041766	1.00860559
1	105	22.82353099	22.17054168	2.16362332

Variances	T	DF	Prob>|T|
Unequal	-3.5153	150.5	0.0006
Equal	-4.0079	306.0	0.0001

For H0: Variances are equal, F' = 2.38 DF = (104,202) Prob>F' = 0.0000

Variable: PPCTCHLG log(Δ Pop)

BIGUNI	N	Mean	Std Dev	Std Error
0	174	2.88830362	0.56818442	0.04307395
1	90	3.18170826	0.61703263	0.06504095

Variances	T	DF	Prob>|T|
Unequal	-3.7611	167.6	0.0002
Equal	-3.8613	262.0	0.0001

For H0: Variances are equal, F' = 1.18 DF = (89,173) Prob>F' = 0.3578

Variable: EPCTCHLG log(Δ EMPL)

BIGUNI	N	Mean	Std Dev	Std Error
0	203	3.62347127	0.42500932	0.02982981
1	105	3.77558292	0.50289267	0.04907730

Variances	T	DF	Prob>|T|
Unequal	-2.6486	182.2	0.0088
Equal	-2.7935	306.0	0.0055

For H0: Variances are equal, F' = 1.40 DF = (104,202) Prob>F' = 0.0436

Correlations Between University Impact and State Growth

The simple Pearson correlation coefficients between the four measures of university impact and state population or employment growth are all of the expected sign and highly statistically significant. See table 8.

Table 8

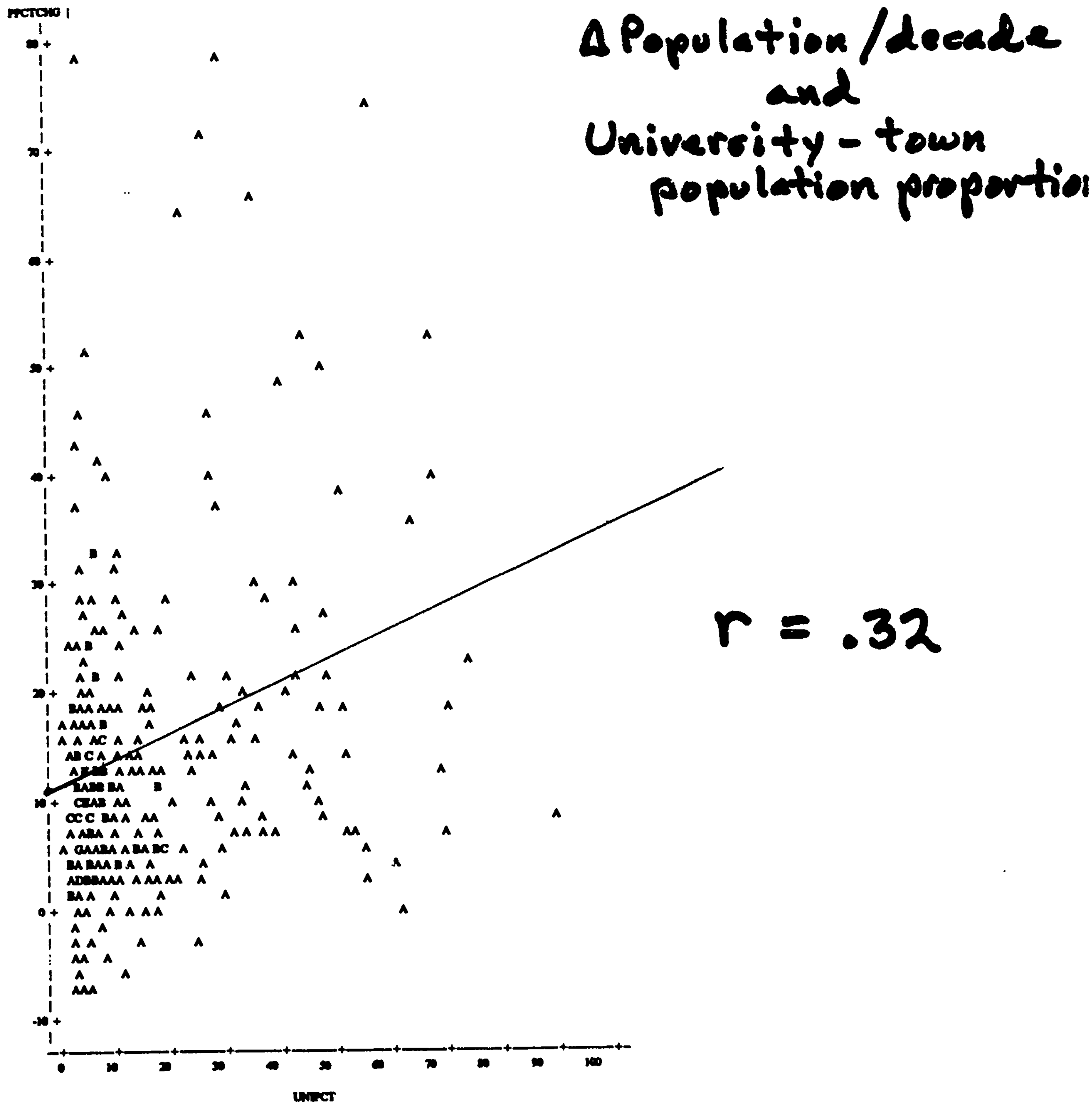
CORRELATION ANALYSIS

Pearson Correlation Coefficients / Prob > |R| under Ho: Rho=0 / Number of Observations

	Population Proportion UNIPCT	log (Population Proportion) UNIPCTLG	Average Ranks UNIRANK1	Highest Rank UNIRANK5	log (Average Ranks) UNIRNK1L	log (Highest Rank) UNIRNK5L
PPCTCHG Δ Pop	0.32122 0.0001 280	0.31407 0.0001 280	-0.16451 0.0051 288	-0.15579 0.0081 288	-0.16938 0.0039 288	-0.22204 0.0001 288
PPCTCHLG log(Δ Pop)	0.28481 0.0001 280	0.28757 0.0001 280	-0.16490 0.0050 288	-0.19146 0.0011 288	-0.15631 0.0079 288	-0.23757 0.0001 288
EPCTCHG Δ Empl	0.27700 0.0001 325	0.28542 0.0001 325	-0.14722 0.0069 335	-0.13985 0.0104 335	-0.15103 0.0056 335	-0.18631 0.0006 335
EPCTCHLG log(Δ Empl)	0.23205 0.0001 325	0.24617 0.0001 325	-0.11824 0.0305 335	-0.12288 0.0245 335	-0.11886 0.0296 335	-0.15556 0.0043 335

One can visualize the relationships in scatterplots. For example, figure 1 displays the relationship between UNIPCT, the percent of a state's population residing in university communities, and PPCTCHG, a state's population growth per decade. The Pearson correlation coefficient between the two variables is .32 and highly statistically significant. The slope of the regression line is .26. Literally interpreted, it means that for every 10 percent increase of a state's population residing in university communities, a state's population growth rate will increase by 2.6 percentage points. See figure 1.

Plot of PPCTCHG*UNIPCT. Legend: A = 1 obs, B = 2 obs, etc.



NOTE: 56 obs had missing values.

Figure 1

The relationship between the same university impact variable and employment growth is similar to that for population growth. See figure 2.

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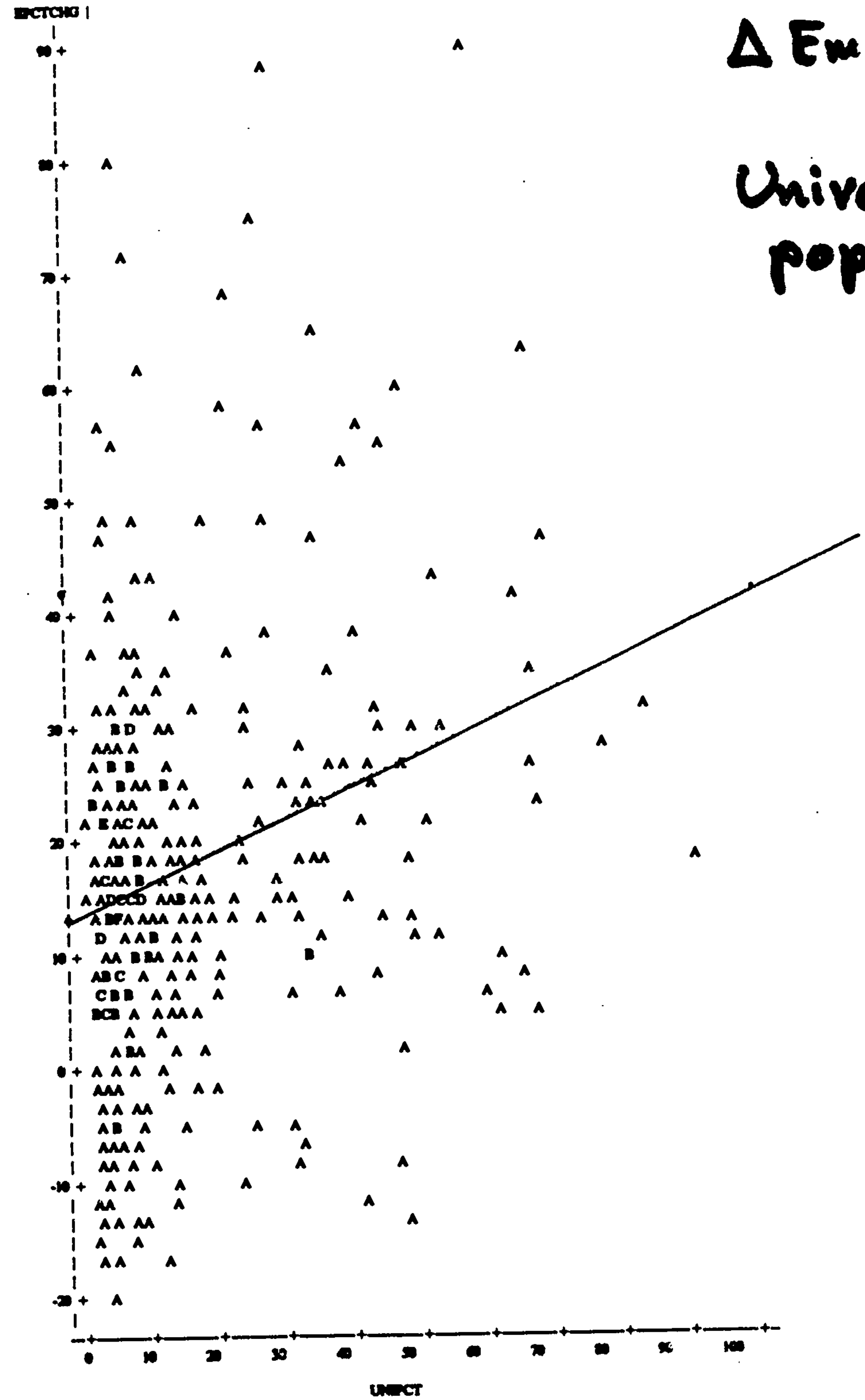
Plot of EPCTCHG*UNIPCT. Legend: A = 1 obs, B = 2 obs, etc.



Δ Employment/decade and University-town population proportion

r = .28

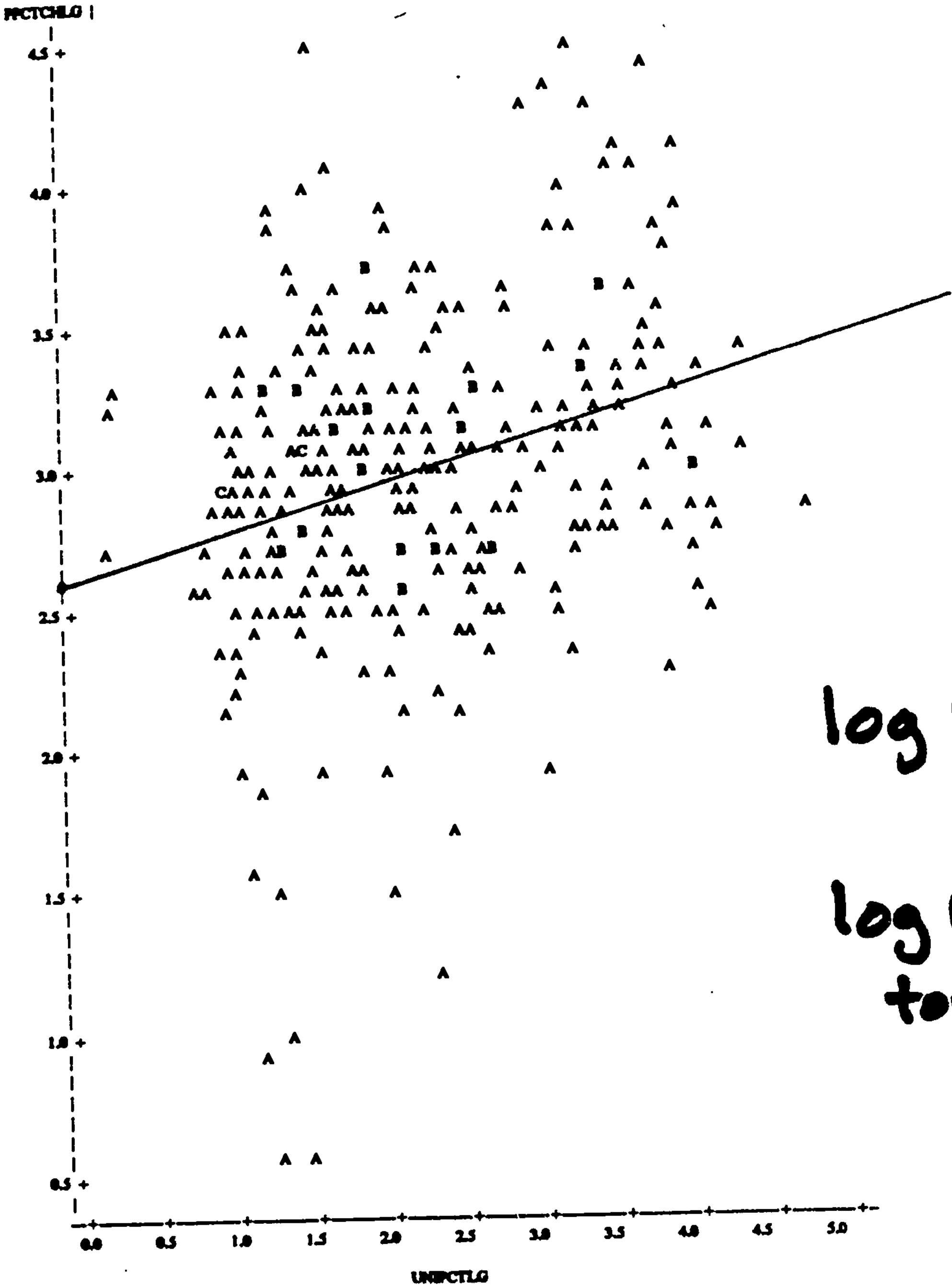
NOTE: 11 obs had missing values.

②

Besides well displaying the positive relationship between the university impact variables and state growth, these scatterplots also reveal the positive skewness of the variables on both axes. Indeed, *all* the state growth variables and all the university impact variables betray positive skewness. One might have expected this. Recalling the theoretical arguments for why larger university towns might accelerate state growth, they imply *cumulative* (or, exponential) effects over time.

Taking logs of both sides, then, reveals a relationship only slightly weaker between UNIPCT and PPCTCHG. Now, the correlation coefficient is .29 and the slope of the regression line is .18, both still highly statistically significant. See figure 3.

Plot of PPCTCHLG*UNIPCTLG. Legend: A = 1 obs, B = 2 obs, etc.

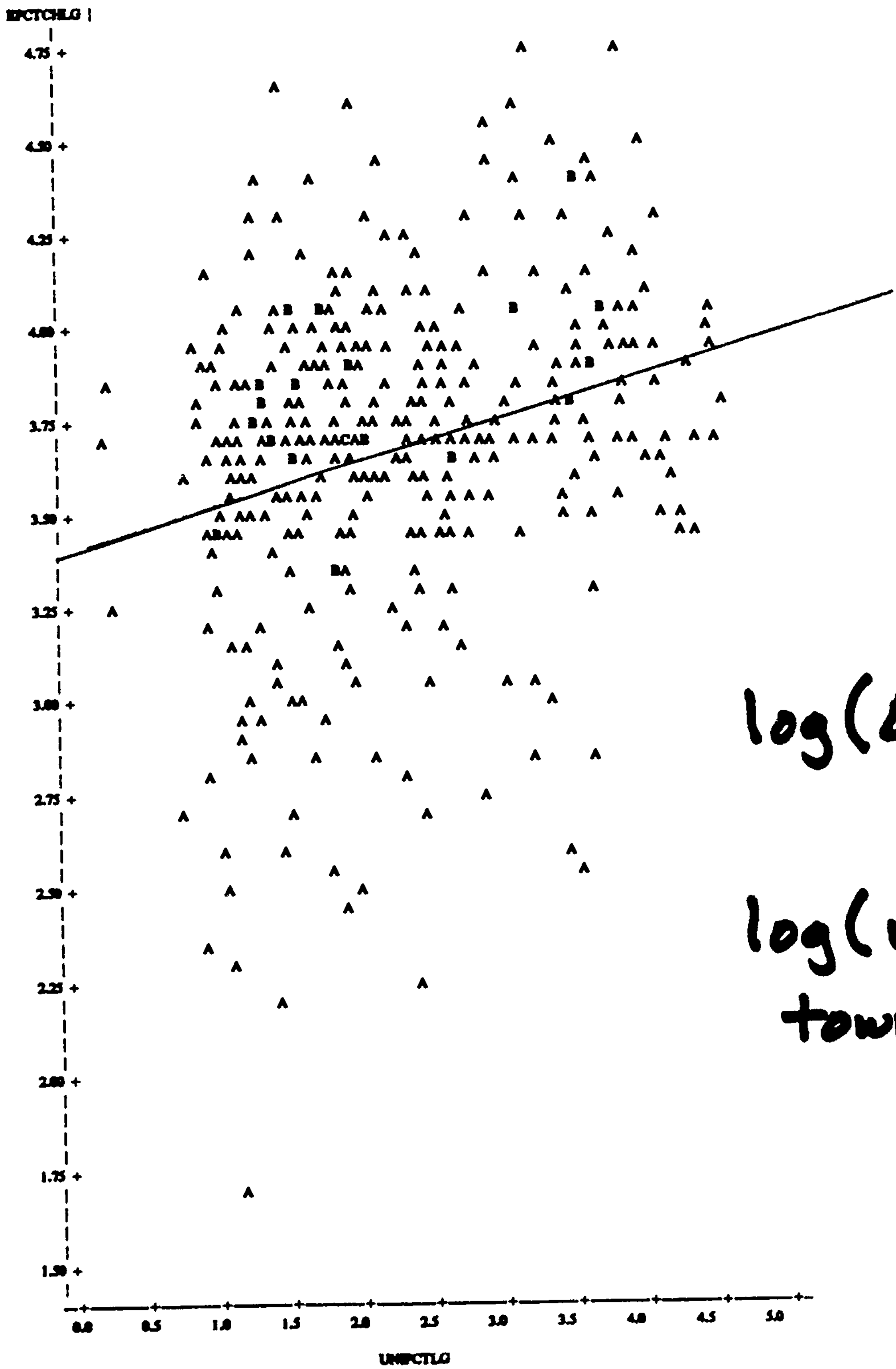


r = .29

log(Δ population) and log(university-town proportion)

NOTE: 56 obs had missing values.

Plot of EPCTCHLG*UNIPCTLG. Legend: A = 1 obs, B = 2 obs, etc.



NOTE: 11 obs had missing values.

r= .25

log(Δ employment) and log(university-town proportion)

④

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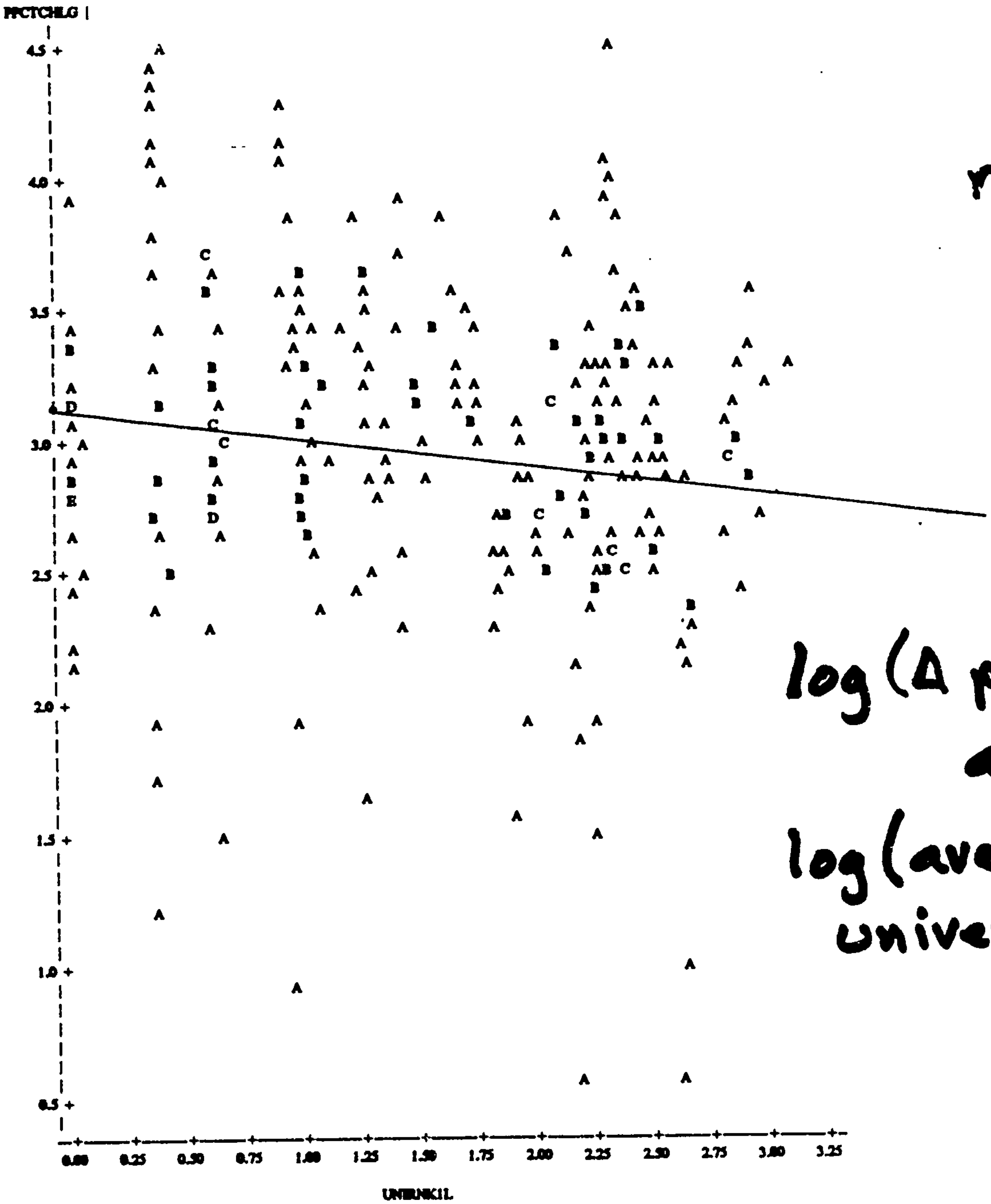
Plot of PPCTCHLG*UNIRNKIL. Legend: A = 1 obs, B = 2 obs, etc.



NOTE: 48 obs had missing values.

r = -.16

log(Δ population) and log(average university-towns' rank)

(5)

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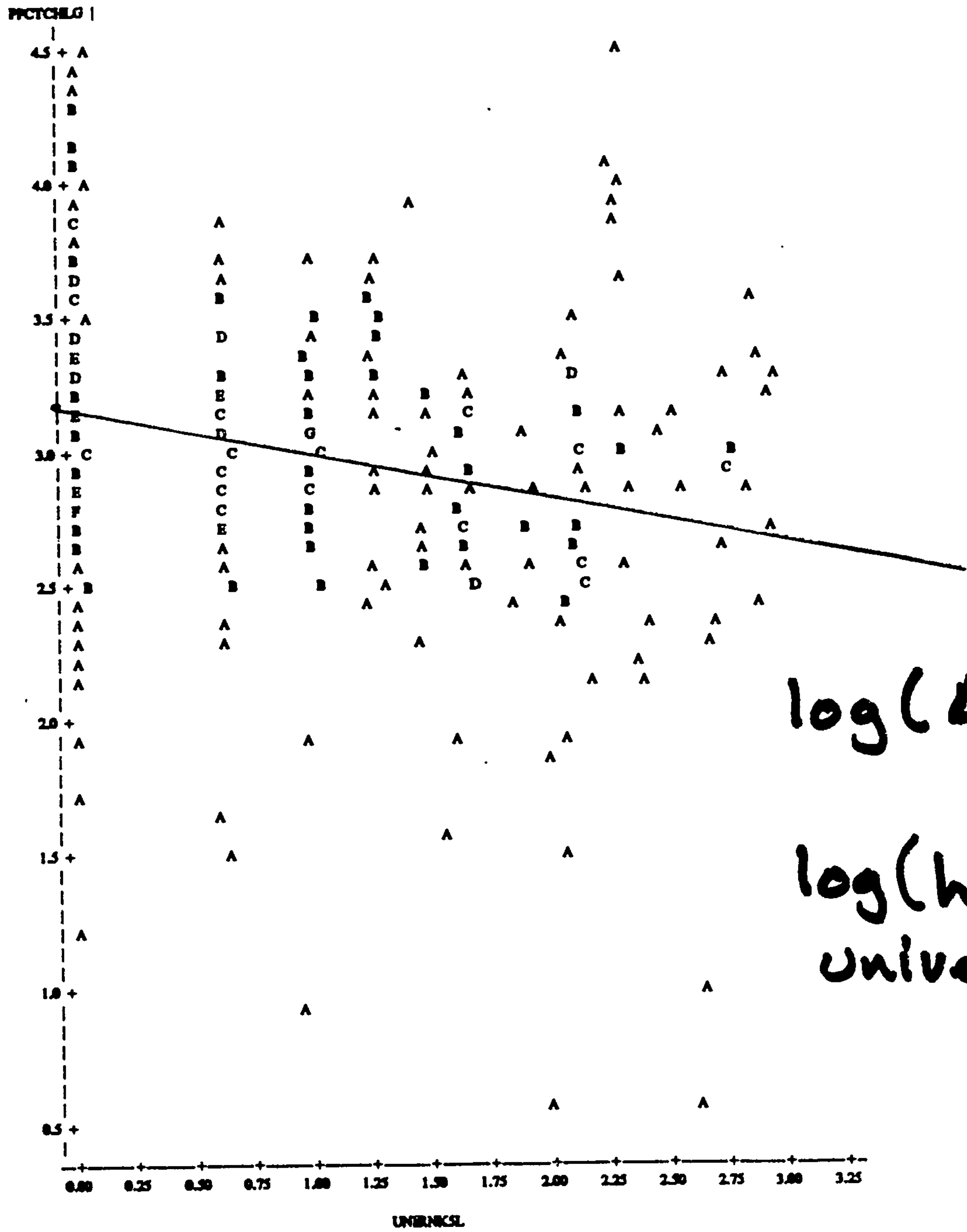
Plot of PPCTCHLG*UNIRNKSL. Legend: A = 1 obs, B = 2 obs, etc.



r = -.24

log(Δ population) and log(highest university-towns' rank)

NOTE: 48 obs had missing values.

6

Multivariate Analysis

Control Variables

Most of the better-known underlying forces pushing differential regional population growth rates in the 20th century U.S. are mentioned in John Kasarda's two summary articles (1980, 1988). Improved transportation and communication networks have made business location in the lower-cost South and West more efficacious and allowed regional disparities to equilibrate as the former poor regions "catch up." Air conditioning, retirement pensions and predilections for lower density living have made the warmer South and West more appealing. The Northeast and North Central states have lost their traditional cost advantages in transport and primary resources.

Control variables to account for these factors include the regional dummy variables, January temperature[1] (JT), and state age (SA).

Studies of and arguments for agglomeration economies are well summarized in Carlino (1978). Agglomeration economies or, more specifically, localization and urbanization economies,

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[1]The mean January temperature measure comes from the Statistical Abstract of the U.S., 1981, which borrows from the U.S. National Oceanic and Atmospheric Administration airport data. Some states have more than one airport monitoring station (eg. Minnesota has Duluth and Minneapolis-St. Paul). For those states a single measure was derived from interpolation between or among the separate sites such that the single measure would represent the approximate geographical population center of the state. Using the Minnesota example, the state temperature figure is and average of those from Duluth and the Twin Cities, weighted toward the Twin Cities where the greater population resides.

suggest that firms in most industries benefit by relatively close proximity to suppliers, services, and customers. To the degree that this is true and outweighs any agglomeration diseconomies (congestion, crime, etc.) more urbanized areas should prosper more than less urbanized areas, everything else being equal.

Recognizing this, the percentage of each state that was urbanized (in the base year) (UR) was included in the analysis.

Different decades have had different demographic character, too. There were fewer births and lower urbanization rates in the 1930s. There were more births and higher urbanization rates in the 1960s.

Accounting for the differential effects of the different decades, decade dummy variables were included in the analysis. See table 9 for a listing of all the control variables.

Table 9

Control Variables

To Account for Differential Regional Population Growth:

Regional Dummy Variables
State's Mean January Temperature
State's Age

To Account for Agglomeration Economies *Not* Necessarily Associated With University Towns:

State Percent Urban in Base Year

To Account for Differential Temporal Effects:

Decade Dummy Variables

Multivariate Model

A complete multivariate model, then, is in general form like this:

SG = f(UV, JT, SA, UR, Rd, Dd)

SG = State population or employment growth rate over decade

UV = University impact variable

JT = Mean January temperature of state

SA = Age of state

UR = Percent of state population in urban areas in base year

Rd = Regional dummy variables (based on Census regions)

Dd = Decade dummy variables

Results

This multiple regression was run with population or employment growth as a dependent variable (in unlogged and logged form) regressed onto one of the three university impact variables (in unlogged and logged form) and the control variables. In almost all cases the coeficient for the university impact variable was highly statistically significant. T values for the coefficient were sometimes larger than 4. F-tests were also performed on the coefficient and, generally, found the coefficient to be significantly different from zero, by a wide margin. These results are summarized in table 10.

. Table 10a

Model: MODEL1
Dependent Variable: PPCTCHG Δ Pop

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	17	28590.85719	1681.81513	16.515	0.0001
Error	261	26579.50061	101.83717		
C Total	278	55170.35780			

Root MSE	10.09144	R-square	0.5182
Dep Mean	14.28971	Adj R-sq	0.4868
C.V.	70.62035		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	-12.713502	5.23796590	-2.427	0.0159
→ UNIPCT	1	0.133257	0.04233792	3.147	0.0018
JANTEMP	1	0.662312	0.09635045	6.874	0.0001
STATEAGE	1	-0.037406	0.02928486	-1.277	0.2026
URBBASE	1	0.165717	0.05032049	3.293	0.0011
NE	1	1.322889	3.23446113	0.409	0.6829
MA	1	-7.326933	3.71622392	-1.972	0.0497
ENC	1	2.371444	3.35593448	0.707	0.4804
WNC	1	-0.300803	3.41655479	-0.088	0.9299
ESC	1	-7.481418	2.58883220	-2.890	0.0042
WSC	1	-8.340522	2.90467918	-2.871	0.0044
MTN	1	8.199239	3.47712229	2.358	0.0191
PAC	1	3.772119	3.60898617	1.045	0.2969
DUMMY30S	1	-6.696342	2.11374771	-3.168	0.0017
DUMMY40S	1	0.571413	2.16761017	0.264	0.7923
DUMMY50S	1	3.036233	2.29691876	1.322	0.1874
DUMMY60S	1	-3.776742	2.48408803	-1.520	0.1296
DUMMY70S	1	-0.920070	2.65701351	-0.346	0.7294

Dependent Variable: PPCTCHG

Test: TEST1	Numerator:	1008.8537	DF: 1	F value:	9.9065
on UNIPCT	Denominator:	101.8372	DF: 261	Prob>F:	0.0018

"University-Town Population Proportion"

· Table 10b

Model: MODEL3
Dependent Variable: PPCTCHG Δ Pop

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	17	30194.45382	1776.14434	18.561	0.0001
Error	261	24975.90398	95.69312		
C Total	278	55170.35780			

Root MSE	9.78229	R-square	0.5473
Dep Mean	14.28971	Adj R-sq	0.5178
C.V.	68.45687		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	-5.376216	5.04996806	-1.065	0.2880
→ UNIRANK1	1	-0.584454	0.11185786	-5.225	0.0001
JANTEMP	1	0.734791	0.09497489	7.737	0.0001
STATEAGE	1	-0.080173	0.02963224	-2.706	0.0073
URBBASE	1	0.214675	0.04819103	4.455	0.0001
NE	1	1.920419	3.08951982	0.622	0.5348
MA	1	-7.816146	3.60368755	-2.169	0.0310
ENC	1	-0.749848	3.14536430	-0.238	0.8118
WNC	1	-2.549035	3.25897665	-0.782	0.4348
ESC	1	-8.370063	2.49939477	-3.349	0.0009
WSC	1	-12.730166	2.84685268	-4.472	0.0001
MTN	1	3.491350	3.47210705	1.006	0.3156
PAC	1	0.274207	3.59980258	0.076	0.9393
DUMMY30S	1	-6.330016	2.04979422	-3.088	0.0022
DUMMY40S	1	1.358134	2.10571869	0.645	0.5195
DUMMY50S	1	3.799579	2.23177940	1.702	0.0899
DUMMY60S	1	-2.562636	2.41720114	-1.060	0.2900
DUMMY70S	1	0.761917	2.59032554	0.294	0.7689

Dependent Variable: PPCTCHG

Test: TEST1	Numerator:	2612.4503	DF: 1	F value:	27.3003
on UNIRANK1	Denominator:	95.69312	DF: 261	Prob>F:	0.0001

"Average Rank"

. Table 10c

Model: MODEL4
Dependent Variable: PPCTCHG Δ Pop

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	17	29063.01626	1709.58919	17.091	0.0001
Error	261	26107.34154	100.02813		
C Total	278	55170.35780			

Root MSE	10.00141	R-square	0.5268
Dep Mean	14.28971	Adj R-sq	0.4960
C.V.			

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	-3.982732	5.30088023	-0.751	0.4531
→ UNIRANK5	1	-0.572710	0.14883889	-3.848	0.0001
JANTEMP	1	0.684632	0.09600590	7.131	0.0001
STATEAGE	1	-0.092334	0.03253925	-2.838	0.0049
URBBASE	1	0.232453	0.05012765	4.637	0.0001
NE	1	2.181556	3.22645009	0.676	0.4995
MA	1	-9.098923	3.71237972	-2.451	0.0149
ENC	1	-1.835369	3.23830603	-0.567	0.5714
WNC	1	-4.441669	3.38078264	-1.314	0.1901
ESC	1	-8.077969	2.55547088	-3.161	0.0018
WSC	1	-13.607122	3.02667520	-4.496	0.0001
MTN	1	1.742185	3.79565937	0.459	0.6466
PAC	1	-1.619962	4.05606999	-0.399	0.6899
DUMMY30S	1	-6.284270	2.09688186	-2.997	0.0030
DUMMY40S	1	1.499963	2.16000819	0.694	0.4880
DUMMY50S	1	3.928015	2.28914378	1.716	0.0874
DUMMY60S	1	-2.443224	2.48248746	-0.984	0.3259
DUMMY70S	1	0.934924	2.66723670	0.351	0.7262

Dependent Variable: PPCTCHG

Test: TEST1	Numerator:	1481.0128	DF:	1	F value:	14.8060
on UNIRANK5	Denominator:	100.0281	DF:	261	Prob>F:	0.0001

"Highest Rank"

. Table 10d

Model: MODEL8
Dependent Variable: PPCTCHLG log (Δ Pop)

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	17	46.87985	2.75764	14.414	0.0001
Error	261	49.93485	0.19132		
C Total	278	96.81470			

Root MSE	0.43740	R-square	0.4842
Dep Mean	2.98735	Adj R-sq	0.4506
C.V.	14.64181		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	1.545869	0.24285211	6.365	0.0001
→ UNIPCTLG	1	0.103477	0.03396777	3.046	0.0026
JANTEMP	1	0.022759	0.00419892	5.420	0.0001
STATEAGE	1	0.001523	0.00127100	1.198	0.2318
URBBASE	1	0.008787	0.00214880	4.089	0.0001
NE	1	-0.036548	0.13815329	-0.265	0.7916
MA	1	-0.399858	0.16135481	-2.478	0.0138
ENC	1	0.146229	0.14360605	1.018	0.3095
WNC	1	-0.025243	0.14747240	-0.171	0.8642
ESC	1	-0.198212	0.11225904	-1.766	0.0786
WSC	1	-0.181365	0.12574183	-1.442	0.1504
MTN	1	0.483785	0.15114086	3.201	0.0015
PAC	1	0.281454	0.15968261	1.763	0.0791
DUMMY30S	1	-0.390801	0.09162776	-4.265	0.0001
DUMMY40S	1	-0.102790	0.09397376	-1.094	0.2750
DUMMY50S	1	-0.122800	0.09969494	-1.232	0.2191
DUMMY60S	1	-0.363933	0.10795250	-3.371	0.0009
DUMMY70S	1	-0.277336	0.11564370	-2.398	0.0172

Dependent Variable: PPCTCHLG
Test: TEST1 Numerator: 1.7755 DF: 1 F value: 9.2801
Denominator: 0.191321 DF: 261 Prob>F: 0.0026

log(Pop. Proportion)

. Table 10e

Model: MODEL11
Dependent Variable: PPCTCHLG log (Δ Pop)

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	17	48.73079	2.86652	15.559	0.0001
Error	261	48.08391	0.18423		
C Total	278	96.81470			

Root MSE	0.42922	R-square	0.5033
Dep Mean	2.98735	Adj R-sq	0.4710
C.V.	14.36788		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	2.099359	0.22644905	9.271	0.0001
→ UNIRNK1L	1	-0.164820	0.03714938	-4.437	0.0001
JANTEMP	1	0.025301	0.00419613	6.030	0.0001
STATEAGE	1	0.000187	0.00129329	0.145	0.8848
URBBASE	1	0.009513	0.00210972	4.509	0.0001
NE	1	0.005669	0.13582964	0.042	0.9667
MA	1	-0.320650	0.15846820	-2.023	0.0440
ENC	1	0.097152	0.13826077	0.703	0.4829
WNC	1	-0.078058	0.14301882	-0.546	0.5857
ESC	1	-0.235601	0.10966463	-2.148	0.0326
WSC	1	-0.322755	0.12387619	-2.605	0.0097
MTN	1	0.408956	0.14996939	2.727	0.0068
PAC	1	0.246300	0.15489922	1.590	0.1130
DUMMY30S	1	-0.372846	0.08995124	-4.145	0.0001
DUMMY40S	1	-0.068120	0.09240899	-0.737	0.4617
DUMMY50S	1	-0.071769	0.09801203	-0.732	0.4647
DUMMY60S	1	-0.291994	0.10619500	-2.750	0.0064
DUMMY70S	1	-0.182737	0.11382326	-1.605	0.1096

Dependent Variable: PPCTCHLG

Test: TEST1	Numerator:	3.6264	DF: 1	F value:	19.6842
	Denominator:	0.18423	DF: 261	Prob>F:	0.0001

log (Average Rank)

. Table 10f

Model: MODEL12
Dependent Variable: PPCTCHLG log (Δ Pop)

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	17	48.44253	2.84956	15.375	0.0001
Error	261	48.37217	0.18533		
C Total	278	96.81470			

Root MSE	0.43050	R-square	0.5004
Dep Mean	2.98735	Adj R-sq	0.4678
C.V.	14.41089		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	2.178731	0.23350620	9.331	0.0001
→ UNIRNK5L	1	-0.190166	0.04480814	-4.244	0.0001
JANTEMP	1	0.024699	0.00418320	5.904	0.0001
STATEAGE	1	-0.000546	0.00135986	-0.402	0.6882
URBBASE	1	0.010250	0.00213247	4.806	0.0001
NE	1	0.047457	0.13900000	0.341	0.7331
MA	1	-0.421053	0.15897409	-2.649	0.0086
ENC	1	0.063660	0.13838778	0.460	0.6459
WNC	1	-0.132981	0.14367919	-0.926	0.3555
ESC	1	-0.202064	0.11019484	-1.834	0.0678
WSC	1	-0.362935	0.12633174	-2.873	0.0044
MTN	1	0.283783	0.15845514	1.791	0.0745
PAC	1	0.065836	0.17247528	0.382	0.7030
DUMMY30S	1	-0.368702	0.09026404	-4.085	0.0001
DUMMY40S	1	-0.057695	0.09291224	-0.621	0.5352
DUMMY50S	1	-0.060294	0.09859659	-0.612	0.5414
DUMMY60S	1	-0.278668	0.10693762	-2.606	0.0097
DUMMY70S	1	-0.164890	0.11484583	-1.436	0.1523

Dependent Variable: PPCTCHLG

Test: TEST1	Numerator:	3.3382	DF: 1	F value:	18.0116
	Denominator:	0.185334	DF: 261	Prob>F:	0.0001

log (Highest Rank)

· Table 10g

Model: MODEL13
Dependent Variable: EPCTCHG   Δ EMPL

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	17	61413.08476	3612.53440	26.836	0.0001
Error	261	35134.41149	134.61460		
C Total	278	96547.49625			

Root MSE	11.60235	R-square	0.6361
Dep Mean	17.02352	Adj R-sq	0.6124
C.V.	68.15486		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	-6.943810	6.02220590	-1.153	0.2500
→ UNIPCT	1	0.118566	0.04867685	2.436	0.0155
JANTEMP	1	0.550157	0.11077625	4.966	0.0001
STATEAGE	1	-0.049053	0.03366946	-1.457	0.1463
URBBASE	1	0.179782	0.05785459	3.107	0.0021
NE	1	-0.839945	3.71873191	-0.226	0.8215
MA	1	-8.367375	4.27262530	-1.958	0.0513
ENC	1	0.378659	3.85839251	0.098	0.9219
WNC	1	0.216452	3.92808903	0.055	0.9561
ESC	1	-7.735530	2.97643796	-2.599	0.0099
WSC	1	-7.705419	3.33957426	-2.307	0.0218
MTN	1	7.741149	3.99772483	1.936	0.0539
PAC	1	3.012902	4.14933167	0.726	0.4684
DUMMY30S	1	-22.814427	2.43022276	-9.388	0.0001
DUMMY40S	1	9.656103	2.49214963	3.875	0.0001
DUMMY50S	1	4.771470	2.64081859	1.807	0.0719
DUMMY60S	1	0.335696	2.85601126	0.118	0.9065
DUMMY70S	1	11.838487	3.05482753	3.875	0.0001

Dependent Variable: EPCTCHG

Test: TEST1	Numerator:	798.6748	DF: 1		F value:	5.9330
	Denominator:	134.6146	DF: 261		Prob>F:	0.0155

Population Proportion

Table 10h

Model: MODEL20
Dependent Variable: EPCTCHLG log(ΔEMPL)

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	17	47.60408	2.80024	43.475	0.0001
Error	261	16.81107	0.06441		
C Total	278	64.41515			

Root MSE	0.25379	R-square	0.7390
Dep Mean	3.65927	Adj R-sq	0.7220
C.V.	6.93559		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	3.099889	0.14090867	21.999	0.0001
→ UNIPCTLG	1	0.046204	0.01970892	2.344	0.0198
JANTEMP	1	0.010274	0.00243631	4.217	0.0001
STATEAGE	1	0.000130	0.00073747	0.177	0.8599
URBBASE	1	0.004257	0.00124678	3.414	0.0007
NE	1	-0.103734	0.08015988	-1.294	0.1968
MA	1	-0.254275	0.09362197	-2.716	0.0070
ENC	1	-0.008709	0.08332371	-0.105	0.9168
WNC	1	-0.027515	0.08556706	-0.322	0.7480
ESC	1	-0.191483	0.06513541	-2.940	0.0036
WSC	1	-0.156089	0.07295845	-2.139	0.0333
MTN	1	0.148474	0.08769558	1.693	0.0916
PAC	1	0.073450	0.09265171	0.793	0.4286
DUMMY30S	1	-0.839450	0.05316464	-15.790	0.0001
DUMMY40S	1	0.185904	0.05452585	3.409	0.0008
DUMMY50S	1	0.026459	0.05784541	0.457	0.6478
DUMMY60S	1	-0.047625	0.06263665	-0.760	0.4477
DUMMY70S	1	0.171575	0.06709927	2.557	0.0111

Dependent Variable: EPCTCHLG

Test: TEST1	Numerator:	0.3540	DF:	1	F value:	5.4958
	Denominator:	0.06441	DF:	261	Prob>F:	0.0198

log (Population Proportion)

· Table 10i

Model: MODEL23
Dependent Variable: EPCTCHLG log (Δ EMPL)

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	17	48.44696	2.84982	46.580	0.0001
Error	261	15.96820	0.06118		
C Total	278	64.41515			

Root MSE	0.24735	R-square	0.7521
Dep Mean	3.65927	Adj R-sq	0.7360
C.V.	6.75949		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	3.380292	0.13049642	25.903	0.0001
→ UNIRNK1L	1	-0.094688	0.02140817	-4.423	0.0001
JANTEMP	1	0.012111	0.00241812	5.008	0.0001
STATEAGE	1	-0.000664	0.00074529	-0.891	0.3737
URBBASE	1	0.004642	0.00121578	3.818	0.0002
NE	1	-0.068558	0.07827492	-0.876	0.3819
MA	1	-0.212470	0.09132090	-2.327	0.0208
ENC	1	-0.025502	0.07967591	-0.320	0.7492
WNC	1	-0.048957	0.08241785	-0.594	0.5530
ESC	1	-0.208799	0.06319674	-3.304	0.0011
WSC	1	-0.230629	0.07138647	-3.231	0.0014
MTN	1	0.100725	0.08642327	1.165	0.2449
PAC	1	0.034410	0.08926420	0.385	0.7002
DUMMY30S	1	-0.829728	0.05183645	-16.007	0.0001
DUMMY40S	1	0.204982	0.05325278	3.849	0.0001
DUMMY50S	1	0.053726	0.05648166	0.951	0.3424
DUMMY60S	1	-0.009386	0.06119729	-0.153	0.8782
DUMMY70S	1	0.221680	0.06559324	3.380	0.0008

Dependent Variable: EPCTCHLG

Test: TEST1	Numerator:	1.1969	DF: 1	F value:	19.5626
	Denominator:	0.061181	DF: 261	Prob>F:	0.0001

log (Average Ranks)

· Table 10j

Model: MODEL24
Dependent Variable: EPCTCHLG log (Δ EMPL)

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	17	48.05315	2.82666	45.090	0.0001
Error	261	16.36201	0.06269		
C Total	278	64.41515			

Root MSE	0.25038	R-square	0.7460
Dep Mean	3.65927	Adj R-sq	0.7294
C.V.	6.84233		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	3.397386	0.13580599	25.016	0.0001
UNIRNK5L	1	-0.093272	0.02606018	-3.579	0.0004
JANTEMP	1	0.011355	0.00243293	4.667	0.0001
STATEAGE	1	-0.000894	0.00079088	-1.131	0.2593
URBBASE	1	0.004963	0.00124024	4.002	0.0001
NE	1	-0.058779	0.08084168	-0.727	0.4678
MA	1	-0.265941	0.09245850	-2.876	0.0044
ENC	1	-0.045291	0.08048561	-0.563	0.5741
WNC	1	-0.077301	0.08356307	-0.925	0.3558
ESC	1	-0.191942	0.06408874	-2.995	0.0030
WSC	1	-0.242847	0.07347388	-3.305	0.0011
MTN	1	0.048743	0.09215669	0.529	0.5973
PAC	1	-0.038779	0.10031072	-0.387	0.6994
DUMMY30S	1	-0.828815	0.05249710	-15.788	0.0001
DUMMY40S	1	0.207734	0.05403728	3.844	0.0002
DUMMY50S	1	0.056412	0.05734326	0.984	0.3261
DUMMY60S	1	-0.006866	0.06219436	-0.110	0.9122
DUMMY70S	1	0.225270	0.06679374	3.373	0.0009

Dependent Variable: EPCTCHLG

Test: TEST1	Numerator:	0.8030	DF:	1	F value:	12.8099
	Denominator:	0.06269	DF:	261	Prob>F:	0.0004

log (Highest Rank)

Implications for Policy

A most straightforward implication from these empirical results is that states will get a higher return on their public investment if their universities are located in large metropolitan areas.

There are a number of policies a state could adopt if it wished to take advantage of the beneficial effect of university location in large metro areas. If a state presently has an urban university and a small town university, it can bias its investment decisions toward the urban school. New faculty hires, new programs, and new capital investment can be directed to the urban campus.

If a state has universities only in small towns, it is forced to open a branch campus in the city. It can then subsidize communication and transportation links between the rural campuses and the city - the results in this paper suggest that the social benefits may outweigh the costs. Again, new faculty hires, new programs, and new capital investment can be directed to the urban campus. The state could also subsidize the move of older faculty to the city. If the state has two small town universities, it could play them against each other by offering expanded programs and facilities to the one willing to move programs to the city campus.

States with university-poor large cities might even wish to consider luring private colleges from college-surplus areas such as Massachusetts, or stimulating local colleges to become universities or to form a collective graduate school, in the manner of the Claremont Graduate School.

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