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Evidence-based policy making

Do higher levels of education and skills in an area benefit wider society?

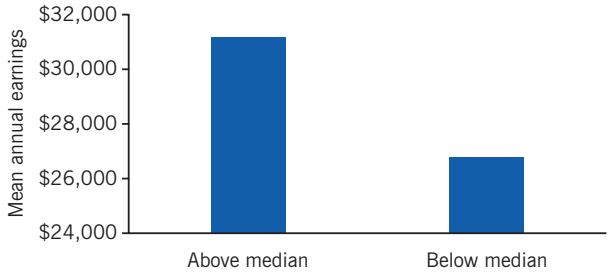
Education benefits individuals, but the societal benefits are likely even greater

Keywords: human capital, education, schooling, externalities, earnings, employment

ELEVATOR PITCH

Formal schooling increases earnings and provides other individual benefits. However, societal benefits of education may exceed individual benefits. Research finds that higher average education levels in an area are correlated with higher earnings, even for local residents with minimal education. Science, technology, engineering, and mathematics (STEM) graduates appear to generate especially strong external effects, due to their role in stimulating innovation and economic growth. Several strategies to test for causality find human capital externalities do exist.

Higher earnings for high school graduates in US states with above-median education levels



Source: Author's own calculations based on the 2016 American Community Survey. Online at: https://www.census.gov/programs-surveys/acs/

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KEY FINDINGS

Pros

- Economic theory suggests that there are external benefits of education, such as learning from peers and synergies in problem-solving.
- Empirical studies find a positive correlation between higher local education levels and higher earnings.
- Human capital externalities are strongly linked to increases in the stock of college graduates in an area.
- Externalities associated with higher local education levels benefit all workers, especially less educated workers.
- Externalities appear to be particularly strong from STEM graduates.

Cons

- Positive correlation between high local education levels and earnings of other workers may result from highly educated workers moving to areas that already pay high wages.
- There may be unobservable characteristics that increase both local education levels and wages.
- Policies to raise education levels by encouraging highly educated immigrants could adversely affect some native workers.
- Human capital may increase the local price of non-tradable goods and services such as housing, to the detriment of the less educated.
- Local education levels may increase inequality if more educated workers benefit more.

AUTHOR'S MAIN MESSAGE

Studies generally find a positive causal impact of higher education and skill levels in an area on earnings, even for less educated workers. These external effects likely differ by type of human capital. STEM graduates appear to generate especially strong external effects, by stimulating innovation and economic growth. Policies that increase the stock of college graduates, especially STEM graduates, by increasing domestic production and immigration, are likely to yield benefits now and in the future. This may include improving primary and secondary mathematics and science education and relaxing employment restrictions for foreign workers.

MOTIVATION

Productivity and average incomes differ widely across countries and even within countries, and researchers and policymakers are interested in knowing why. Differences in worker knowledge and skills, often referred to as human capital, are widely believed to be a major reason for income differences across areas. Why might human capital be so important for productivity and economic growth? Both direct and indirect effects are likely the reason.

An individual with greater knowledge and skills will be more productive than one with less human capital because greater knowledge and skills enable people to produce more output value per unit of time. In competitive labor markets, skilled workers will reap the rewards of their higher productivity in the form of higher wages and salaries. Higher education levels in an area will directly increase average incomes in the area because having more highly educated workers with high wages raises the local average. However, this effect alone does not necessarily mean that an individual worker is better off by living in an area with more educated people.

If there are spillover effects from human capital, then living in an area with more educated people may boost wages and well-being for workers of all education levels. A high human capital worker might increase the productivity of coworkers, friends, and neighbors because of knowledge spillovers and the generation of new ideas. Additionally, imperfect substitutability in production between different types of workers will cause increases in the local proportion of high-skilled workers to affect the wages of both high-skilled and low-skilled workers in the area. This might be beneficial for low-skilled workers if their work is complementary to that of high-skilled workers but might adversely affect high-skilled workers if the additional high-skilled workers are substitutes and provide increased labor market competition that drives down their wages.

DISCUSSION OF PROS AND CONS

Theoretical mechanisms

Proponents have offered several explanations for why human capital externalities would be expected to exist [1]. First, a high human capital worker may share knowledge with peers, both intentionally and unintentionally; these transfers are often referred to as knowledge spillovers. Knowledge spillovers will make peers more productive, resulting in higher wages. Second, interactions among high human capital workers may create synergies in problem-solving and idea creation that can lead to new and more efficient production processes and technologies that increase demand for labor in the area, thus boosting employment and earnings for workers of all types. Similarly, human capital is a prerequisite for the discovery and adoption of technologies that increase the productivity of all workers. Knowledge flows and opportunities for interaction decline with physical and social distance, so workers who regularly interact with a large number of high human capital workers will benefit the most from human capital externalities. Also, workers will benefit most from human capital in their own area and will benefit less from human capital levels in other countries or other areas within the same country.

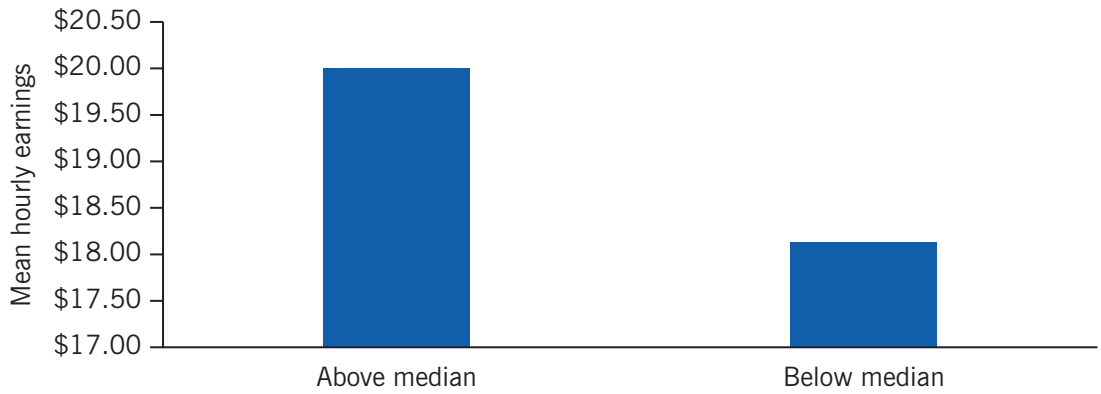
High human capital workers may also affect the productivity of others in the same local labor market because of substitutability between workers. Production processes typically involve different types of tasks to be performed by workers with different knowledge, skills, and abilities. There is some degree of substitutability between high-skilled and low-

skilled workers, but if the low-skilled workers perform manual tasks that cannot be done much more efficiently by high-skilled workers or by computers and other machines, then substitution possibilities are limited. That means that having a larger stock of high-skilled workers will increase labor demand for less-skilled workers and increase their productivity and earnings. However, because workers with very similar skills are likely to be very substitutable, increasing the stock of high-skilled workers may reduce the productivity and earnings of workers with very similar skills [2].

Estimating causal effects is complicated by non-random assignment

The ideal way to evaluate whether human capital externalities exist and, if so, how large they are, would be to randomly assign individuals to particular education levels and geographic locations. Since that is not feasible, one must observe individuals based on their own education and location decisions. The initial approach to examining human capital externalities offered descriptive evidence on the correlation between local human capital levels and local wages, while controlling for individual education. For example, Figure 1 shows that mean hourly earnings for high school graduates in the US are higher in states with education levels above the median, suggesting that high school graduates benefit from working in states with more highly educated workers. However, a positive correlation between local human capital levels and local wages does not necessarily imply that higher human capital levels among nearby workers cause external benefits.

Figure 1. Mean hourly earnings for high school graduates are higher in US states with above-median education levels, 2016



Note: State education levels are measured as the percentage of the population aged 25–55 with a bachelor's degree or higher. Mean hourly earnings are computed for a sample of high school graduates with no college education aged 25–55 who are full-year workers. Excludes residents of Alaska, Hawaii, and the District of Columbia.

Source: Author's own calculations based on the 2016 American Community Survey. Online at: https://www.census.gov/programs-surveys/acs/

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A fundamental concern is that individuals may make education and location decisions in ways that make it difficult to accurately assess the importance of human capital externalities. For example, people with higher unobserved ability and motivation are likely to complete more education than their less able counterparts. Similarly, more productive workers, even at a given level of education, may choose to locate in areas with greater endowments of productive resources and stronger labor markets—and this may especially

be the case for highly educated workers. Even without human capital externalities, average earnings could be higher in areas with higher average education levels simply because highly productive workers choose to live in highly productive areas.

Additionally, workers may be attracted to particular areas because of the locational amenities offered. For a spatial equilibrium to occur, workers must implicitly pay for these amenities through higher housing prices, lower wages, or both. If implicit amenity expenditures occur primarily through higher housing prices and if more productive workers earn higher incomes and can spend more on housing, then highly productive workers will likely outbid their less productive counterparts for locations in high-amenity areas. As a result, workers of a given education level in high-amenity areas may have greater unobserved ability, productivity, and wages than their counterparts in lower-amenity areas. Because individual productivity is strongly positively linked with individual education, high-amenity areas will also likely have high average education levels. Thus, locational amenities could drive a positive correlation between average human capital levels and average earnings even at a given education level.

Empirical analysis can easily account for observable individual and locational characteristics, but accounting for unobservable characteristics is much more difficult. However, some progress has been made in accounting for unobservable differences.

Estimation strategies to account for unobservable individual characteristics

A useful way to account for unobservable individual characteristics is to observe the same individuals at several points in time to see how they react to changes around them [1]. Any effects due to individual characteristics that do not vary over time can then be subtracted out. Such an analysis essentially compares how individuals perform at different points in time as the average education level in their area changes.

A second widely used approach takes advantage of a natural experiment—some historical event or occurrence that would later affect human capital levels in different areas but has no direct effect on wages and employment. One example is the geographic distribution of land grant universities in the US [1]. Land grant universities educate local populations and therefore increase average education levels in the area. They were created by federal legislation at the end of the 19th century and their locations appear largely random relative to recent economic activity. Thus, researchers have examined the effects of land grant universities on average education levels and wages to infer the effect of human capital externalities on wages. A major assumption is that land grants have no effect on wages other than through their effects on average human capital levels.

Studies based on natural experiments have also been conducted using changes in compulsory schooling and child labor laws, the historical age structure of the local population, and the historical location decisions of skilled immigrants. Over time, many developed countries have increased the age at which young people may legally drop out of school and the age at which they can legally work for paid employment. In some countries, there is even regional variation in the timing of the policy changes. Since these policies increase average education levels, they can be used to examine the external effects of human capital [3].

The past age structure of an area can also be used to predict how the area's average education level will change over time [1]. Younger cohorts have tended to complete more education than older cohorts, and the average education level in a city at a particular point in time depends strongly on the age structure. Areas with large shares of young adults (aged 15–24) and older adults (aged 55 and over) at the start of a decade are likely to see average education levels in their local labor force rise rapidly by the end of the decade as highly educated cohorts of younger workers replace less educated cohorts of older workers in the labor force. If this age structure induced increase in average human capital is otherwise unrelated to wage outcomes, then it can be studied as a natural experiment to infer the existence and magnitude of human capital externalities.

Another natural experiment that has been exploited is using past location decisions of skilled immigrants to predict the location decisions of newly arriving skilled immigrants [3]. Specifically, geographic clusters of specific immigrant nationalities have been used to predict future population flows for immigrants of the same nationality. New immigrants tend to settle in areas where their compatriots have located before them because of social networks and the benefits of locating in an ethnic enclave. If the past location decisions of skilled immigrants predict future inflows of skilled immigrants, an area's average education level would be expected to rise over time. If past location decisions are otherwise unrelated to future changes in labor market conditions, then past immigrant population densities may provide a natural experiment to infer the effect of human capital externalities on wages.

No consensus but estimated effects are usually positive

The research community has not yet reached a strong consensus on the existence and magnitude of human capital externalities. Some studies find little or no evidence of human capital externalities [4]. However, the majority of research studies find evidence of positive human capital externalities, and the magnitudes are typically quite large. The differing findings across studies are likely the result of differing estimation strategies and differing time periods and countries considered.

In particular, the external effects of human capital likely differ by the type of human capital. Research based on compulsory schooling and child labor laws typically finds minimal evidence of human capital externalities [3]. This is likely because compulsory schooling and child labor laws affect education at lower levels: the laws increase the percentage of young people who complete high school and the number of years of high school completed for dropouts.

However, the theoretical mechanisms predicting human capital externalities typically emphasize the stock of highly educated individuals. Natural experiment-based studies examining the effects of college graduates tend to find large positive effects. Commonly cited research for the US suggests that a one percentage point increase in the share of the population with a college degree raises individual wages by more than 1% [1]. However, other research suggests that the external effects of college graduates may have been much smaller in the US during the 1990s than in the 1980s, perhaps because the strong national economy especially benefited areas with less educated populations [4].

Many studies of human capital externalities, including those discussed above, use US data. However, there is growing research for other countries that also tends to find positive external effects of increased local shares of college graduates [5].

Especially strong externalities in areas with high concentrations of STEM graduates

Since college graduates create larger human capital externalities than high school graduates, it seems plausible that different types of college graduates could have different effects. In particular, graduates in STEM disciplines are likely to have especially large positive external effects on the productivity and wages of other workers because of the important role those disciplines play in local technological innovation [6]. Descriptive analysis corroborates this hypothesis: the wages of non-college graduates are much higher in areas with a greater share of STEM graduates.

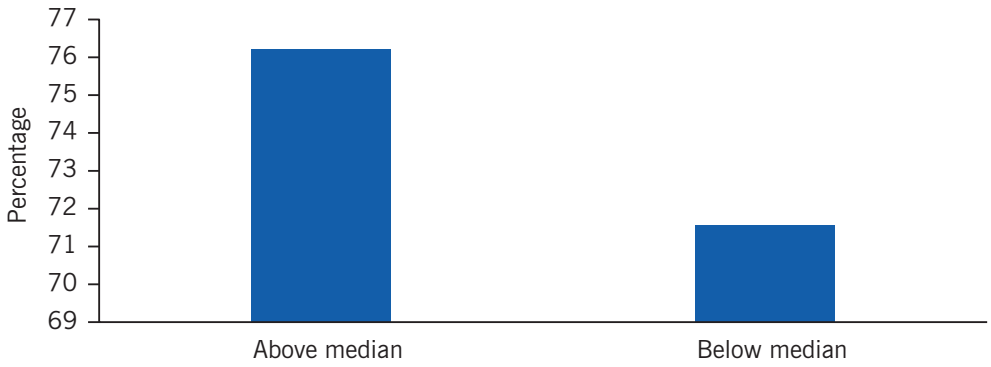
Researchers have also used the natural experiment strategy to examine the external effects of foreign STEM workers on the wages of native-born workers [7]. To estimate causal effects, the past location decisions of foreign STEM workers are used to predict future flows of foreign STEM workers. Results suggest very large positive human capital externalities of foreign STEM workers on the wages of native workers. This appears to result in part because of more efficient task specialization. Other research suggests that human capital externalities may also result in part from the large positive effects of more STEM graduates on innovation, as measured by patenting per capita [8], [9]. Furthermore, innovation has been shown to be a major causal driver of long-term economic growth and other measures of regional economic development including population growth and financial development [10]. Thus, education-driven increases in innovation are human capital externalities that benefit other people, even those with less education.

Effects on employment and unemployment

The higher productivity and wages due to human capital externalities are also likely to affect employment and unemployment outcomes [11]. Greater productivity in an area will encourage firms to hire more workers and will thereby increase the demand for labor. Individuals make decisions about whether to work for paid employment based on the benefits and costs of doing so. Higher wages are likely to increase the benefits of working, so workers will supply more labor.

Furthermore, knowledge spillovers may provide a future benefit to working in the labor market that is above and beyond the effects on current wages [11]. Learning from skilled coworkers increases a worker's productivity in both the present and the future and thus increases the benefits of working. Therefore, human capital externalities are likely to increase labor force participation and decrease unemployment. Figure 2 shows that mean employment rates for high school graduates are higher in states with above-median shares of college graduates. More rigorous analysis confirms this finding [11]. Results from multiple research strategies and time periods suggest that a higher share of college graduates in an area increases the probability that a given individual is employed and reduces the probability that the individual is unemployed, even controlling for the individual's own education and other characteristics. The effects are relatively large and explain a large share of the differences in employment and unemployment rates across geographic areas.

Figure 2. Mean employment rates for high school graduates are higher in US states with above-median education levels, 2016



Note: Employment rates are computed as the share of a sample of high school graduates with no college education aged 25–55 who are employed. Excludes residents of Alaska, Hawaii and the District of Columbia.

Source: Author's own calculations based on the 2016 American Community Survey. Online at: https://www.census.gov/programs-surveys/acs/

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Differences in effects across people who benefit from externalities

The size of human capital externalities may vary by the education level of those who benefit from externalities. In particular, increasing the stock of highly educated workers might harm other highly educated workers in the area who have very similar skills [2]. This concern is especially relevant for policies that seek to increase the stock of skilled workers in an area by increasing the inflow of skilled immigrants. If skilled native-born workers and immigrants are highly substitutable, increased inflows of skilled immigrants might harm the wages and employment prospects of native-born workers with similar skills.

Some research finds that an increase in the share of the college-educated population benefits all workers but that the benefits are greatest for less educated workers and lowest for highly educated workers [1], [11]. This outcome is consistent with theoretical predictions related to imperfect substitutability. Highly educated workers may be close substitutes for each other but weaker substitutes for less-skilled workers. However, these studies are not based on natural experiments specifically linked to predicted inflows of skilled foreigners.

Other research using past location decisions of foreign STEM workers as a natural experiment finds that human capital externalities from increases in the stock of foreign STEM workers benefit college graduates the most and that the effects are very large [7]. In particular, a one percentage point increase in foreign STEM workers as a share of the population increases average weekly wages by about 8% for native-born college graduates and by roughly 4% for native-born non-college graduates. This result may suggest that college graduates are better equipped to reap the benefits of knowledge spillovers from other high-skilled workers, or it may indicate that foreign and native-born college graduates are not as easily substitutable as many people fear. There may be considerable complementarities in the production process between skilled foreign and native-born workers, so that increasing the flow of skilled foreign workers actually increases the demand for native workers and increases their productivity, wages, and well-being.

Intergenerational transmission

The bulk of the research literature on human capital externalities focuses on interdependencies at a single point in time. Researchers examine external effects of the local human capital level at one period of time on the wage and employment outcomes of given individuals at the same point in time. However, there are likely important effects through intergenerational transmission of human capital [12]. For starters, more highly educated parents tend to produce more highly educated children. Increased educational attainment by a parent creates an external benefit for a child that should be included in the broad definition of a human capital externality. Furthermore, a parent's human capital will indirectly affect the well-being of the child's peers and coworkers later in life through its effect on the child's education. In other words, if more highly educated individuals benefit their contemporaries and if parents' education increases the education of their children, then parents' education will indirectly affect their children's contemporaries.

Because young people are imperfectly mobile, intergenerational transmission of human capital can lead to considerable persistence in human capital levels across cities and regions [12]. Human capital externalities are gifts that keep giving. Even when educated young people move away from their area of origin as adults, they are still likely to create human capital externalities. However, the external benefits will accrue to their new area instead of their origin area.

Inventors

Human capital can also be occupation-specific and industry-specific, and a child is much more likely to enter the same occupation or industry as their parent than an unrelated child selected at random [13]. This includes the choice to become an inventor, with children of inventors being much more likely to become inventors and in the same technology class as their parents [13]. More generally, growing up in an innovative area increases an individual's likelihood of becoming an inventor as an adult, i.e. there is a human capital externality from growing up in an innovative area. Furthermore, local inventors create new production opportunities that increase the local demand for labor and provide external benefits for local workers.

LIMITATIONS AND GAPS

Much is still unknown about human capital externalities. The research relying on natural experiments comes largely from the US, and there is less such evidence for other countries. Very little is known about how localized human capital externalities may be. Do they spill across cities and regions within countries? Do they spill across highly connected countries, as in the EU? How important are the various theoretical mechanisms such as knowledge spillovers, innovation, and imperfect substitutability in production? How mobile are educated workers, and how much of the benefits of human capital externalities accrues to the origin areas that helped create the human capital? How strong is the connection between human capital externalities and entrepreneurship? How have the various effects changed over time?

There are also further issues regarding the externalities created by different types of human capital. STEM graduates appear especially beneficial for generating externalities,

but there may also be differential benefits among non-STEM graduates (for example, business fields might create larger externalities than humanities) and within STEM fields (e.g. computer science and engineering might have greater benefits than zoology and astronomy). Identifying the separate effects of many different areas of learning poses considerable challenges for researchers but has the potential to be very useful for policymakers.

SUMMARY AND POLICY ADVICE

There is still some debate in the research community about the existence and size of human capital externalities, but the bulk of the literature supports the importance of human capital externalities. Working in a locality where a greater share of the population has a college degree is correlated with higher wages and better employment outcomes even controlling for individuals' own education and other characteristics. Studies based on various natural experiments suggest that this positive relationship is causal.

STEM graduates appear to create especially large human capital externalities, perhaps because of their role in innovation, which contributes to the creation of more and better jobs. Public policies that increase the numbers of college graduates, particularly STEM graduates, through higher domestic production of graduates or increased inflows of highly educated foreigners are likely to benefit other nearby workers. For many countries and regions, increasing the production of native STEM graduates likely requires improving primary and secondary mathematics and science education, perhaps by devoting more instructional time and more resources to these areas. Increasing the inflow of skilled foreigners can be achieved in many countries by relaxing or eliminating employment restrictions for these workers and streamlining the administrative process for both foreign workers and firms wishing to hire them.

Acknowledgments

The author thanks anonymous referees and the IZA World of Labor editors for many helpful suggestions on earlier drafts. Previous work by the author contains a larger number of background references for the material presented here and has been used intensively in all major parts of this article [6], [11]. Version 2 of the article updates the figures, includes new material on innovation and inventors, and adds new "Key references" [5], [10], [13], moving previous ones to the "Additional references" section online, where more references have also been added.

Competing interests

The IZA World of Labor project is committed to the *IZA Guiding Principles of Research Integrity*. The author declares to have observed these principles.

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Further reading

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