A Study of Regional Economic Policy Focusing on Three Approaches

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Abstract: Regional economic growth can have a quite different dynamic and logic than national economic growth. This paper empirically investigates whether three major approaches to regional economic development: industrial mix, human capital, and quality of place significantly contribute to the regional economy. This paper tests the hypotheses using ordinary least squares (OLS) based on state-level data from the United States. The OLS results indicated a significant effect of industrial mix on regional economic growth when other factors were controlled for, though significance levels differed depending on the definition of "high-tech industry." The joint hypothesis test on human capital and quality of place showed they were statistically insignificant. The insignificance of the human-capital variables was different from the expectation. This may be caused by the fact that the level of analysis of this study is a state rather than a city, which may dilute the concentration of human capital in major cities. The significance of the industrial mix variables is meaningful because the positive relation between the concentration of high-tech industries and regional economic growth supports regional governments' efforts in Korea to establish or lure more high-tech industries into their regions. However, because the result is sensitive to various definitions of high-tech industries, it needs cautious interpretation.

INTRODUCTION

What affects regional economic growth? There is extensive literature that has examined the determinants of economic growth at the national level or at the level of the metropolitan statistical areas (MSAs) in the United States or in cities (Audretsch et al., 1996; Glaeser et al., 1995; Simon, 1998). However, there is little literature on economic development at the state level. Although some literature discusses economic development at the state level, most of it focuses only on employment growth, a quantitative aspect of economic growth. The qualitative side of economic growth, such as per capita income and gross state product per capita, has not been extensively investigated. This essay investigates the determinants of economic growth at the state level, with an emphasis on the qualitative aspect of economic growth. This study tests the effect of three factors on economic growth; industrial mix, human capital, and quality of place.

Traditionally, labor and capital have been thought of as the only factors that matter in the production process. However, this perspective changed in light of Robert Solow's 1957 study. Neoclassical economic growth theory explains that capital investment and labor cannot explain all of the variation in productivity growth. The unexplained residual in the production function is called "Solow's residual" because, Solow argued, it can be explained by technological

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advancement. However, Solow fell short of providing a detailed picture of how technological development contributes to productivity growth. Denison's study (1962, 1985) supports Solow's main points. Denison found that 34% of recorded growth in America from 1929 to 1982 came from "the growth of knowledge." Following Solow's study, there have been various studies on the contribution of knowledge (or technology) to economic growth. In addition to technological advancement, various attempts have been made to explain the residual, and some of these can be categorized into one of three approaches, depending on their focus: industrial mix, human capital, and quality of place. The details of each approach are explained in the following sections.

Industrial-Mix Approach

It has been suggested that the right mixture of industries in a region is a significant factor in regional economic growth. There have been numerous discussions about what is the best mixture of industries for regional economic growth. During the late 1990s, attention to the high-tech industries was tremendous, and many states in the United States tried to develop or lure high-tech industries to replicate the success of the Silicon Valley. Because high-tech industries are expected to be more knowledge intensive compared to other manufacturing industries, policy makers in many states assume that attracting more high-tech industries will be beneficial for regional economic development.

The importance of knowledge in economic growth is supported by several studies. Griliches (1986) applied the idea of knowledge stock and finds that research and development contributes significantly to productivity growth and enjoys a relatively high rate of return. Romer (1990) showed that technological change is essential in explaining productivity changes, and Jaffe (1989) found that academic research is significant in increasing corporate patents.

Some scholars argue that the concentration of similar kinds of industries can generate a synergy effect (Stuart and Sorenson, 2003), whereas other scholars argue that a mixture of diverse industries can improve the economy (Jacobs, 1961; Glaeser et al., 1995). The key concept in this debate is the knowledge-spillover effect. Because knowledge spillover is one of the main reasons why firms cluster and is more crucial for knowledge-intensive industries, policy makers have been interested in finding ways to promote it. Policies designed to replicate the success of the Silicon Valley based on high-tech industries are one example. However, empirical evidence for such endeavors is not satisfactory, especially at the state level. In this essay, it is hypothesized that a state that has a higher share of high-tech industry than other states will enjoy faster economic growth if other things are equal.

Human-Capital Approach

The human-capital approach focuses on the significant role of economic actors in the process of knowledge creation and diffusion. In recent years, many scholars have paid attention to the importance of the role of human capital in regional economic growth (Lucas 1988; Mathur 1999; Simon 1998). Human capital is different from labor, which is a traditional production factor. Labor addresses a quantitative aspect of human resources, whereas the human-capital approach focuses on the qualitative aspect. If a more knowledgeable worker can produce twice as much as an ordinary worker, he or she could be counted as two units instead of one unit.

Mathur (1999) defined human capital as "an accumulated stock of skills and talents" that is manifest in the educated and skilled workforce in a region. He argues that continuing technological development empowered by human capital can overcome decreasing returns to scale in capital. Lucas (1988) emphasized the importance of human capital in economic development by arguing that regional growth originates from human-capital accumulation in a region. Glaeser et al. (1995) also found that higher education plays an important role in explaining the growth of the cities. Simon (1996) found that employment growth and human capital have a positive and significant relationship on economic development at the MSA level. He uses the percentage of the population with a high school degree or higher and a college degree or higher as a proxy for the human-capital stock in a region. This paper will use the same proxy to measure human capital in a state. In this essay, it is hypothesized that a state with better human capital will enjoy higher economic growth.

Quality-of-Place Approach

The concept of "quality of place" is not well defined, and the literature shows various mixtures of different measures depending on the source and definitions. As a result, there are numerous reports about the best places to live or work, which makes it very difficult to develop a comprehensive measure for quality of place. Typically, quality of place is measured by a mixture of measures such as crime rate, pollution, quality of schools, comfort of the weather, and so forth. A high level of amenities in a region is hypothesized to positively influence the location decisions of firms as well as workers. Especially with the prosperity of high-tech industries and the emergence of the new economy, a worker's decision is hypothesized to be influenced more by the quality of place. Gottlieb (1994) found that amenities significantly influence firms' location decisions. Many cities in the United States are trying to lure professional sports teams by providing hefty incentives to improve the quality of place. The underlying assumption is that more amenities will make cities more attractive. It is hypothesized that a state with higher level of amenities will enjoy better economic growth compared to other states if other things are equal.

In addition to these three approaches, many studies on regional development have used employment growth as the dependent variable. They have found that military-procurement contract awards (Hooker & Knetter, 1987), higher education (Simon, 1998), knowledge spillover (Smith, 1999), right-to-work laws(Holmes, 1998), and state economic development spending (de Bartolome & Spiegel,

1997) have significant effects on employment change at the MSA or state level. Some of these variables will be used as control variables.

So far, very few studies have tested the three approaches together, even though many studies have tested one of the three approaches. This paper will test the three approaches to regional economic growth together to investigate whether the effect of each approach is significant when other factors are controlled for. This research is an exploratory study of the effects of the three approaches on regional economies. Industrial mix and quality of place have no conclusive support from the literature, whereas human capital has been found to have a significant effect on economic growth. It is expected that all three approaches will be statistically significant in explaining economic growth.

To test these hypotheses, ordinary least squares (OLS) was used with various specifications. The main findings are as follows: Industrial mix was found to have a positive and significant effect, though the significance is sensitive to the definition of "high-tech industry" (various definitions will be explained later). Contrary to the expectation based on the literature, both the human-capital and quality-of-place variables had an insignificant effect. The findings were relatively robust to specification changes.

In the next section, the variables and the measurement issues will be discussed. The OLS models and possible problems related to this model will be discussed in the following section. Then, the OLS results will be explained and discussed.

MEASUREMENT ISSUES

To properly test the significance of the three approaches' contributions to regional economic growth, it is important to find proper variables for each approach. The dependent variable should be a variable that measures economic growth or development at the state level. Although economic growth is defined as the expansion of a country's potential gross national product (GNP) in economics textbooks, it is often unclear what definition of economic development politicians and policy makers have in mind when they mention economic development. In empirical papers, economic development is measured in various ways. The most popular way is to use unemployment rates or job growth rates, a method that is preferred by politicians. The problem with job growth rates and unemployment rates is that they address only the change in the quantity instead of the quality of economic development.

An alternative way to measure economic development is to use per capita income. Per capita income can measure the improvement of people's lives, but only if we believe that more money can improve the quality of individuals' lives. Another similar measure is gross state product (GSP), which is the state-level counterpart to gross domestic product (GDP). A nation's GDP is used as a dependent variable in the production-function approach. However, as

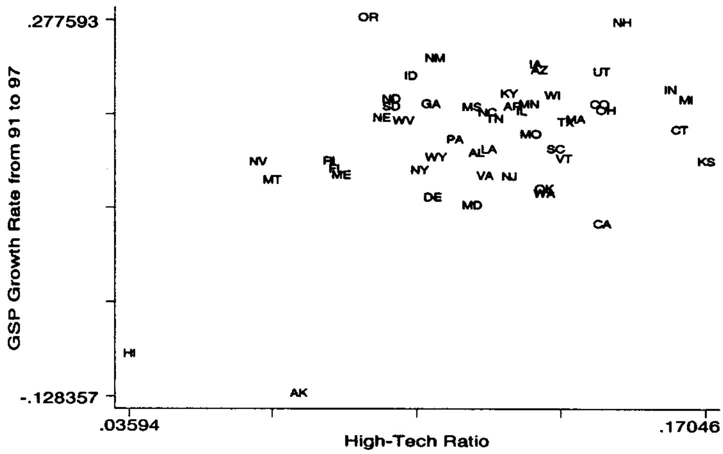
Griliches points out, GDP has some problems. First, it is hard to measure the increase in output in service industries. Second, it is hard to measure the increase in output in some manufacturing industries. Defense or space are good examples. Finally, a fundamental problem with GDP is that this measure cannot address the quality adjustment. In spite of its shortcomings, GSP is still a good measure of economic growth at the state level. By definition, per capita income and GSP do not show any significant difference, and they are highly correlated ($r = 0.8$). Therefore, for this study, GSP was used as the dependent variable. The summary statistics are shown in Table 1.

For the industrial-mix approach, the ratio of high-tech industries in each state is used. The high-tech ratio is defined as the percentage of employees hired in high-tech industries out of the total employees within a state. To calculate the ratio, we used the County Business Patterns (CBP) published by the U.S. Census Bureau. It is not difficult to determine whether an industry is high-tech or not and, as a result, there are many definitions of the high-tech industry. However, the definitions consist of two main factors: research and development (R&D) personnel and spending. In this paper, four measures were used to determine whether an industry is a high-tech industry. Two of the measures were based on the share of technical workers in the industry and one of them was based on R&D spending within the industry. The last measure was based on the combination of the share of technical workers and R&D spending. The two measures based on the share of technical workers included 48 and 30 industries, respectively. The measure based on R&D spending included only 6 industries. The definition and sources of data are explained in the appendix. The list of industries based on each definition is shown in Table 2.

There are two limitations of this definition of high-tech industry. First, the definition of high-tech industry is decided at the Standard Industrial Classification (SIC) three-digit level. Because data on R&D and technical workers at the SIC four-digit level are not available, there is a possibility that an industry that is categorized as high-tech may contain a non-high-tech component. This kind of measurement error may bias the estimate toward zero.

The other problem is that all of the employees who were categorized as working in high-tech industries may not necessarily have high-tech jobs. For example, employees working on a simple assembly line with low wages could be counted as high-tech workers under the working definition. That could not be remedied using the CBP data because it is based on SICs. A measure of high-tech industries based on occupation may be a better one compared to the high-tech-ratio approach because it may contain less "noise"in measuring the high-tech capacity of a state and may provide a more precise measure of the high-tech industry. However, it would create another problem for this paper because occupation data have a very high correlation with human-capital variables. In the human-capital literature, the education level of the labor force is the most important measure of human capital. Considering the high correlation between the education level of a state and the number of scientists and engineers (presumably R&D workers), a measure based on occupation would be a subset of the human-capital measure. This may create multicollinearity problem in the estimation. Therefore, it would not be suitable to use the occupation-based definition to test the industrial-mix approach. Figure 1 shows there is a roughly positive relationship between the high-tech ratio and the GSP growth rate from 1991 to 1997. For the high-tech industry, the definition based on the number of technical workers was used. Hawaii and Alaska were outliers.

Figure 1. High-Tech Ratio and GSP Growth Rate, 1991-97

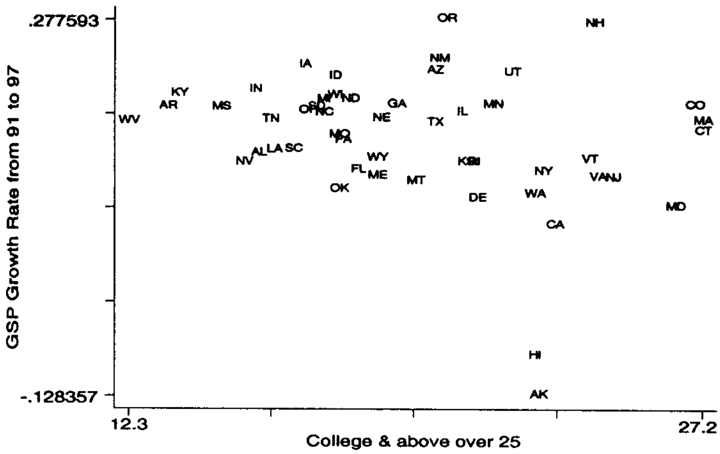


In the human-capital literature, the number of years of education is used as a proxy for the stock of human capital in a region. For example, we could use the percentage of people who have a college degree or higher as a proxy for human capital. Simon (1998) found that the presence of college graduates is correlated more with employment growth than the presence of high school graduates at the MSA level. Two measures of higher education are available at the state level. One is, mentioned previously, is the percentage of people who have a college degree or higher. The other is the number of people who stayed in college for three or more years.

In addition to these measures, the enrollment in tertiary educational institutions within a state per one million people was used to control for the endowed human capital within a state. According to the Digest of Education reports by National Center for Education Statistics, about 84% of college students in 1996 chose a school in his or her home jurisdiction. Therefore, this variable is expected to control for the human-capital flow inside a state, not outside.

The correlation matrix shows that the number of people who stayed in college for three or more years was highly correlated with tertiary educational institution enrollment (r = 0.8892) and with the percentage of people with a college degree or higher (r = 0.6957). However, tertiary educational institution enrollment and the percentage of people with a college degree or higher were not highly correlated (r = 0.4788). Therefore, to avoid a redundant measurement, we used the percentage of people with a college degree or higher as a proxy for human capital. The percentage of people with a college degree or above comes from the 1990 Census. Figure 2 and 3 show the relationship between GSP growth rate and the human-capital variables. Alaska and Hawaii were outliers. Without these two states, the figures did not show any significant positive or negative relationship between variables.

Figure 2. College Degree or Above and GSP Growth Rate, 1991-97



For quality-of-place approach, there are no generally acknowledged variables. In this study, the scores for climate, art, and recreation created by Boyer and Savageau (1989) were used. The score for climate is calculated by using a combination of temperature and humidity factors. The score for art is calculated by considering fine arts broadcasting, public libraries, art museums and galleries, the lively arts calendar, and CMSA access. The score for recreation uses factors such as good restaurants, public golf courses, bowling lanes, zoos, aquariums, family theme parks, auto racing, pari-mutuel betting, professional sports, NCAA Division I football and basketball, coastlines, inland water area, national forests, parts, wildlife refuges, and CMSA access. As these measures are constructed at the MSA level, the average score of the MSAs within a state was used to get an overall state score. A limitation of this measure is that it may not be appropriate to aggregate the scores on the MSA level to calculate a score for a state because a significant portion of the variation in the raw data could be lost by aggregation. However, because other quality-of-place data are not available at the state level so far, the average scores were used in spite of the possible measurement error.

In addition to the variables mentioned previously, it is important to control for labor and capital inputs because the levels of both production factors vary across states. Labor has two aspects, one quantitative and the other qualitative.

The quantitative labor force was controlled for using per capita data of variables in the model.

Figure 3. Tertiary Educational Institution Enrollment and GSP Growth Rate

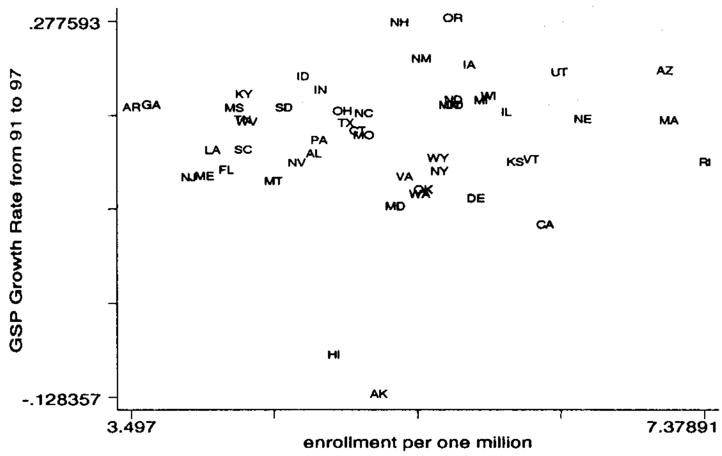
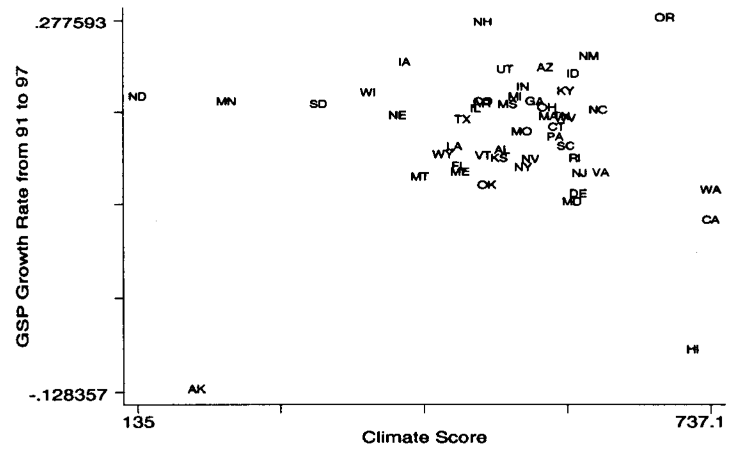


Figure 4. Climate and GSP Growth Rate, between 1991-97



For capital, the ideal measure would be the amount of total investment for durable goods and facilities in a state. At the national level, such information is readily available from the gross national product accounts. However, there is no ready-to-use data at the state level. Smith (1991) used the dollar value of private nonresidential construction authorized annually in each state as a proxy for capital investment at the state level. Although it captures just a part of capital investment, and therefore is not a perfect measure, it was used as a proxy for the capital investment in a state.

Military-procurement contract awards are another example. In empirical studies, military-procurement contract awards were found to be exogenous, and their impact on state economic performance was found to be significant (Hooker & Knetter, 1997). To control for military-procurement contract awards, we added a military-procurement variable to the list of independent variables.

The unionization rate also was found to be significant in empirical studies, and therefore it was added to the RHS variables. The unionization rate is expected to control for the difference of labor relations over states. Table 3 shows the list of RHS variables and the data sources in detail.

THE OLS MODEL

Under the assumption that the speed of knowledge diffusion is slow, the OLS equation was set up to measure the effect of the average values of each variable in 1987 and 1988 on the change in GSP between 1991 and 1997 and on the GSP growth rate between 1991 and 1997. This model evaluates the impact of earlier variables on later economic performance. A one-year gap was created between the variables of GSP growth to address the endogeneity caused by the lag variables in the equation. For the ceiling effect (a higher GSP state will grow slower than a lower GSP state), the initial level of GSP and the growth rate or change in GSP between 1987 and 1990 were included. The size of population was controlled for in the equations using per capita data or standardized measures.

EQUATIONS

1) Equation (1)

$$Log(GSP_{97_i} / GSP_{91_i}) = \beta_1 + \beta_2 HTR_i + \beta_3 Defense_i + \beta_4 AllHEDU_i$$
$$+ \beta_5 R\,\&\,D_i + \beta_6 GSP_i + \beta_7 Union_i + \beta_8 Capital_i + \beta_9 Log(GSP_{90i} / GSP_{87i})$$
$$+ \beta_{10} HEDU_i + \beta_{11} Weather_i + \beta_{12} REC_i + \beta_{13} Art + \varepsilon_i$$

2) Equation (2)

$$GSP_{97_i} - GSP_{91_i} = \beta_1 + \beta_2 HTR_i + \beta_3 Defense_i + \beta_4 ALLHEDU_i$$
$$+ \beta_5 R\,\&\,D_i + \beta_6 GSP_i + \beta_7 Union_i + \beta_8 Capital_i + \beta_9 (GSP_{90i} - GSP_{87i})$$
$$+ \beta_{10} HEDU_i + \beta_{11} Weather_i + \beta_{12} REC_i + \beta_{13} Art + \varepsilon_i$$

In these equations,

- $\log(GSP_{97}/GSP_{91})$ is the growth rate of GSP per capita between 1991 and 1997 in state
- $\log(GSP_{90}/GSP_{87})$ is the growth rate of GSP per capita between 1987 and 1990 in state
- GSP_{97} - GSP_{91} is the difference in GSP per capita between 1991 and 1997
- GSP_{90} - GSP_{87} is the difference in GSP per capita between 1987 and 1990
- *HTR* is the average high-tech ratio between 1987 and 1988
- *Defenseis* the average military-procurement contract between 1987 and 1988
- *HEDU* is the average enrollment in tertiary educational institutions between 1987 and 1988
- *ALLHEDU* is the percentage of people with a college degree or higher
- *R&D87* is the academic R&D spending in 1987
- *GSP* is the average GSP between 1987 and 1988
- *Union* is the rate of unionization
- *Weather, Art,* and Rec are variables for the climate mildness, arts, and recreation of state
- i = state
- ε is an error term.

RESULTS

The regression results are shown in Table 4. Mainly two specifications were tested by using the various specifications, and the OLS results were robust to specification changes. The adjusted $R^2$of most specifications were close to 0.5. The F statistics of all regressions were significant at the 1% level. The results of the joint hypothesis test are shown in Table 5. When jointly tested for significance, human capital and quality of place were insignificant. Only industrial mix was significant at the 5% level.

The initial GSP level was found to be highly significant and showed a negative sign as expected. The initial growth rate was significant and showed a negative sign as expected. This shows that fast-growing cities cannot maintain the speed of growth they enjoyed in the past. The coefficient for academic R&D was significant but negative, different from the expectation. Interestingly, Rauch (1993) found the same negative and insignificant coefficient for federal R&D funding at the MSA level, although he found a significant and positive coefficient on the human-capital measure.

Table 5. Joint Hypothesis Test on the Three Approaches

Human Capital	Industrial Mix	Quality of Place
(1) Percentage of people with a college degree or above	(1) High-tech ratio	(1) Score for climate
(2) Tertiary educational institution enrollment per one million people		(2) Score for recreation
		(3) Score for arts
$F(2, 39) = 1.49$ Prob > F = 0.2382	$F(1, 39) = 4.17$ Prob > F = 0.0479	$F(3, 39) = 1.06$ Prob > F = 0.3787

DISCUSSION

The research question of this paper was to find out whether the three approaches to regional economic development; industrial mix, human capital, and quality of place significantly contribute to a region's economic growth.

The three approaches were tested using OLS based on state-level data. The joint hypothesis test on human capital and quality of place failed to reject the null hypothesis, whereas the industrial-mix variables showed a significant effect on regional economic growth when other factors were controlled. However, the significance of the industrial mix (high-tech ratio) depends on the definition of the variable. We considered four measures of the industrial mix. The wider measure, which is based on the share of technical workers, showed that industrial mix significantly contributes to a region's economy. When the narrower definition of high-tech industry was used, R&D expenditures in the industry, the coefficient became insignificant. The narrower measure included SIC codes 283 (drugs), 357 (office, computing, and accounting machines), 366 (communication equipment), 367 (electronic components and accessories), and 372 (aircraft and parts). The analysis showed that the significance of high-tech industries depends on the definition of high-tech industries. The sensitiveness of the regression result to the definition implies that policy makers should be very careful when they argue that high-tech industries will solve all the economic problems in a region. Unless the definition of high-tech industry is clarified, it may be hard to have a concrete conclusion on this matter.

This point has some implications for Korea. The Korean government's recent policy drive to set up multiple high-industry clusters does not seem to be based on solid academic and empirical supports If only political justification exists, it will be very difficult to make the proposed policies for regional clusters successful. Policy makers need to be more cautious in promoting such policies.

What is puzzling is the insignificance of the human-capital variables in the regression results. As mentioned previously, many papers have shown the significant effect of human-capital variables on economic growth or employment growth. The insignificance may be caused by a difference of the unit of analysis. Most studies that showed a significant impact of human capital on economic development used MSA-level data or national data rather than the state-level data used in this study. Considering that knowledge diffuses faster in more concentrated areas, it may bias the result toward zero by diluting human capital at the MSA level.

Measures on amenities turned out to be insignificant. Considering that the measures on amenities were constructed based on MSA-level data, this is not totally unexpected. Because the size of states in the United States is quite large, it is very hard to get satisfying measures of amenities at the state level.

For future research, it would be interesting to use MSA-level data to test the effect of these three approaches on regional economic development because it would be more dynamic and provide more variations, along with a bigger sample size.

This paper is an exploratory study on the determinants of regional economic growth. More precise measures of human capital and quality of place will help us to come to a more solid conclusion on the issue. I believe openness to various approaches will widen opportunities to make regions economically more prosperous.

Appendix

For this study, the ratio of high-tech industries was used to measure the effect of high-tech industries on state economic growth. The ratio of high-tech industry is defined as the percentage of persons employed in high-tech industries among total state employees. Four definitions of high tech industry were examined and compared in this research. Three definitions come from Riche, Hecker, and Burgan (1983) the other comes from Hadlock, Hecker, and Gannon (1991).

There are two major ways to define high tech industry. One is to look at R&D intensity and the other is to look at technical workers as a share of total employees. Riche and others have provided definitions based on both approaches. One of the definitions is to look at the share of technical workers. An industry is categorized as high-tech if the share is at least one and a half times the average for all industries (48 industries). This definition is very broad and is labeled Definition 1 in the analysis. The second approach is to look at R&D intensity. An industry is included if its ratio of R&D expenditures to net sales is at least twice the average for all industries (6 industries). This definition is labeled Definition 2 in the analysis and is limited to the manufacturing sectors because of the limitation of R&D data. The third approach is a mixture of the two preceding definitions. In this definition, an industry is considered high-tech if the share of technical workers is equal to or greater than the average for all manufacturing industries and the ratio of R&D expenditures to sales is close to or above the average for all industries (28 industries). This is called Definition 3.

The definition by Hancock and others is based on the share of technical workers. Those authors used data from the U.S. Bureau of Labor Statistics'

Occupational Employment Statistics (OES) program and define a high-tech industry as one with a significant concentration of R&D employment (the share of technical workers is at least 50% higher than the average for all industries [30 industries]). The strength of this approach is that the employers determine the number of workers who spend the majority of their time in R&D (R&D employment). This definition is labeled Definition 4 in the analysis.

Markusen, Hall, and Glasmeier suggest a definition similar to Definition 1. Their definition is based on OES. Their list of high tech industries (29) almost exactly overlaps with Definitions 1 and 3. Therefore, the analysis of their definition is omitted.

For the calculation of the ratio of high-tech industry at the state level, CBP data for 198796 were used. Because of privacy concerns, some CBP data are provided in the form of a letter instead of a number, and only range of the real number is provided. For the analysis, the researcher took the middle value of the range. For example, if A refers to 019, 10 was assigned.

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