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Sunbelt Growth and the Knowledge Economy: An Exploratory Approach

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Abstract. Focusing on the narrower concept of a knowledge-economy-based growth strategy, this paper explores whether a strong link between a college-educated population and a region's economic performance was an important ingredient in the growth experience of the Sunbelt during the 1990s. The issue is addressed through analysis of two different datasets. First, the education and income characteristics of the people moving to the Sunbelt region are examined using migration data from the 2000 census. Then we look at the link between the knowledge-economy metric of the share of college educated adults and economic growth in the Sunbelt in the 1990s using data for 116 Sunbelt MSAs. The results of our analysis provide little evidence that a college educated workforce was a major factor promoting economic growth in Sunbelt cities during that period.

1. Introduction

Policy makers in the Sunbelt have recognized that the traditional approach to economic development – a strategy of offering a lower cost of doing business to attract business relocation and using job growth as the metric of success – must be replaced in a world characterized by globalization and rapid technological change. While the fundamental goal for economic development has always been prosperity, the operational goal has shifted from providing jobs to increasing living standards. Dollar-denominated metrics – most often wages and/or per capita income – have supplanted or at least supplemented job growth as the target variables of regional development.

In many cases, the initial change in strategy was to shift the focus to attracting high-wage jobs – often characterized as "high tech" manufacturing. Over time, this approach has been broadened to recognize that the standard of living is fundamentally determined by the productivity of the regional economy and that high productivity and productivity growth come from producing higher value products and services and by increasing efficiency in producing those goods and services. Based on this concept of economic development, the challenge facing policy makers is to attract high value-added economic activity and to create conditions conducive to high productivity and sustained productivity growth.

A popular way to characterize this approach to economic development is in terms of the "knowledge economy" or "knowledge-based economy" The concept of the "knowledge-based economy" recognizes the importance of knowledge and technology in economic growth (OECD 1996). A knowledge-based economic growth strategy often is defined broadly to incorporate innovation, research and development activities, and non-education aspects of human capital (Raspe and Van Oort 2006), but much of the discussion of the knowledge economy has focused on the link between economic growth and the stock of human capital measured in terms of the college-educated population. Based on national datasets, empirical research clearly links economic growth (prosperity) and college-educated population (see for example, Glaeser and Saiz 2003 and Moretti 2004). And one study actually asserts "the percentage of adults with a college degree is the single most important driver of economic growth" (Weissbourd and Berry 2004).

Over the past fifty years, the southeastern and southwestern regions of the U.S. have experienced much more rapid growth than the rest of the nation. This portion of the U.S. is popularly referred to as the Sunbelt.[1] The Sunbelt's share of the national population jumped from 28 percent in 1950 to 40 percent by 2000. At the beginning of the 21st century, the population of the Sunbelt nearly equals the combined population of the nation's traditional Northeast and Midwest "core" regions – 110 million versus 118 million (Lang and Rengert 2001). While "mainstream" economic analyses identified lower costs of doing business and a less unionized labor force as key factors leading to a shift of economic activity in the U.S. to the south and west (see for example, Olson 1983, Chinitz 1986, and Wright 1987), more recently other researchers have argued that the non-economic factor of climate has been a significant determinant of this growth pattern (see for example, Gallup, Sachs, and Mellinger 1999 and Glaeser, et. al. 2001). Some analysts have speculated that climate has historically been a substitute for human capital development (Quan and Beck 1987; Glaeser and Saiz 2003).

Focusing on the narrower concept of a knowledge-economy-based growth strategy, this paper explores whether a strong link between a college-educated population and a region's economic performance was an important ingredient in the growth experience of the Sunbelt during the 1990s. The issue is addressed through analysis of two different datasets. First, the education and income characteristics of the people moving to the Sunbelt region are examined using migration data from the 2000 census. Then we look at the link between the knowledge-economy metric of the share of college educated adults and economic growth in the Sunbelt in the 1990s using data for 116 Sunbelt MSAs.

2. A selective review of the literature

The 2003 Glaeser and Saiz study of the link between education and urban growth served as the initial motivation for the research on which this paper is based. Their 2003 analysis built upon an earlier study by Glaeser and Shapiro (2001) in which somewhat less sophisticated empirical analysis identified what were termed "three large trends that determined the recent growth of cities" – human capital, movement to warmer, drier places, and reliance on autos. The regression analysis in the 2003 study, which included a battery of control variables and regional fixed effects, found a strong link between the share of college-educated adults and population growth using primarily census data for a national set of MSAs for the 1970–2000 period. The results also showed positive effects of warm and dry climate measures. Of particular interest to the current project were the results of two sets of regression models in the study:

1. The analysis included two simple models of population growth as a function of the share of college graduates – one using the entire MSA sample and the other using only MSAs that had average January temperatures of 40+ degrees. The regression coefficient and R^2 for the "warm climate" subsample were much smaller than for the national sample. Glaeser and Saiz interpreted these results to mean skills do not matter in warm cities.
2. Models that included interaction effects between education and climate also found a weaker link between education and both MSA growth and MSA wage levels in warmer areas.

Empirical results from an earlier study of regional growth also tangentially addressed the link between the knowledge economy and economic growth in the Sunbelt. Quan and Beck (1987) looked at the link between education and state economic growth, but their analysis focused on the relationships between per capita income, wages and employment and public expenditures on K-12 and higher education. They found positive links between education spending and the economic variables for Northern states, but little evidence (with some results actually showing a negative relationship) of any link for Sunbelt states.

In neither case do the results offer support for the hypothesis that human capital was an important factor in explaining the economic success of the Sunbelt in the late 20th century.

3. Growth and educational attainment

Some areas of the Sunbelt have achieved great economic success along with sheer aggregate growth. Metro areas like Atlanta and Charlotte are obvious examples. Other areas have experienced explosive population and job growth but have not done as well in raising the living standards of their residents (at least in comparison with the national average). For example,

[1] The geographic area defined as the Sunbelt for this study is based on U.S. Census Bureau definition. It is composed of 13 states (North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Louisiana, Tennessee, Arkansas, Oklahoma, Texas, New Mexico, and Arizona) plus Clark County, NV (Las Vegas), and a nine-county region of Southern California (Imperial, Kern, Los Angeles, Orange, Riverside, San Bernardino, San Diego, Santa Barbara, and Ventura). Some parts of the analysis are based on state-level data. In those cases the Sunbelt region is defined to include the 13 states plus the entire states of California and Nevada

McAllen-Edinburg-Mission, TX was the second fastest growing Sunbelt MSA in the 1990s, but income grew slower than the national average so that its per capita personal income figure fell from 48 percent of the national level in 1990 to 45 percent in 2000. And not all Sunbelt states have shared in the rapid growth experienced by the rest of the region. Four states (Alabama, Arkansas, Mississippi, and Oklahoma) actually trailed the national growth trend over the 1950–2000 period.

Focusing on the last decade of the 20th century, the aggregate statistics presented in Table 1 show that the population of the 15-state Sunbelt region grew more than twice as fast as the Non-Sunbelt states between 1990 and 2000. The Sunbelt states also outpaced the rest of the nation in terms of aggregate economic growth – for example, the GDP of the Sunbelt region increased 78 percent over the decade compared with 60 percent for the Non-Sunbelt states. But the Sunbelt region was not as successful in terms of personal economic measures. The average per capita GDP in 2000 for the 15 state Sunbelt region was $33,104–92 percent that of the Non-Sunbelt region, and per capita GDP growth for the Sunbelt states also lagged behind the rest of the nation during the decade.

While the region as a whole surpassed the rest of the U.S. in terms of aggregate growth, the pattern of growth during the 1990s was not uniform among the individual Sunbelt states. Some states like Arizona, California, and North Carolina had rapid aggregate growth and also managed 60+ percent increases in per capita GDP. Others like Nevada and South Carolina grew rapidly but had below average increases in per capita GDP. And at the other end of the scale, Louisiana lagged behind the Non-Sunbelt region in all four measures.

Turning to comparisons of the 15-state Sunbelt region vis-à-vis the rest of the nation in terms of the proportion of college graduates – the human capital metric often used in studies of the knowledge economy – the figures demonstrate that the share of those 25+ with at least bachelor's degree in 2000 was lower for the Sunbelt region than in the Non-Sunbelt states. Looking specifically at younger adults (aged 25 to 39), the relative ranking remains the same, and the gap between the Non-Sunbelt and Sunbelt regions is even larger than for all adults.

The economies of some areas in the Sunbelt have clearly benefited from knowledge economy-based growth, but the statistics in Table 1 show that much of the region still lags far behind in developing knowledge-based resources. For example, a recent Milken Institute study of Arkansas' position in the knowledge-based economy ranked the state next-to-last in knowledge-economy resources, and the analysis cautioned that several other Sunbelt states were in similar, if slightly better situations (Milken Institute 2004).

Table 1. Growth in Population, Gross Domestic Product, Per Capita GDP & Proportions of College-Educated Adults

	1990-2000 Population Growth (percent)	1990-2000 GDP Growth (percent)	Per Capita GDP 2000 ($)	1990-2000 Per Capita GDP Growth (percent)	Population 25+ 2000 (percent)	Population 25-39 2000 (percent)	Difference 25-39 vs 25+ 2000 (percent)
Sunbelt States	18.9	77.9	33,104	49.7	23.0	24.1	1.1
Alabama	10.1	61.2	25,764	46.4	19.0	21.6	2.6
Arizona	40.0	128.7	30,899	63.4	23.5	23.5	0.0
Arkansas	13.7	75.3	24,987	54.1	16.7	18.3	1.6
California	13.8	63.3	38,001	43.5	26.6	26.5	-0.1
Florida	23.5	83.2	29,490	48.3	22.3	23.4	1.1
Georgia	26.4	108.5	35,533	65.0	24.3	27.2	2.9
Louisiana	5.9	40.5	29,430	32.7	18.7	20.3	1.6
Mississippi	10.5	65.8	22,592	50.0	16.9	18.1	1.2
Nevada	66.3	131.7	36,892	39.3	18.2	17.6	-0.6
New Mexico	20.1	88.8	27,885	57.2	23.5	20.7	-2.8
North Carolina	21.4	95.1	34,003	60.7	22.5	25.5	3.0
Oklahoma	9.7	55.5	26,012	41.8	20.3	20.9	0.6
South Carolina	15.1	71.2	28,044	48.8	20.4	22.0	1.6
Tennessee	16.7	84.9	30,733	58.5	19.6	22.6	3.0
Texas	22.8	89.3	34,876	54.2	23.2	23.6	0.4
Non-Sunbelt States	9.0	67.7	35,845	53.7	25.5	29.3	3.9
United States	13.2	71.8	34,642	51.8	24.4	27.0	2.6

Source: Computed by authors based on data from U.S. Census Bureau & U.S. Bureau of Economic Analysis websites; 2000 Census IPUMS 5% files.

4. U.S. domestic net migration

Recent decades have witnessed steady north-to-south net domestic migration in the U.S. A Census report, *Domestic Net Migration in the United States: 2000 to 2004* (Perry 2006) reveals the progression of north to south migration continued in a pattern that prevailed throughout the 1990s. Eight of the top ten states for domestic net migration were Sunbelt states while California (partially Sunbelt) experienced significant net domestic out-migration.

Behind the aggregate net migration numbers, questions remain. What are the knowledge and skill characteristics of the people that dominate these population flows? What role does age play in the observed domestic net migration patterns? Are the knowledge and skills of the people migrating from north to south different from the average state-to-state migrant? And is this north-to-south migration consistent with the arguments that knowledge and skill development is an important catalyst for economic growth and prosperity?

Comparing attributes of people who migrated to the Sunbelt at some point between 1995 and 2000 with people who moved from the Sunbelt in the same time period (based on analysis of the 2000 Census migration DVD dataset), it turns out that their characteristics are quite similar. The data suggest the educational attainment of people migrating north to south are essentially identical to those migrating south to north. For example, 34.9 percent of the north-to-south migrants had college degrees, while 35.5 percent of the south-to-north migrants were college graduates. Similarly, 47.9 percent of the north-to-south migrants reported incomes in excess of $50,000, while 49.5 percent of the south-to-north migrants reported incomes in excess of $50,000. So, in the aggregate, it appears education and income-earning skill characteristics are essentially randomly distributed across domestic migrants regardless of their (north vs. south) direction of movement.

But this aggregate analysis ignores age differences that may prevail among the domestic migrants, and it assumes the Sunbelt is comprised of essentially a homogeneous set of states. We consider each in turn.

4.1 Age issues

As is widely known, significant migration of people aged 55^{+} from north to south has been a continuing phenomenon. The Census 2000 report, *Internal Migration of the Older population: 1995 to 2000* (He and Schachter 2003) shows seven of the top 10 destination states for elderly interstate migrants were Sunbelt states. Nevada, Arizona and Florida received most of these elderly migrants. In many Sunbelt states this population flow of older people serves to boost local economies. In Nevada, as reported in the *Economist* (2006), the elderly population is serving as an important source of service industry labor. And across the Sunbelt, the migrating elderly are generally more educated and wealthier in comparison with national averages at the same age cohort – resulting in a positive tug on average educational attainment and income in the 25^{+} population for many Sunbelt states. The challenge of course is that the elderly provide little boost to the quality of skills in the working age labor force and may indeed result in increasing pressures for more service industry jobs. Further, as the Baby Boom generation ages, Sunbelt states will no doubt find themselves with increasing proportions of very elderly people – especially in the most attractive states for the elderly migrants, Arizona, Florida and Nevada.

A special Census 2000 report highlighted the migration patterns of the young (25–39), single and college-educated population for the period 1995 to 2000 (Franklin 2003b). The analysis revealed that seven of the ten states with the highest rates of net domestic migration among this group were Sunbelt states. These findings suggest that Sunbelt states added significantly to their numbers of young, college-educated people. However, the Sunbelt states also received most of the total net domestic migration, so it may not be surprising that they saw significant increases in the number of young, single, educated people as well.

Seventeen states, plus the District of Columbia, had net positive domestic in-migration for the young, single and college educated population during the 1995–2000 period. Eight of the 15 Sunbelt states were included in the group. The other 33 states, including seven Sunbelt states and 26 non-Sunbelt states, saw outflows of the young, single and college educated in the late 1990s.

The figures in the Census report reveal the Sunbelt generally performed well in terms of net migration for this subpopulation, but they also show the absolute numbers of this group are small relative to total net migrants. For example, only 6,788 of the 233,934 net in-migrants to Nevada were in this young, single, and college-educated demographic group in Arizona 9,264 out of 316,148, and in Florida only 10,454 out of 607,023. In contrast, California, Alaska, Maryland, Illinois, and the District of Columbia, increased their shares of young, single and college educated while actually having a net outflow of domestic migrants from 1995 to 2000.

While this special Census report chose to focus on young, unmarried college graduates, it makes more sense to take a somewhat broader look at all young college graduates as the subgroup most important for what is happening with an area's human capital resources. The numbers presented in Table 1 already demonstrated this desirable subpopulation is a smaller share of all young adults in the 15-state Sunbelt region than in the Non-Sunbelt states. The net migration figures in Table 2 show that the Sunbelt states as a region gained a total of more than 200,000 young college-educated individuals from the rest of the nation over the 1995–2000 period. And young, college-educated persons made up 13.9 percent of total net migration into the region – substantially higher than the 5.8 percent share this subpopulation made up of the 5^{+} population of the region in 2000. Still, even after adding gaining these "economically desirable" new residents at the expense of the Non-Sunbelt states, the proportion of college-educated young adults in the Sunbelt region remained substantially below the rest of the nation in 2000 (see Table 1).

Table 2. Domestic Migration of Young, College-Educated (YCE) Persons 1995 - 2000

	In-migrants	Out-migrants	Net Migration	YCE share Percent Total 5+ Net Migration	Total 5+ Population in 2000
Sunbelt States					
Alabama	35,512	47,552	-12,040	-	4.9
Arizona	84,306	59,235	25,071	7.9	5.6
Arkansas	19,485	21,380	-1,895	-	4.0
California	320,594	239,188	81,406	-	6.6
Florida	170,187	145,864	24,323	4.1	5.1
Georgia	151,572	101,960	49,612	14.3	7.1
Louisiana	30,400	51,950	-21,550	-	4.5
Mississippi	19,781	27,911	-8,130	-	4.1
Nevada	31,255	16,307	14,948	6.4	4.4
New Mexico	22,348	28,661	-6,313	21.9	4.5
North Carolina	127,276	97,213	30,063	8.7	6.3
Oklahoma	24,993	39,479	-14,486	-	4.4
South Carolina	49,855	48,229	1,626	1.3	5.1
Tennessee	69,399	63,410	5,989	4.2	5.3
Texas	204,228	164,438	39,790	29.9	5.9
All Sunbelt States	1,361,189	1,152,779	208,410	13.9	5.8
All Non-Sunbelt States	2,017,952	2,226,362	-208,410	-	6.8
United States	3,379,141	3,379,141	0	-	6.3

Sources: U.S. Census Bureau, 2000 Census IPUMS 5 percent files and Census 2000 Special Tabulations PHC-T-22, Gross and Net Migration Tables.

Six of the 15 Sunbelt states actually had net outflows of young, college-educated individuals, and for states like Florida, Nevada, and Arizona these potential knowledge economy workers made up a very small part of their population gains. In a few Sunbelt states, however, the young college-educated in-migrants were a major positive factor. For Georgia and Texas in particular they constituted a large share of the states' total net-migration. And California had a net gain of more than 80,000 young, college-educated individuals at the same time that the state's overall net outflow was almost 800,000 over the 1995–2000 period.

4.2 Knowledge and skills across the Sunbelt

While considerable north-to-south migration has occurred, it is clear the migration patterns to and from individual Sunbelt states vary considerably. Table 3 depicts the distribution of domestic in-migrants into individual Sunbelt states by income and educational attainment. The figures reveal considerable heterogeneity across the Sunbelt. The states with the highest income in-migrants are California, Georgia, and Texas; the share of high income migrants exceeds the average state by 21.1 percent for California and Georgia and by 15.3 percent for Texas. All three of these states also

reported shares of college educated among in-migrants over 20 percent above the average Sunbelt state. The states with the lowest income in-migrants are Arkansas, Mississippi and Oklahoma with the proportions of in-migrants with income above the $50,000 level that lagged the average Sunbelt state by 21.7 percent, 13.9 percent and 19.5 percent respectively. In each of the lowest income states the proportion of in-migrants with college degrees was more than 20 percent below the average Sunbelt state.

Table 3. Income and Educational Attainment of Domestic In-Migrants to the Sunbelt States: 1995-2000

State	Income over $50,000 Non- Hispanic Migrants (percent)	Deviation from Sunbelt average (percent)	Income over $50,000 Total Migrants (percent)	Deviation from Sunbelt average (percent)	Migrant reports some college education (percent)	Deviation from Sunbelt average (percent)	Migrant has college degree (percent)	Deviation from Sunbelt average (percent)
AL	42.5	-7.8	42.0	-5.8	31.3	-1.4	29.9	-4.9
AZ	49.8	8.0	47.7	7.0	34.2	7.8	31.3	-0.5
AK	5.9	-22.1	34.9	-21.7	30.2	-4.9	22.7	-27.8
CA	55.9	21.3	54.0	21.1	29.8	-6.1	44.8	42.5
FL	46.5	0.9	45.2	1.4	31.1	-2.0	29.6	-5.9
GA	54.8	18.9	54.0	21.1	30.6	-3.6	38.0	20.8
LA	40.2	-12.8	39.8	-10.7	31.3	-1.4	31.0	-1.4
MS	38.6	-16.3	38.4	-13.9	32.9	3.7	24.5	-22.1
NV	52.4	13.7	49.1	10.1	34.1	7.4	21.5	-31.6
NM	42.7	-7.4	38.5	-13.7	32.4	2.1	35.0	11.3
NC	49.8	8.0	48.4	8.5	30.4	-4.2	37.4	18.9
OK	36.8	-20.2	35.9	-19.5	34.0	7.1	24.4	-22.4
SC	46.0	-0.2	45.4	1.8	32.2	1.4	32.3	2.7
TN	44.6	-3.3	44.2	-0.9	30.6	-3.6	31.4	-0.1
TX	55.0	19.3	51.4	15.3	31.0	-2.3	37.9	20.5
Average	46.1		44.6		31.7		31.4	

Source: US Census, 2000 Census Migration DVD

Table 3 also reveals the income/skill correlation is not monotonic across the Sunbelt states. Arizona, Florida, and Nevada, the preferred destinations of many elderly in-migrants, all reported above average income frequencies with below-average college graduation frequencies overall, with Nevada the lowest frequency of college graduates among the Sunbelt states – yet reporting high-income frequency that was 10 percent above the average Sunbelt state. Similarly, New Mexico had a high frequency of college educated in-migrants but a below average frequency of high-income in-migrants.

Data for the in-migrant streams of young, college-educated individuals demonstrate similar patterns (Table 4). For the entire 15-state Sunbelt region, the proportion of high-income ($50,000+) individuals was only slightly below that for the Non-Sunbelt region, but this aggregate measure is misleading as only two of the states – California and Texas – actually had proportions above the Non-Sunbelt average.

This examination of domestic migration data reveals that, while the Sunbelt has been the beneficiary of significant net domestic migration, these flows (with the exception of California, and to some degree Georgia and Texas) are not being accompanied by large numbers of people prepared to contribute to knowledge economy endeavors.

5. The "knowledge economy" explanation

This section summarizes an exploratory analysis of alternative metrics of economic success and of the knowledge economy for the 116 MSAs in the Sunbelt that are included in the Department of Housing and

Urban Development's State of the Cities Data System.[2] The metro areas included in the dataset are very diverse – in terms of whatever characteristic one might choose – ranging from huge (Los Angeles-Long Beach, CA and Houston, TX) to small (Pine Bluff, AR and Enid, OK); rapidly growing (Las Vegas, NV) to declining (Alexandria, LA); rich (West Palm Beach-Boca Raton, FL) to poor (McAllen-Edinburg-Mission, TX), etc.

The analysis looked at four alternative measures of economic success:

1. *The growth rate of the MSA population over the 1990-2000 period* – The population growth measure was included to be consistent with the Glaeser and Saiz analysis. Glaeser and Saiz could argue either (a) they focused on population rather than economic variables because they were looking at "urban growth" not economic growth, or (b) their analysis was in the context of looking at growing areas versus declining areas. But population growth is not really a good measure of economic growth – particularly for Sunbelt regions. In the entire sample of 116, only three MSAs suffered a decline in total population, and many of the poorest areas have grown rapidly.
2. *The growth rate of total employment for the 1990–2000 period* – Job growth has more validity than population growth as a measure of economic growth. Historically, it has been one of the primary metrics used to measure regional economic growth by policy makers, economic development professionals, and economists. However, it does not do an adequate job of monitoring what is happening to the standard of living of area residents.
3. *Per capita personal income in 2000* – For this analysis per capita personal income was chosen as the proxy measure for the material standard of living of area residents.
4. *The growth rate of per capita personal income for the 1990–2000 period* – The growth rate of per capita personal income serves as a metric for the change in the material standard of living.

The following discussion focuses on the two income-related measures and secondarily on employment growth. Population growth is included to mirror Glaeser and Saiz. Table 5 lists the simple correlation coefficients between each of the four metrics. These figures show a very high correlation between population growth and employment growth. The coefficients also indicate positive correlations between per capita income and all three growth measures, but a negative relationship between income growth and population growth; although none are statistically significant at a .05 confidence level. The correlation statistics indicate that income level, income growth, and employment growth were not highly correlated among the set of 116 Sunbelt MSAs.

The three alternative education-related variables used in the analysis are (1) the share of college graduates in the adult (25^+) population in 2000, (2) the growth rate of that share over the 1990–2000 period, and (3) the ratio of net in-migrants to the MSA ages 25 to 39 in 2000 who were single and college graduates to the population of the MSA ages 5+ in 2000 (net migration of young, single, college educated persons hereafter referred to as YSCMR).[3] This statistic was computed from data produced for the special Census 2000 report (Franklin 2003b) discussed earlier. Table 5 also presents the simple correlation coefficients between the three education metrics, and also between each of the three and the four economic measures. The correlation coefficients imply that the share of college graduates and growth of that share are not closely related, but somewhat surprisingly (at first glance anyway) that there is a statistically significant negative relationship between share of college graduates and the YSCMR. Upon closer examination of the data, it appears that this is a result of out-migration of young, single college-educated adults from "college towns" like Austin. On the other hand, the figures show a modest positive (statistically significant at the .05 percent level of confidence) correlation between the YSCMR and growth in the share of college graduates.

5.1. Correlating education and economic growth

The correlation coefficients between the three education metrics and the four economic measures provide mixed signals. All of the coefficients are positive, but not all are statistically significant. The highest correlation is found between the share of college graduates and per capita income. This could be interpreted simply as the result of a higher proportion of college graduates with higher incomes or more broadly in terms of a knowledge economy-based argument –

[2] The 116 MSAs in the dataset include two multi-state MSAs for which some portion of the area lies outside the formal Census definition of the Sunbelt region. In some cases, HUD's State of the Cities database included two or more PMSAs that are part of a single CMSA as separate observations. The authors have chosen not to include a complete list of the 116 MSAs but would be happy to provide one on request. All of the data in the dataset were compiled from the HUD database, with the exception of the per capita personal income data compiled from the BEA REIS CD and the climate measures from the U.S. Census Bureau's *City-County Databook*.

[3] Data for this variable was not available in the Census report for seven MSAs in the dataset.

Table 4. Young, College-Educated (YCE) Domestic In-Migrants 1995 - 2000

	YCE In-migrants	Percent of Total 5+ In-Migration	Percent with Incomes of $50,000 or more	Deviation from National Average (%)	Deviation from Sunbelt Average (%)
Sunbelt States					
Alabama	35,512	10.9	24.3	-18.8	-17.9
Arizona	84,306	10.6	27.8	-7.2	-6.2
Arkansas	19,485	7.8	26.1	-12.9	-11.9
California	320,594	21.6	36.7	22.4	23.7
Florida	170,187	9.1	25.8	-13.8	-12.9
Georgia	151,572	15.6	30.1	0.5	1.6
Louisiana	30,400	11.8	24.3	-19.0	-18.2
Mississippi	19,781	8.8	23.0	-23.2	-22.4
Nevada	31,255	6.8	23.6	-21.1	-20.3
New Mexico	22,348	11.0	21.1	-29.5	-28.7
North Carolina	127,276	13.7	26.3	-12.3	-11.3
Oklahoma	24,993	8.0	21.9	-27.1	-26.3
South Carolina	49,855	11.3	23.8	-20.6	-19.7
Tennessee	69,399	12.3	25.2	-15.9	-15.0
Texas	204,228	14.9	32.6	8.8	10.0
All Sunbelt States	1,361,189	13.0	29.6	-1.1	
All Non-Sunbelt States	2,017,952	17.2	30.2	0.7	
United States	3,379,141	15.2	30.0		

Sources: U.S. Census Bureau, 2000 Census IPUMS 5 percent files and Census 2000 Special Tabulation PHC-T-22, Gross Migration Table.

Table 5. Simple Correlation Matrix, 116 Sunbelt MSAs

	PG	EG	PCI	PCIG	SC	SCG
EG	**0.920**					
PCI	0.192	0.096				
PCIG	-0.079	0.047	0.104			
SC	**0.281**	**0.241**	**0.647**	0.108		
SCG	**0.284**	0.345	**0.227**	0.144	0.058	
YSCMR	0.180	0.102	**0.257**	0.140	**-0.270**	**0.277**

PG: Population growth rate, 1990-2000
EG: Employment growth rate, 1990-2000
PCI: Per capita personal income, 2000
PCIG: Per capita personal income growth rate, 1990-2000
SC: Share of college graduates in the 25+ population, 2000
SCG: Growth rate of the share of college graduates in the 25+ population
YSCMR: Share of single, college educated net migrants in the 5+ population
Note: Coefficients with statistical significance at the .05 level are in bold font.
Source: computed by the authors.

a more productive/innovative workforce produces a higher standard of living. The correlations are more modest between the other two education variables and per capita income, but still statistically significant – providing more support for the knowledge economy argument. Similar positive and significant coefficients are found between both the share of college graduates and growth in that measure and job growth – supporting the idea that a more educated workforce promotes aggregate economic growth. However, these simple

statistical tests do not indicate the presence of strong links between the education measures and per capita income growth – a result not supporting the knowledge economy hypothesis.

5.2. Glaeser and Saiz-like regression models

Our regression analysis using the Sunbelt MSA database mirrors some of the regression models estimated by Glaeser and Saiz. As in their analysis, our models take a form in which the change in the economic measure over the 1990–2000 period is a function of values of the explanatory variables at the beginning of the period. While regression models only identify correlation, not causality, this formulation is much less subject to the added confusion with respect to the direction of causality found in models based on contemporaneous dependent and explanatory variables.

We estimated alternative regression equations for each of our four measures (Tables 6a through d). In each of the four sets, equation A includes only the percent college educated in 1990 and the log of the 1990 level of the respective dependent variable. Equation B includes initial percent college educated, the log of the initial level of the dependent variable, the log of heating degree days, the log of average precipitation, the unemployment rate, and the shares of the labor force in (a) manufacturing, (b) trade, and (c) professional services. For employment growth and the income variables, a third model, equation C was also estimated that included the log of 1990 population as a scale variable.

Note that our models retained the two climate variables included in the Glaeser and Saiz models, even though our analysis is based on a sample of Sunbelt MSAs rather than a national sample. This approach was chosen for two reasons: first, we wanted to follow their formulation to investigate how the results changed looking only at the Sunbelt region. More importantly, however, there is substantial heterogeneity in climate across the Sunbelt, and we wanted to investigate whether climate differences also had effects within the region.

Looking first at the regression results for equation A, the coefficient for the education variable was positive and statistically significant only in the equations for the two income variables. Not surprisingly the positive and significant coefficient for initial income level in Table 6c implies a strong connection between the 1990 income level and at its level in 2000. The high value of adjusted R^2 for the equation also emphasizes the strength of that relationship. For the income change equation (Table 6d) on the other hand, the negative and significant coefficient for initial income level implies convergence over the period with faster income growth in lower-income MSAs. It should also be noted that the value of adjusted R^2 shows that the percent of college educated was able to explain little of the pattern of income change among Sunbelt MSAs – at least in the simpler regression model.

For the more complex version (Equation B), positive and statistically significant coefficients were found in the population growth and both income equations, but not for employment growth. In the population change equation, no significant link was indicated between initial population size and the growth rate, but for the income change equation, the negative and significant coefficient for initial income level implies convergence with faster growth in the lower-income MSAs. For employment growth, the results do not indicate a significant link with either the size of the labor market or the unemployment rate at the beginning of the period.

Including the initial population as a scale variable in the employment and income models (Equation C) produced very different results. While the R^2 for the employment growth equation remained small it did improve substantially, and the estimated coefficient for the education was positive and significant. The estimated coefficients for the initial population and the initial employment level were also indicated to be statistically significant but with opposite signs. The positive coefficient for the initial population variable would indicate faster employment growth in the larger MSAs, but the negative sign for employment seems to contradict that implication. One possible explanation might be convergence with faster growth in those MSAs with relatively low labor force participation. For both income models, the inclusion of the initial population variable caused the estimated coefficient of the education variable to become statistically insignificant.

As in the Glaeser and Saiz analysis, all the explanatory variables except education were included in the equations as controls, with the major focus of the exercise to look at the impact of the stock of human capital (as measured by percent college educated) on economic growth. However, it is interesting to note in passing the differences in the results with respect to the climate variables. Glaeser and Saiz used a national sample for their analysis and found that "warm, dry places grew much more quickly than cold, wet places." (2003, p. 10) Since our sample included only Sunbelt MSAs, we were not sure what to expect, and the results varied among the four sets of equations. In the population change equation – equivalent to the Glaeser and Saiz models – no significant link was found with the temperature variable but the estimated coefficient for average precipitation was negative and sig-

Table 6a. Regressions for Population Growth: log (2000 Population) – log (1990 Population)

	(A)		(B)	
	Coeff.	S.E.	Coeff.	S.E.
Percent College Graduates-1990	0.2067	0.1819	**0.7473**	**0.3150**
Log(1990 Population)	**0.0313**	**0.0094**	0.0036	0.0122
Log(Ave. Heating Degree Days)			-0.0154	0.0136
Log(Ave. Precipitation)			**-0.0409**	**0.0165**
Unemployment Rate - 1990			-0.1118	0.6273
Percent Employment by Industry				
Manufacturing			-0.1556	0.2078
Trade			0.4828	0.5452
Professional Services			**-0.8639**	**0.3560**
Observations	116		112	
Adjusted R-squared	0.114		0.233	

Note: Coefficients with statistical significance at the .05 level are indicated with bold font.
Source: Computed by the authors.

Table 6b. Regressions for Employment Growth: log (2000 Employment) – log (1990 Employment)

	(A)		(B)		(C)	
	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.
Percent College Graduates-1990	0.2527	0.1986	0.6140	0.3594	**0.9033**	**0.3575**
Log(1990 Population)					**0.6228**	**0.2001**
Log(1990 Employment)	0.0120	0.0100	0.0006	0.0135	**-0.6126**	**0.1974**
Log(Ave. Heating Degree Days)			0.0015	0.0153	0.0168	0.0155
Log(Ave. Precipitation)			-0.0092	0.0186	-0.0148	0.0180
Unemployment Rate - 1990			0.3941	0.7000	-1.8610	0.9883
Percent Employment by Industry						
Manufacturing			-0.2905	0.2344	-0.2814	0.2252
Trade			0.5077	0.6147	0.3974	0.5914
Professional Services			-0.5863	0.4035	-0.7362	0.3905
Observations	116		112		112	
Adjusted R-squared	0.025		0.059		0.097	

Note: Coefficients with statistical significance at the .05 level are indicated with bold font (source: computed by the authors).

nificant. In the employment growth equation, no statistically significant link with either climate measure was found. In the two income equations, however, the coefficients of both climate variables were positive and significant – implying higher levels of per capita income and faster income growth in relatively cooler, wetter places versus warmer, drier places.

6. Commentary

A review of domestic migration data reveals that while the Sunbelt has been the beneficiary of significant net domestic migration flows, these flows (with the exception of California, and to some degree Georgia and Texas) are not necessarily being accompanied by large numbers of people prepared to contribute to knowledge economy endeavors.

Table 6c. Regressions for Income Level: log (2000 Percapita Income)

	(A)		(B)		(C)	
	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.
Percent College Graduates-1990	**0.3111**	**0.1206**	**0.4354**	**0.1669**	0.2142	0.1797
Log(1990 Population)					**0.0196**	**0.0070**
Log(1990 Percapita Income)	**0.8736**	**0.0358**	**0.8544**	**0.0497**	**0.8085**	**0.0508**
Log(Ave. Heating Degree Days)			**0.0317**	**0.0078**	**0.0351**	**0.0077**
Log(Ave. Precipitation)			**0.0327**	**0.0091**	**0.0367**	**0.0090**
Unemployment Rate-1990			-0.2389	0.4118	-0.6336	0.4226
Percent Employment by Industry						
Manufacturing			-0.1780	0.1181	-0.2080	0.1148
Trade			0.2762	0.3075	0.1580	0.3006
Professional Services			**-0.3779**	**0.1869**	-0.1444	0.1990
Observations	116		112		112	
Adjusted R-squared	0.891		0.917		0.922	

Note: Coefficients with statistical significance at the .05 level are indicated with bold font.
Source: Computed by the authors.

Table 6d. Regressions for Income Growth: log (2000 Percapita Income) – log (1990 Percapita Income)

	(A)		(B)		(C)	
	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.
Percent College Graduates-1990	**0.3111**	**0.1206**	**0.4354**	**0.1669**	0.2142	0.1797
Log(1990 Population)					**0.0196**	**0.0070**
Log(1990 Percapita Income)	**-0.1264**	**0.0358**	**-0.1456**	**0.0497**	**-0.1915**	**0.0508**
Log(Ave. Heating Degree Days)			**0.0317**	**0.0078**	**0.0351**	**0.0077**
Log(Ave. Precipitation)			**0.0327**	**0.0091**	**0.0367**	**0.0090**
Unemployment Rate-1990			-0.2389	0.4120	-0.6336	0.4226
Percent Employment by Industry						
Manufacturing			-0.1780	0.1181	-0.2080	0.1148
Trade			0.2762	0.3075	0.1580	0.3006
Professional Services			**-0.3779**	**0.1869**	-0.1444	0.1990
Observations	116		112		112	
Adjusted R-squared	0.088		0.307		0.351	

Note: Coefficients with statistical significance at the .05 level are indicated with bold font.
Source: Computed by the authors.

The data relating to the migration of the subpopulation of young, single, college-educated adults at the MSA level show that some Sunbelt MSAs were just as appealing to this demographic group as the leading cities in other parts of the U.S. Based on comparisons in terms of the YSCMR (recall that this is the ratio of net migration of young, single, college educated persons to the total 5^+ population), Sunbelt MSAs like Atlanta (8.4 per 1,000 persons 5^+), Charlotte-Gastonia-Rock Hill, NC-SC (7.2), and Dallas (5.0) compare favorably with Denver (8.2), San Francisco (7.2), Portland (5.4), Seattle (5.3), and Washington, DC (3.6). But only 39 percent of the entire set of Sunbelt MSAs in the

dataset had positive net migration of this subpopulation prized by proponents of the knowledge economy.

Another potentially negative trend for proponents of the knowledge economy was the widening of the gap among Sunbelt MSAs with respect to share of college graduates. Berry and Glaeser (2005) found a divergence in human capital levels across U.S. cities, and a similar situation occurred within the Sunbelt region in the 1990s. The variance for the proportion of college educated in the adult population across the 116 Sunbelt MSAs in the dataset increased from 27.0 in 1990 to 35.3 in 2000.

Initial analysis of the experience of the Sunbelt with respect to the link between a college-educated workforce and economic growth/success produced mixed results. Simple correlation statistics showed a strong relationship between the share of college graduates and per capita personal income, and a modest link with employment growth, but no statistically significant correlation with income growth.

The results of our regression analysis also provided only minimal support for the link between percent college educated and economic growth. The evidence from the more complex models that included a set of control variables produced conflicting results. Of the three "true" economic variables included in the analysis, the education variable was indicated to have a positive and significant impact in both the income level and income growth equations, but not for employment growth. However, when the initial population of the MSA was added as an additional control variable, the results were reversed, with the proportion of college-educated adults was found to have a positive and significant effect only in the case of employment growth, and the equation was only able to explain about 10 percent of the variance in employment growth across the sample of Sunbelt MSAs. In the case of both income measures, the size of the MSA in 1990 was a better predictor of economic success than the proportion of college graduates.

Finally, our analysis based only on Sunbelt MSAs seems to imply that the relationship between climate and economic success may be more complicated than the finding cited in Glaeser and Saiz (and other studies based on national samples) that "warm, dry places grow more quickly than cold, wet places." (Glaeser and Saiz, p. 10) Our results do indicate a positive link between population growth and drier climate within the Sunbelt. But, ceteris paribus, those places that are relatively cooler and wetter enjoyed more economic success in the 1990s – as measured in terms of both employment and income measures.

In summary, while the empirical evidence of a link between the college-educated population and growth among Sunbelt MSAs is weaker than the results of Glaeser and Saiz that were based on the whole nation, the results of this exploratory analysis do show some support for proponents of the knowledge economy. At the same time, they fail to show that expanding the college-educated workforce is the only ingredient necessary to insure economic success as some boosters of the knowledge economy seem to believe.

Clearly the Sunbelt is a diverse set of states and MSAs that face the same challenges as do areas in the rest of the nation. Considerably more work will have to be done to understand these challenges and to fully understand what determines where knowledge economy workers will choose to locate and how much they will add to regional economies.

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References

Berry, C.R. and E. L. Glaeser. 2005 The divergence of human capital levels across cities. *HIER Discussion Paper No. 2091*, Harvard University, September 2005.

Chinitz, B. 1966. The regional transformation of the American economy. *American Economic Review* 76: 300-303.

DeVol, R.C., K. Klowden, J. Collins, and L. Wallace. 2004. *Arkansas' Position in the Knowledge-based Economy*, Milken Institute..

Economist, The. 2006. Of gambling, grannies and good sense: The baby-boomers retire. *The Economist*, July 22, 2006.

Franklin, R.S. 2003. Domestic migration across regions, divisions, and states. *Census 2000 Special Report,* U. S. Census Bureau, August 2003.

Franklin, R.S. 2003. Migration of the young, single, and college educated: 1995 to 2000. *Census 2000*

Special Report, U. S. Census Bureau, November 2003.

Gallup, J.L., J. D. Sachs, and A. D. Mellinger. 1999. Geography and economic development. *International Regional Science Review* 22: 179-232.

Glaeser, E.L., J. Kolko, and A. Saiz. 2001. Consumer city. *Journal of Economic Geography* 1: 27-50.

Glaeser, E.L. and A. Saiz. 2003. The rise of the skilled city. *HIER Discussion Paper No. 2025,* Harvard University, December 2003.

Glaeser, E.L and J. Shapiro. 2001. Is there a new rrbanism? The growth of U.S. cities in the 1990s. *HIER Discussion Paper No. 1925*, Harvard University, June 2001.

He, W. and J. R. Schachter. 2003. Internal migration of the older population: 1995 to 2000. *Census 2000 Special Report*, U. S. Census Bureau, August 2003.

Lang, R.E. and K. M. Rengert. 2001. The hot and cold sunbelts: Comparing state growth rates, 1950-2000. *Fannie Mae Foundation Census Note 02*, April 2001

Moretti, E. 2004. Estimating the social return to higher education: Evidence from longitudinal and repeated cross-section data. *Journal of Econometrics* 121: 175-212.

O.E.C.D. 1996. *The Knowledge-Based Economy*.

Perry, M.J. 2006. Domestic net migration in the United States: 2000-2004. *Current Population Report P25-1135*, U.S. Census Bureau, April 2006.

Olson, M. 1983. The South will fall again: The South as leader and laggard in economic growth. *Southern Economic Review* 49: 917-932.

Perry, M.J. 2003. State to state migration flows: 1995 to 2000. *Census 2000 Special Report*, U. S. Census Bureau, August 2003.

Quan, N.T. and J. H. Beck. 1987. Public education expenditures and state economic growth: Northeast and sunbelt regions. *Southern Economic Journal* 54: 361-376.

Raspe, O. and F. Van Oort. 2006. The knowledge economy and urban economic growth. *European Planning Studies* 14: 1209-1233.

Schachter, J.R. 2003. Migration by race and Hispanic origin: 1995 to 2000. *Census 2000 Special Report*, U. S. Census Bureau, October 2003.

Weissbourd, R. and C. Berry. 2004. *Changing Dynamics of Urban America*, CEOs for Cities, March 2004.

Wright, G. 1987. The economic revolution in the American South. *Journal of Economic Perspectives* 1: 161-178.