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ABSTRACT

This research examines the effect of skill in cities on regional wages. In place of the extant literature's focus on human capital or knowledge-based or creative occupations, we focus our analysis on actual skills. We use cluster analysis to identify three broad skill types - analytical, social intelligence and physical skills from 87 occupational skills. We then conduct regression analysis to quantify how each skill contributes to regional prosperity and how they are related to regional size, using data from 1999 and 2008. We find that analytical and social intelligence skills have a significant positive effect on regional wages, while physical skills have a negative effect. We also find that analytical skills are somewhat more closely associated with regional wages than social intelligence skills, after controlling for education and regional size. Furthermore, we find that the wage return to analytical and social intelligence skills has increased over time, and the return to physical skills has declined significantly. We also show that larger cities reward analytical and social intelligence skills to a higher degree, whereas smaller cities tend to rely more on physical skills.

Key words: Skills, Education, Occupations, Regional Wages, Cities, Population

JEL: J24, J31, RO

1. INTRODUCTION

Skills are important for individuals and for the cities they inhabit. A wide body of literature (Barro, 1991; Barro and Lee, 2001; Becker, 1993; Jacobs, 1969; Lucas, 1988; Romer, 1986) has shown that human capital knowledge - or skills - contributes to higher individual wages and greater regional productivity. The work that an individual performs is an important driver for regional growth. Those with higher skills are able to produce more and generate greater value for the region. However, it is important to differentiate between the types of skills one possesses. The skills required by someone performing a routine, non-cognitive occupation, such as a mechanic or roofer, have a minimal effect on overall productivity. Conversely, a highly cognitive occupation, such as a biomedical engineer or surgeon, generates significant regional prosperity -- not only individually through high wages, but also through positive spillover effects (Gabe, 2009). The biomedical engineer may create a new product through the innovative process which in turn helps the surgeon become even more productive.

The agglomeration of skilled people in cities has become an increasingly important phenomenon. Over the last century we have seen cities with more skilled people grow faster (Glaeser and Saiz, 2003; Simon, 1998). A city provides a network of connections for the most highly skilled person. Individuals living in cities are able to benefit from reduced transaction costs, economies of scale and positive spillover effects (Scott, 2009; Simon and Nardinelli, 1996). Additionally, these benefits increase with city size (Markusen and Schrock, 2009; Scott, 2009). As a result, we should expect that skills increase with city size. Lucas on Jacobs and the notion of human capital externalities – spell out that skilled individuals are able to learn from each other, and the more people the greater urban synergy and the more one is able to learn (Glaeser and Resseger, 2009; Jacobs, 1969; Lucas, 1988; Marshall, 1890).

Our research advances a straightforward hypothesis. We argue that the distribution of skills is skewed across regions, and that bigger and denser cities host a higher concentration of thinking skills, such as analytical and social intelligence skills. It also tests the notion that such skills are being rewarded to a greater degree in the US labor market than physical skills.

We find that analytical and social intelligence skills are positively and significantly related to wages and regional size. We also find that the regional wage premium to these types of skills has increased from 1999 to 2008. Conversely, we find that physical skills are negatively correlated with wages and regional size – and that the wage return has worsened over time. We also show that analytical and social intelligence skills are positively correlated with regional size, whereas smaller cities tend to draw more on physical skills.

This paper follows the following framework: we begin with a review of the existing literature on human capital and skills, then proceed with a description of the variables and methodology, and conclude with some insights into the results.

2. CONCEPTS AND THEORY

While it is true that human capital plays an important role in economic growth, there has been much contention over how to measure it. Test scores and IQ have long served as proxies for cognitive skills and human capital (Jones and Schneider, 2006). Heckman (2008) has documented the important role that cognitive and non-cognitive (social and behavioral) skills play in determining adult outcomes. He has been a major proponent of early childhood education, citing the importance of targeting youth during their critical skill formation years. Mathematical aptitude, judged by the ability to answer three simple math questions, has also been shown to be a considerable predictor of success in late adulthood (McArdle, Smith, and Willis, 2009). Turning to the labor market, Murnane, Willett and Levy (1995) have argued that basic cognitive skills, as measured through mathematics scores, have become more valuable over the period 1978 to 1986. Some have even used literacy tests to assert that workers need to adapt to the changing, increasingly cognitive labor market, otherwise they will be left behind (Green and Ridell, 2002).

More recently, however, scholars have taken different approaches on quantifying human capital. There are those who focus on education, where skills are measured through highest degree attained (Glaeser, 2009; Mincer, 1974); whereas others focus on occupations and the work people perform (Florida, 2002). Ingram and Neumann (2006) outline the difficulties of using education as a measure for skill, noting that colleges differ in their quality and course content, causing students to graduate with unequal skill levels. In addition, numerous scholars have observed growing wage dispersion within educational groups, suggesting that there are other skills being rewarded in the labor market (Levy and Murnane, 1992; Murnane, Willett, and Levy, 1995; Ingram and Neumann, 2006). Some have even shown that after controlling for skill, the returns to education have been constant. Put differently, workers who do not invest in additional skills, and only rely on educational attainment, have experienced flat income growth from 1970 to 1997 (Ingram and Neumann, 2006). Even further, there are those who believe that it is not the occupation itself, but the skills and knowledge required by that occupation that provides an ideal measure for human capital (Feser, 2003; Gabe, 2009; Scott, 2009).

By studying occupational requirements, scholars are able to differentiate horizontally amongst required skills in order to assess which skills are in high demand (Bacolod and Blum, 2005). Autor, Levy and Murnane (2003) outline the impact of routine and non-routine skills on the labor market, over the period 1970-1998, primarily driven by skill biased technological change. Bacolod and Blum (2005) have attributed the US rising income inequality and narrowing of the male-female wage gap to changes in the returns to four different types of skills: cognitive, motor, people and physical. Some scholars use general knowledge requirements of occupations to quantify which knowledge areas generate significant economic returns (Feser, 2003; Gabe, 2009). Gabe (2009) shows that knowledge requirements of occupations generate different public and private returns. He shows that knowledge in areas such as medicine and dentistry have significant private returns, whereas occupations with knowledge about producer services, such as law and government, have positive spillover effects in that they enhance the earnings of those around them. Scholars have even studied skills by employment, showing employment growth in cognitive-intensive occupations and decline in physical-intensive occupations (Scott, 2009). In all cases, it seems the knowledge economy is rewarding occupations requiring cognitive and social skills.

For the various measures of human capital, it has been shown that skills locate differently across cities. Some scholars believe the role of city size plays an important role in harnessing the creative capabilities of the labor force (Florida, Mellander and Stolarick, 2008). They show that labor productivity rises in larger cities (Elvery, 2006). Specifically, some scholars have shown that cognitive activities are usually concentrated in large cities, while the opposite is true of physical activities (Markusen and Schrock, 2006; Scott, 2009). While many scholars have noted the relationship between skills and city size, others have observed the same patterns but caution over the weak relationship (Bacolod, Blum and Strange, 2009). Bacolod, Blum and Strange

(2009) show that average skill levels increase moderately with city size. They also show that larger cities are able to attract occupations with high thinking skills, while smaller cities have a comparative advantage in physical and motor skills.

Our research builds from the existing literature on the impact of clustered concentrations of skills on wages over time. There is a city component to this. We hypothesize that cities with greater concentrations of thinking skills will have higher wages, and that physical skills will not drive regional wages. We also posit that bigger cities will have more skills, and that the horizontal differentiation of skills across cities is significant. In other words, certain skills locate differently across regions of various sizes. To do so, we examine the role of skills on regional development in the US via analysis on 307-361 geographic city units, or MSAs.

3. METHODOLOGY

To test for this, we develop an empirical model for cities, skills and wages. Theory indicates that education and density should be positively related to wages. We also expect thinking skills, such as analytical and social intelligence skills, to be significant contributors to regional prosperity. The model is based on extant theory and includes variables for skills, density, population and percent of baccalaureate holders in the city region. We follow a log-linear functional model, where the coefficients measure elasticities. In addition, we allow each skill to enter separately into the equation due to multicollinearity.

The model is as follows:

$$\ln Wage_{rt} = \beta_0 + \beta_1 LnSkill_{irt} + \beta_2 LnPercentBA_{rt} + \beta_3 LnPopulation_{rt} + \beta_4 LnDensity_{rt} + \varepsilon_{rt}$$

where i is the skill (analytical, social intelligence and physical), r is the region, and t can be either year 1999 or 2008.

VARIABLES

We now turn to the variables in our model.

Dependent Variable:

Wages – Our dependent variable measures average regional employment wages. The data are from Occupational Employment Statistics (OES), developed for the Bureau of Labor Statistics, for the years 1999 and 2008. The OES is an employment based survey that measures full time and part time employees and excludes the self-employed. The wage estimate measures annual full-time equivalency wages (in order to obtain an annual estimate for part-time workers the OES scales hourly wages up by 2080 – 40 hours per week times 52 weeks per year). The wages include base rate, cost-of-living allowances, guaranteed pay, hazardous duty pay, on-call pay and tips. It excludes back pay, jury duty pay, overtime and severance pay, shift differentials, nonproduction bonuses and tuition reimbursements.

Wages are set through the basic market mechanism of supply and demand. At an aggregate level, the regional wage level should reflect regional labor productivity. Labor productivity is affected by human capital measures, such as skills and education. As a result, we expect that the wage levels should be in proportion to the regional human capital stock.

Independent Variables:

Occupational Skill Percentile- This measures the skill value for each occupation. It is based on the O*NET database which was developed for the U.S. Department of Labor, and contains detailed analysis conducted by occupational specialists, occupational analysts, and job incumbents. These occupational experts quantify how much of a certain "skill" is required for each of 728 occupations, resulting in 87 identified skill variables. We used cluster analysis to categorize these 87 skill variables in three distinct groupings: (1) analytical skills, (2) social intelligence skills and (3) physical skills (See Appendix 1 for skills descriptives). The value is assigned through cluster analysis performed on 87 'skill' and 'ability' variables from the O*NET database. These 87 "skill" and "ability" variable, as defined by O*NET, measure various dimensions of occupational requirements. Each variable has two components -- importance and level; the former is measured on a scale of 1-5 and asks "how important is this skill (or ability) to performance on the job," while the latter, measured on a scale of 0-7, asks "what level of skill (or ability) is needed to perform this job?" We multiplied the scales together to obtain a single measure for each variable, and then took the percentile rank across all occupations.

The O*NET database is updated on a rotating basis, with continual updates every year. In this analysis, we use the 12.0 database, from 2007. However, the slightly different sorting of variables, still into 3 skill groups, does not alter our results. Irrespective of our choice of database, certain variables have a tendency to group together. We were able to complete cluster analysis and robustness checks with databases 4.0, 11.0 and 13.0. One difficulty that arises from the changing nature of O*NET is that it is not primarily intended for time-series analysis. Our decision to hold the skill values constant reflects this difficulty. A chief assumption of our analysis, moving forward with O*NET 12.0, is that the skill composition of jobs remains constant over time. While this may not be true in practice, a lawyer today does still requires the same average skill set as a lawyer would 10 years ago.

The skills are as follows:

(1) Analytical skills

This skill set consists of numerical facility, and general cognitive functioning. It involves skills such as developing and using rules and methods to solve problems, determining how a system works and how changes in conditions will affect the outcome. Occupations that require the highest level of analytical thinking skills include surgeons and biomedical engineers, while those that require the least include pile-driver operators and fashion models.

(2) Social intelligence skills

This skill set has a personal element. It encompasses occupations which require interpersonal skills – skills such as understanding, collaborating with, and managing other people. It also includes complex thinking skills that are essential for assessing fluid, ambiguous human situations – such as deductive reasoning, the ability to apply general rules to specific problems to produce answers that make sense, or judgment – and for decision making. The occupations which draw most significantly on this skill set include psychiatrists, chief executives, marketing managers, and lawyers.

(3) Physical skills

This skill set includes the ability to use body and strength in an occupational capacity. It includes arm-hand steadiness, coordination and dexterity, among others.

Derrick operators draw intensely on this skill, as do steel workers, fire fighters, and electricians.

Table 1 provides a list of the top and bottom ten occupations by skill:

(Table 1 about here)

Skill Score – This variable, used in our analysis, is the employment weighted skill value. To obtain regional skill scores, we take the occupational skill percentile and weight it by employment share in each occupation for each region. The score for a region tells us the average skill percentile across all occupations. This measure takes into account all occupations and all skill values. The data is a combination of the O*NET data for year 2007 and BLS data for occupations for years 1999 and 2008.

It is important to remember that most jobs require a mix of analytical, social intelligence, and physical skills in varying degrees. We will use each of the skill groups and examine their relation to regional wage levels. In order to do so, we conduct a number of analyses: bivariate correlations, scatterplots and regression analysis. We will also carry out the analysis for two points in time – 1999 and 2008 – to search for possible changes over time.

Other Independent Variables: We use a variety of independent and control variables in our analysis.

Population– This variable measures the population living within the metropolitan statistical area for the two respective years. The data comes from the US Census Bureau archive files for 1999 and annual CBSA and NECTA estimates for 2008.

Density– This variable measures the concentration of people living within each metropolitan area. It is calculated as the population divided by the area in square kilometers. The area data comes from the US Census Bureau 2008 Tiger/Line Shapefiles.

Percent BA- This variable acts as a proxy for regional stock of human capital. The data is collected from American Community Survey from the years 1999 and 2008.

The estimate tells us the number of Baccalaureate holders as a percentage of the population aged 25 and over.

The variables cover up to 311 or 361 metropolitan regions in the U.S. for the years 1999 and 2008, respectively. The descriptive statistics for all measures and variables are provided in Table 2.

(Table 2 about here)

Table 2 highlights how the variables have changed over time. We can see that the average levels of analytical and social intelligence skills have increased over time, whereas physical skills have declined, as would be expected. We can also see that the standard deviations for all three skills have decreased from 1999 to 2008. For social intelligence and physical skills we can understand why the standard deviation decreased by looking at the range. The spread in skills by city decreased for these two types of skills. However, the same is not true for analytical skills. The range actually increased in 2008, while the standard deviation decreased. This may indicate that skills have become more concentrated in majority of the cities, while a few outliers can account for the increased range. Overall we can say that the variation in skills from 1999 to 2008 has decreased.

Modeling approach

We begin our analysis with two simple correlation matrices for 1999 and 2008. The correlation coefficients give us some initial insight into the relationships amongst the various variables. From here, we examine the average skill score for the three types of skills across various region sizes. We look at cities ranging from very small in size (population between 100,000 and 250,000) to very large (greater than 2 million). We then examine how the data are distributed through scatter plot analysis. This allows us to examine the strength of the relationship between skills and wages, and also skills and population. Finally, we perform a multivariate regression analysis to gauge a better understanding of the wage returns to skills. We include various control variables, such as density, population and education, to net out their effects on regional prosperity. Here we are able to ascertain the true wage return to the three types of skills.

4. RESULTS

To identify the interrelations between analytical, social intelligence and physical skills, as well as their relation with regional wage levels, we start with a bivariate correlation analysis. We study the correlations for two points in time to determine whether certain skills have become more valuable, or more highly correlated with wages. Table 3 summarizes the results for 1999 and 2008.

(Table 3 about here)

We find that the correlations between regional wages and analytical and social intelligence skills are positive and strong in 1999 and 2008. We can also see that the relationship between these two skills and wages has gone up over time. The coefficient of variation of variation for analytical skills and regional wage levels is 0.558 in 1999 and 0.684 in 2008. This is a substantial change, which we will later explore by netting out the impact of other factors on regional wages. The same pattern holds for social intelligence skills and regional wages. The correlation coefficient was 0.603 in 1999 and.681 in 2008

Physical skills are negatively correlated with wages. The correlation was -0.292 in 1999 and increased to -0.518 in 2008. The jump is even greater than for analytical or social intelligence skills. It seems that the returns to physical skills significantly worsened over the period.

We now look at the correlations by region size. Physical skills have a negative relation with regional size, and that relationship has become stronger over time. The correlation between physical skills and region size changed from no relationship in 1999 to a significant negative one (-0.331) in 2008. This finding indicates that occupations demanding high physical skills are moving away from bigger market places towards smaller and medium sized regions. It seems physical skills aren't benefiting from concentrated cities. This result coincides with precious scholar's findings that smaller cities attract activities intensive in physical and motor skills (Bacolod, Blum and Strange, 2009).

Analytical skills have a positive correlation with region size. The correlation is 0.574 in 1999 and 0.542 in 2008. But as we can see, the correlation coefficient has become weaker over time. Social intelligence skills are also positively correlated with region size. The correlation was 0.524 in 1999 and 0.573 in 2008. Here we see the correlation coefficient increasing over time. It makes sense that social intelligence skills have become more correlated with regional size over time, while analytical skills have not. Analytical skills can be done by individuals who are dispersed or collocated. However, social intelligence skills offer higher and increasing returns to clustering. The results are consistent with Jacobs (1969) finding that it's not doing something more efficiently, or even smarter, that stands at the center of regional growth, but rather doing something new – and that is the essence of social intelligence skills.

(Table 4 about here)

Tables 4 outlines the differences in average skill level by city size. We can see that physical skills actually decrease in larger cities, with the highest concentration occurring in very small cities, or those with a population between 100,000 and 250,000. Additionally, over time the average physical skill has declined across all population groupings, except the smallest cities. Very small cities increased their average physical skill level from 1999 to 2008, whereas cities of other sizes did not.

We can also see that larger cities have higher thinking skills. Put differently, as you increase the population size the average level of analytical and social intelligence skills will increase. This corresponds with previous findings that thinking skills can benefit from clustering, given that denser and larger cities afford opportunities for synergies that smaller cities do not. Furthermore, over time we see that cities have increased their average skill levels. Social intelligence skills have increased across all population groupings form 1999 to 2008. The same is true for analytical skills, but not for very large cities.

To further examine the relations between skills and economic performance, we run a number of scatter graphs (Figure 1):

(Figure 1 about here)

Figure 1 above further outlines the correlations between skills and wages. We are able to ascertain that there is a strong positive relation between regional wages and analytical and social intelligence skills, and that these relationships have become stronger over time. However, regions are not experiencing the same marginal return to physical skills as they are with analytical and social intelligence skills. In fact, physical skills are associated with lower regional wages, and the relationship has become worse over time.

We also found a significant relationship between regional size, or population, and skills concentration; this relationship can be seen in Figure 2.

(Figure 2 about here)

These scatter-plots give us further insight into how regions are locating in the two-dimensional skill and population space. We can see that analytical and social intelligence skills are positively correlated with population size – meaning that larger cities tend to employ more of these types of skills. While the relationship between analytical skills and population seems to have worsened over time, we can say that it is not statistically different. Put differently, there is no change in the relationship between analytical skills and region size between 1999 and 2008. For social intelligence skills, we can say that they become more highly correlated with region size, and the relationship is statistically different.[1]

Physical skills follow a different pattern. We find that physical skills are negatively correlated with region size. We can also see that from 1999 to 2008, physical skills have changed from having no relationship with regional size to having a significant negative one. Bacolod, Blum and Strange (2009) reach similar conclusions. Namely, that larger regions tend to have lower physical skills, and they are continuously substituting away from these kinds of skills.

Regression Results

To further explore the role of skills in relation to regional size and wages, we proceed with some multivariate OLS regression analyses. We model the relationship between wages and various control variables. The goal is to predict, or explain, the variation in regional wages through skills, density, population and education, and also

[1] The statistical tests can be requested through the authors.

to gauge a sense of the strength of these relationships. We start by running the regressions for 1999, and then run the same regressions for 2008 in order to identify possible differences over time. Since the regional definitions differ substantially for the two points in time, we are unable to examine if the initial skill levels had an impact on wage growth over time. Table 5 illustrates the results for 1999 and 2008.

(Table 5 about here)

Overall, the variables within the model are explaining a large portion of the variation in wages. With R^2's ranging from 0.60 to 0.66, we are capturing important drivers of regional wages. In all three specifications, we include percent of baccalaureate holders in a city region, as it has been well established that human capital is important in explaining of regional wages (Glaeser and Resseger, 2009). We go even further to include an additional measure of human capital – occupational skills – to help explain differences in wages across city regions.

We find that analytical and social intelligence skills are strong contributors to regional wages. Looking back to Figure 1, we can see that analytical skills alone explain 0.31 of the variation in wages in 1999. This indicates that analytical skills explain a substantial portion of differences in regional wages. The same can be said for social intelligence skills in 1999, with a simple regression R^2 of 0.36. After including control variables, such as density, population and education, and examining the relationship in a multivariate context, we can see the R^2's double, and the coefficients remain strong and statistically significant. From specifications 3 and 6, we can understand that analytical skills have a marginally larger effect on wages than social intelligence skills.

We also find that physical skills have a negative, though insignificant, relation to regional wages. While the R^2's are quite high in the physical skills specifications, we see that the control variables, namely population, density and the educated population are driving the high explanatory power of the model. Looking at the coefficient estimates across specifications 7-9, we can see that physical skills have no relation with regional wages.

For 2008 we see the same story as 1999 – wages increase with analytical and social intelligence skills, but are lower with physical skills. The coefficients across all 3 specifications for analytical and social intelligence skills are significant at the 0.001

level, and significant for physical skills at the 0.01 level. Even when we control for other factors affecting regional prosperity, such as population, density and percent with a Bachelor's degree, we see that analytical and social intelligence skills are still strong, and statistically significant. Looking at specification 3, which controls for all three explanatory variables, we see that a 10 percent increase in analytical skills increases regional wages by 6 percent, ceteris paribus. Similarly, in specification 6, we can say that a 10 percent increase in social intelligence skills increases wages 5 percent. However, the same cannot be said of physical skills. Regardless of the specification we see a negative relation with regional wages – a 10 percent increase in physical skills actually decreases regional wages between 3 to 4 percent.

When we compare the magnitudes of the elasticites, we can see that skills are more important predictors of regional wages than the share of the population with a Bachelor's degree. While the return to a college education has remained relatively flat over the two years, the return to skills has more than doubled. This is consistent with prior findings which show that the return to education has been constant over the years 1970 to 1997 after controlling for other elements of skill (Ingram and Neumann, 2006). We can extrapolate upon that, demonstrating that over the period 1999 to 2008, the wage return to analytical and social intelligence skills has increased substantially.

5. CONCLUSION

Our research has examined the role of skills on regional wage levels. We began with the hypothesis that larger cities have more skills, and that wage returns differ based on the type of skill one possesses. We have shown that analytical and social intelligence skills are associated with higher wages, and that larger cities tend to have greater levels of these skills. We have also seen that physical skills are not associated with higher wages, and that the larger the city the lower the average physical skill level. We tested this for two points in time, 1999 and 2008, and found that the return to analytical and social intelligence skills increased over the period, while physical skills declined.[2]

In addition, we have added to the growing literature on skills. We have seen that skills are equally, if not more, important than education in explaining regional wages. Since wage levels reflect individual productivity levels, we can assume that

[2] The statistical tests over time can be requested through the authors.

education as well as skills will reflect the ability to perform well at work. At the aggregate levels, both skills and education should be associated with regional wage levels. Earlier research (Berry and Glaeser, 2005) has shown how educational based human capital tend to cluster in bigger market places. We suggest that those who possess certain types of skills are locating in larger markets as well, likely due to the fact they are able to reap greater rewards in these regions. The prevalence of thinking skills, such as analytical and social intelligence skills, in larger city regions reinforces some of Jacob's (1969) earlier thinking. She posited that thinking skills benefit from clustering, and that a major driver of economic growth is the ability to do new things – an ability that depends on coordination and flexibility of ideas, which are all central facets to social intelligence skills. While there is still much work to be done in this area, we have begun to tell a new story – one where individuals are rewarded not only based on their educational attainment, but the skills their occupations require.

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APPENDIX: Skills Descriptions.

Skills comprising the Analytical index:

Auditory Attention: The ability to focus on a single source of sound in the presence of other distracting sounds.
Equipment Selection: Determining the kind of tools and equipment needed to do a job.
Far Vision: The ability to see details at a distance.
Flexibility of Closure: The ability to identify or detect a known pattern (a figure, object, word, or sound) that is hidden in other distracting material.
Fluency of Ideas: The ability to come up with a number of ideas about a topic (the number of ideas is important, not their quality, correctness, or creativity).
Hearing Sensitivity: The ability to detect or tell the differences between sounds that vary in pitch and loudness.
Management of Financial Resources: Determining how money will be spent to get the work done, and accounting for these expenditures.
Management of Material Resources: Obtaining and seeing to the appropriate use of equipment, facilities, and materials needed to do certain work.
Management of Personnel Resources: Motivating, developing, and directing people as they work, identifying the best people for the job.
Mathematical Reasoning: The ability to choose the right mathematical methods or formulas to solve a problem.
Memorization: The ability to remember information such as words, numbers, pictures, and procedures.
Number Facility: The ability to add, subtract, multiply, or divide quickly and correctly.
Operations Analysis: Analyzing needs and product requirements to create a design.
Originality: The ability to come up with unusual or clever ideas about a given topic or situation, or to develop creative ways to solve a problem.
Perceptual Speed: The ability to quickly and accurately compare similarities and differences among sets of letters, numbers, objects, pictures, or patterns. The things to be compared may be presented at the same time or one after the other. This ability also includes comparing a presented object with a remembered object.
Quality Control Analysis: Conducting tests and inspections of products, services, or processes to evaluate quality or performance.
Science: Using scientific rules and methods to solve problems.
Selective Attention: The ability to concentrate on a task over a period of time without being distracted.
Speed of Closure: The ability to quickly make sense of, combine, and organize information into meaningful patterns.
Systems Analysis: Determining how a system should work and how changes in conditions, operations, and the environment will affect outcomes.
Systems Evaluation: Identifying measures or indicators of system performance and the actions needed to improve or correct performance, relative to the goals of the system.
Technology Design: Generating or adapting equipment and technology to serve user needs.
Time Sharing: The ability to shift back and forth between two or more activities or sources of information (such as speech, sounds, touch, or other sources).
Troubleshooting: Determining causes of operating errors and deciding what to do about it.
Visual Color Discrimination: The ability to match or detect differences between colors, including shades of color and brightness.
Visualization: The ability to imagine how something will look after it is moved around or when its parts are moved or rearranged.

Skills comprising the Social Intelligence index:

Active Learning: Understanding the implications of new information for both current and future problem-solving and decision-making.
Active Listening: Giving full attention to what other people are saying, taking time to understand the points being made, asking questions as appropriate, and not interrupting at inappropriate times.
Category Flexibility: The ability to generate or use different sets of rules for combining or grouping things in different ways.
Complex Problem Solving: Identifying complex problems and reviewing related information to develop and evaluate options and implement solutions.
Coordination: Adjusting actions in relation to others' actions.
Critical Thinking: Using logic and reasoning to identify the strengths and weaknesses of alternative solutions, conclusions or approaches to problems.

Deductive Reasoning: The ability to apply general rules to specific problems to produce answers that make sense.
Inductive Reasoning: The ability to combine pieces of information to form general rules or conclusions (includes finding a relationship among seemingly unrelated events)
Information Ordering: The ability to arrange things or actions in a certain order or pattern according to a specific rule or set of rules (e.g., patterns of numbers, letters, words, pictures, mathematical operations).
Instructing: Teaching others how to do something.
Judgment and Decision Making: Considering the relative costs and benefits of potential actions to choose the most appropriate one.
Learning Strategies: Selecting and using training/instructional methods and procedures appropriate for the situation when learning or teaching new things.
Mathematics: Using mathematics to solve problems.
Monitoring: Monitoring/Assessing performance of yourself, other individuals, or organizations to make improvements or take corrective action.
Near Vision: The ability to see details at close range (within a few feet of the observer).
Negotiation: Bringing others together and trying to reconcile differences.
Oral Comprehension: The ability to listen to and understand information and ideas presented through spoken words and sentences.
Oral Expression: The ability to communicate information and ideas in speaking so others will understand.
Persuasion: Persuading others to change their minds or behavior.
Problem Sensitivity: The ability to tell when something is wrong or is likely to go wrong. It does not involve solving the problem, only recognizing there is a problem.
Reading Comprehension: Understanding written sentences and paragraphs in work related documents.
Service Orientation: Actively looking for ways to help people.
Social Perceptiveness: Being aware of others' reactions and understanding why they react as they do.
Speaking: Talking to others to convey information effectively.
Speech Clarity: The ability to speak clearly so others can understand you.
Speech Recognition: The ability to identify and understand the speech of another person.
Time Management: Managing one's own time and the time of others.
Writing: Communicating effectively in writing as appropriate for the needs of the audience.
Written Comprehension: The ability to read and understand information and ideas presented in writing.
Written Expression: The ability to communicate information and ideas in writing so others will understand.

Skills comprising the Physical index:

Arm Hand Steadiness: The ability to keep your hand and arm steady while moving your arm or while holding your arm and hand in one position.
Control Precision: The ability to quickly and repeatedly adjust the controls of a machine or a vehicle to exact positions.
Depth Perception: The ability to judge which of several objects is closer or farther away from you, or to judge the distance between you and an object.
Dynamic Flexibility: The ability to quickly and repeatedly bend, stretch, twist, or reach out with your body, arms, and/or legs.
Dynamic Strength: The ability to exert muscle force repeatedly or continuously over time. This involves muscular endurance and resistance to muscle fatigue.
Equipment Maintenance: Performing routine maintenance on equipment and determining when and what kind of maintenance is needed.
Explosive Strength: The ability to use short bursts of muscle force to propel oneself (as in jumping or sprinting), or to throw an object.
Extent Flexibility: The ability to bend, stretch, twist, or reach with your body, arms, and/or legs.
Finger Dexterity: The ability to make precisely coordinated movements of the fingers of one or both hands to grasp, manipulate, or assemble very small objects.
Glare Sensitivity: The ability to see objects in the presence of glare or bright lighting.
Gross Body Coordination: The ability to coordinate the movement of your arms, legs, and torso together when the whole body is in motion.
Gross Body Equilibrium: The ability to keep or regain your body balance or stay upright when in an unstable position.
Installation: Installing equipment, machines, wiring, or programs to meet specifications.
Manual Dexterity: The ability to quickly move your hand, your hand together with your arm, or your two hands to grasp, manipulate, or assemble objects.
Multi-limb Coordination: The ability to coordinate two or more limbs (for example, two arms, two legs, or

one leg and one arm) while sitting, standing, or lying down. It does not involve performing the activities while the whole body is in motion.
Night Vision: The ability to see under low light conditions.
Operation and Control: Controlling operations of equipment or systems**.**
Operation Monitoring: Watching gauges, dials, or other indicators to make sure a machine is working properly.
Peripheral Vision: The ability to see objects or movement of objects to one's side when the eyes are looking ahead**.**
Programming: Writing computer programs for various purposes.
Rate Control: The ability to time your movements or the movement of a piece of equipment in anticipation of changes in the speed and/or direction of a moving object or scene.
Reaction Time: The ability to quickly respond (with the hand, finger, or foot) to a signal (sound, light, picture) when it appears.
Repairing: Repairing machines or systems using the needed tools
Response Orientation: The ability to choose quickly between two or more movements in response to two or more different signals (lights, sounds, pictures). It includes the speed with which the correct response is started with the hand, foot, or other body part. It includes the speed with which the correct response is started with the hand, foot, or other body part.
Sound Localization: The ability to tell the direction from which a sound originated.
Spatial Orientation: The ability to know your location in relation to the environment or to know where other objects are in relation to you.
Speed of Limb Movement: The ability to quickly move the arms and legs.
Stamina: The ability to exert yourself physically over long periods of time without getting winded or out of breath.
Static Strength: The ability to exert maximum muscle force to lift, push, pull, or carry objects.
Trunk Strength: The ability to use your abdominal and lower back muscles to support part of the body repeatedly or continuously over time without 'giving out' or fatiguing.
Wrist Finger Speed: The ability to make fast, simple, repeated movements of the fingers, hands, and wrists.

Table 1: Top and Bottom 10 Occupations by Skill

Top 10 Occupations by Skill

Analytical	Social Intelligence	Physical
Biomedical Engineers	Psychiatrists	Derrick Operators, Oil and Gas
Agricultural Engineers	Chief Executives	Structural Iron and Steel Workers
Physicists	Aerospace Engineers	Manufactured Building and Mobile Home Installers
Nuclear Engineers	Social Work Teachers, Postsecondary	Roof Bolters, Mining
Aerospace Engineers	Surgeons	Airline Pilots, Copilots, and Flight Engineers
Sales Engineers	Nursing Instructors and Teachers, Postsecondary	Excavating and Loading Machine and Dragline Operators
Surgeons	Medical Scientists, Except Epidemiologists	Fire Fighters
Chemical Engineers	Marketing Managers	Motorboat Operators
Aerospace Engineering and Operations Technicians	Anesthesiologists	Industrial Machinery Mechanics
Airline Pilots, Copilots, and Flight Engineers	Oral and Maxillofacial Surgeons	Truck Drivers, Heavy and Tractor-Trailer

Bottom 10 Occupations by Skill

Analytical	Social Intelligence	Physical
Packers and Packagers, Hand	Models	Sociology Teachers, Postsecondary
Crossing Guards	Dredge Operators	Clinical, Counseling, and School Psychologists
Paperhangers	Watch Repairers	Market Research Analysts
Models	Fabric Menders, Except Garment	Political Scientists
Loading Machine Operators, Underground Mining	Paperhangers	Law Clerks
Continuous Mining Machine Operators	Floor Sanders and Finishers	Door-to-Door Sales Workers, News and Street Vendors, and Related Workers
Locker Room, Coatroom, and Dressing Room Attendants	Continuous Mining Machine Operators	Social Work Teachers, Postsecondary
Rock Splitters, Quarry	Rock Splitters, Quarry	Law Teachers, Postsecondary
Graders and Sorters, Agricultural Products	Loading Machine Operators, Underground Mining	Loan Officers
Pile-Driver Operators	Pile-Driver Operators	Public Relations Specialists

Table 2: Descriptive Statistics – all regions

	Obs	*Mean*	*Standard Deviation*	*Minimum*	*Maximum*
Average Wage Levels[3]					
Wages 99	310	$40,694	$4,582	$28,134	$53,664
Wages 08	360	$43,414	$5,280	$28,832	$64,403
Population					
Population 99	311	696,979	1,184,414	63,157	10,600,000
Population 08	358	706,579	1,271,168	54,867	11,700,000
Density					
Density 99	309	138.107	198.995	2.046	2,514.523
Density 08	357	133.687	220.235	2.585	2,622.788
Skill Percentile Scores					
Analytical 99	307	34.061	2.882	26.543	43.303
Analytical 08	361	34.199	2.763	25.688	46.292
Social Intelligence 99	307	38.527	3.573	28.077	48.029
Social Intelligence 08	361	40.279	3.018	32.301	49.719
Physical 99	307	43.595	2.594	35.267	53.134
Physical 08	361	43.227	2.337	37.101	52.347
Percent BA and above					
Percent Bachelor's 99	307	23.77%	7.42%	11.05%	52.38%
Percent Bachelor's 08	356	25.92%	8.05%	10.05%	57.02%

[3] Wages are calculated as the employment weighted average, and are converted to 2008 US$.

Table 3: Skill and Wage Correlations for 1999 and 2008

	Regional Wages	Log Population	Density	Analytical	Social Intelligence	Physical	Percent Bachelor's
Regional Wages							
1999	1						
2008	1						
Log Population							
1999	0.6756**	1					
2008	0.5749**	1					
Density							
1999	0.5559**	0.553**	1				
2008	0.5325**	0.5113**	1				
Analytical							
1999	0.5575**	0.5743**	0.303**	1			
2008	0.6835**	0.542**	0.3129**	1			
Social Intelligence							
1999	0.6033**	0.5242**	0.3508**	0.7688**	1		
2008	0.6805**	0.573**	0.3973**	0.786**	1		
Physical							
1999	-0.2924**	-0.0002	-0.1532	0.0627	-0.4629**	1	
2008	-0.5184**	-0.3307**	-0.3326**	-0.1978**	-0.6298**	1	
Percent Bachelor's							
1999	0.5547**	0.2594**	0.2625**	0.2466**	0.4147**	-0.6057**	1
2008	0.643**	0.3472**	0.321**	0.4697**	0.6005**	-0.6504**	1

** indicating significance at the 0.01 level and * at the 0.05 level.

Table 4: Average skill score and standard deviation by city size, 1999 and 2008[4]

	Very Small	Small	Medium	Large	Very Large
Analytical					
1999	32.76 (2.45)	34.25 (2.67)	35.24 (2.02)	36.29 (2.30)	37.18 (1.70)
2008	32.87 (1.97)	34.51 (3.08)	35.35 (2.08)	36.84 (2.42)	36.61 (1.98)
Social Intelligence					
1999	36.94 (3.08)	38.49 (3.63)	40.21 (2.64)	40.76 (2.57)	42.42 (2.11)
2008	38.85 (2.39)	40.44 (3.05)	41.71 (2.40)	42.93 (2.34)	43.21 (2.40)
Physical					
1999	43.67 (2.57)	43.99 (3.15)	43.98 (2.44)	43.60 (2.03)	42.90 (1.83)
2008	43.85 (2.42)	43.20 (2.32)	42.98 (1.93)	42.22 (2.03)	41.59 (1.55)

[4] Very small measures cities with a population between 100,000 and 250,000; Small is population between 250,000 and 500,000; Medium is population between 500,000 and 1,000,000; Large is population between 1,000,000 and 2,000,000; Very large is population greater than 2,000,000.

Table 5: Regression Results, 1999 and 2008

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Ln (Wage)	Ln (Wage)	Ln (Wage)	Ln (Wage)	Ln (Wage)	Ln (Wage)	Ln (Wage)	Ln (Wage)	Ln (Wage)
Findings for 1999									
Ln (Analytical Score)	0.283***	0.383***	0.242***						
	(4.57)	(6.61)	(4.07)						
Ln (Social Intelligence Score)				0.268***	0.327***	0.221***			
				(4.77)	(5.84)	(4.07)			
Ln (Physical Score)							-0.195*	0.0711	-0.130
							(-2.02)	(0.72)	(-1.40)
Ln (Percent Bachelor's)	0.153***	0.149***	0.141***	0.135***	0.130***	0.127***	0.134***	0.170***	0.129***
	(10.33)	(9.92)	(9.90)	(8.67)	(8.12)	(8.48)	(6.82)	(8.52)	(6.90)
Ln (Population)	0.0514***		0.0343***	0.0536***		0.0369***	0.0659***		0.0451***
	(10.26)		(6.14)	(11.38)		(6.88)	(14.75)		(8.26)
Ln (Density)		0.0542***	0.0352***		0.0569***	0.0344***		0.0689***	0.0373***
		(10.03)	(5.89)		(10.53)	(5.74)		(13.09)	(6.11)
Constant	9.058***	9.112***	9.247***	9.023***	9.230***	9.240***	10.58***	10.16***	10.42***
	(46.12)	(45.51)	(48.59)	(45.99)	(44.84)	(48.22)	(31.26)	(28.62)	(32.32)
N	307	305	305	307	305	305	307	305	305
Adj. R-sq	0.623	0.618	0.660	0.625	0.607	0.660	0.602	0.563	0.643
Findings for 2008									
Ln (Analytical Score)	0.609***	0.630***	0.582***						
	(9.02)	(10.29)	(8.97)						
Ln (Social Intelligence Score)				0.535***	0.579***	0.500***			
				(6.35)	(7.57)	(6.15)			
Ln (Physical Score)							-0.372**	-0.341**	-0.314**
							(-3.25)	(-2.99)	(-2.83)
Ln (Percent Bachelor's)	0.145***	0.142***	0.138***	0.137***	0.132***	0.131***	0.153***	0.166***	0.150***
	(9.25)	(9.36)	(9.14)	(7.65)	(7.61)	(7.61)	(7.62)	(8.40)	(7.73)
Ln (Population)	0.0283***		0.0117*	0.0328***		0.0159**	0.0458***		0.0279***
	(5.87)		(2.13)	(6.40)		(2.75)	(9.64)		(4.94)
Ln (Density)		0.0370***	0.0308***		0.0397***	0.0315***		0.0495***	0.0323***

		(8.08)	(5.72)		(8.16)	(5.54)		(9.99)	(5.45)
Constant	8.244***	8.363***	8.405***	8.348***	8.424***	8.548***	11.58***	11.85***	11.45***
	(36.25)	(37.98)	(38.21)	(27.77)	(29.01)	(29.35)	(26.99)	(28.32)	(27.69)
N	356	355	355	356	355	355	356	355	355
Adj. R-sq	0.608	0.637	0.640	0.567	0.593	0.601	0.531	0.539	0.568

t statistics in parentheses
* p < 0.05, ** p < 0.01, *** p < 0.001

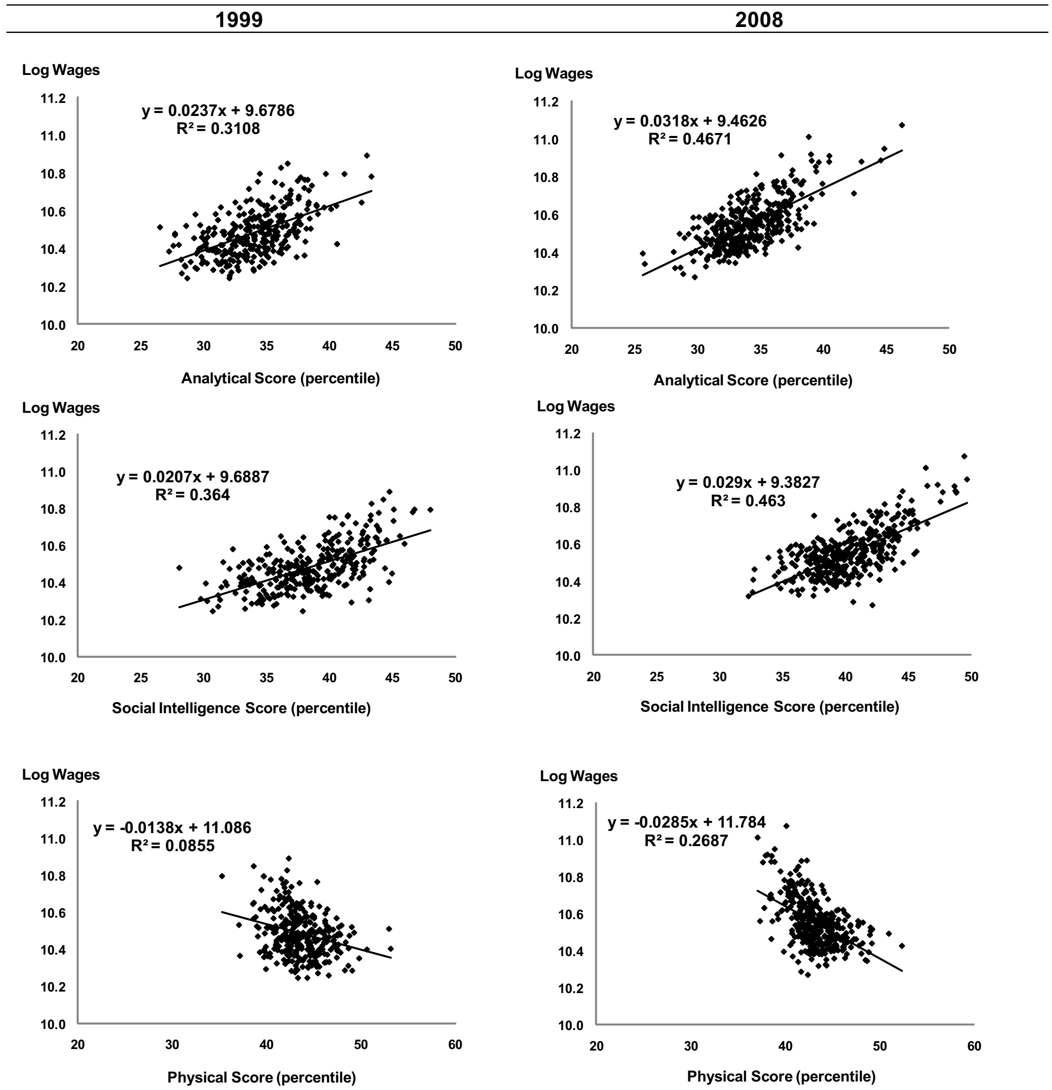

Figure 1: Skills and average wage levels

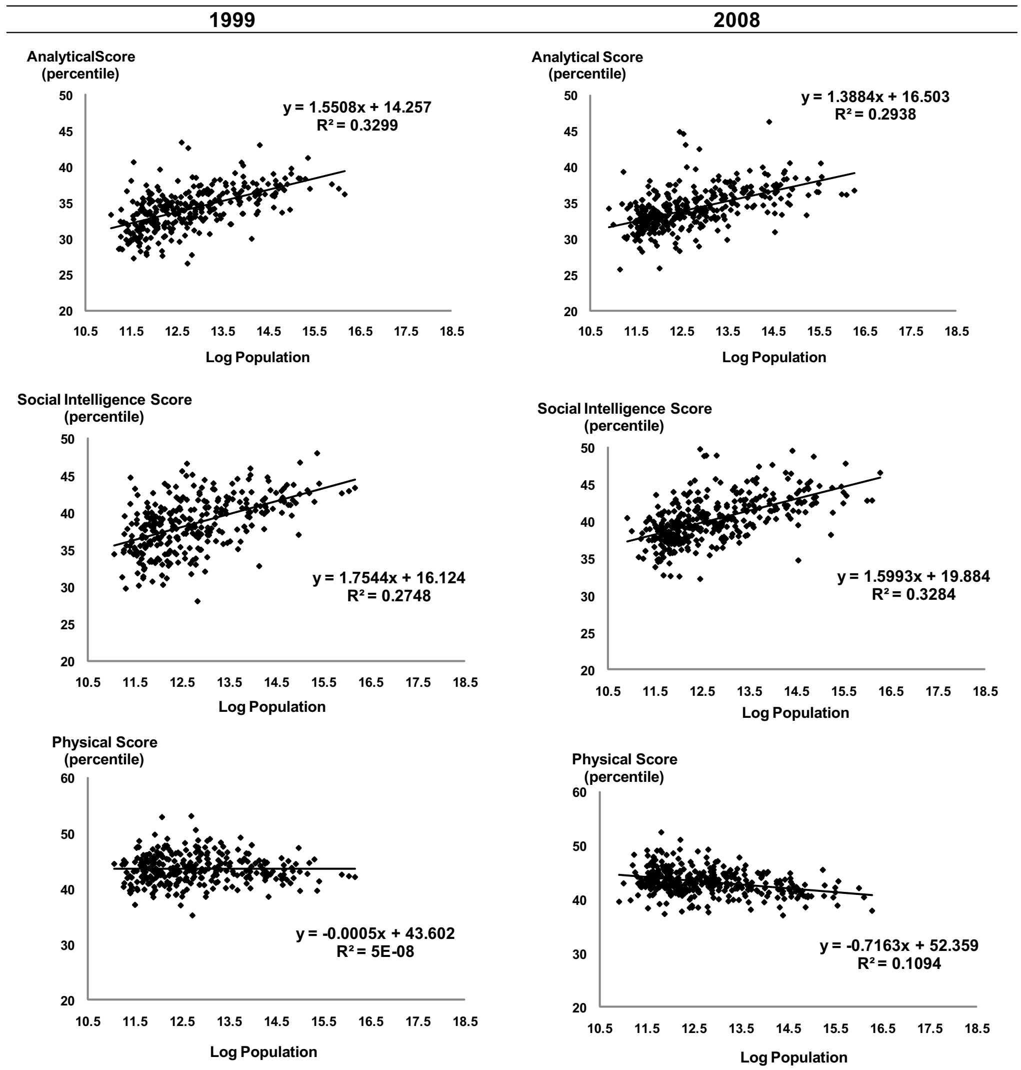

Figure 2: Skills and Population Size

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