Do Education and Training Lead to Faster Growth in Cities?

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Most countries make sustained economic growth a principal policy objective. Although many factors contribute to the growth process, recent research has found that educating workers plays an important role. Individuals invest in education because of expected private benefits, such as higher earnings. But such investments can affect the productivity of others as well as the productivity of the person making the investment. For example, the collaborative effort of many educated individuals in a common enterprise may lead to a higher sustained rate of innovation in the design of products. Such knowledge spillovers provide one justification for subsidizing investment in education.

Recently, some economists have suggested an important link between national economic growth and the concentration of more highly educated people in cities. These economists argue that the knowledge spillovers associated with increased education can actually serve as an engine of growth for local and national economies. They also argue that the concentration of people in cities enhances these spillovers by creating an environment in which ideas flow quickly among people.

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AGGLOMERATION ECONOMIES

For some time economists have understood that the level of productivity is higher in large cities than in less densely populated areas because of agglomeration economies.[1] Agglomeration economies occur when a number of economic enterprises locate near one another. This proximity of firms creates externalities that constitute an important source of a firm's productivity.[2] Recently, economists have suggested that the spatial concentration of large groups of educated people may lead not only to a higher level but also to a faster growth rate of productivity in cities than outside them. The dense concentration of educated people in cities permits a great deal of personal interaction, which, in turn, fosters new ideas, products, and processes that may lead to faster productivity growth for urban firms.

Traditional View. Economists believe that agglomeration economies are important for understanding the development and growth of cities. Other things equal, firms' production costs are lower in large cities than elsewhere because large cities offer access to a variety of specialized business services. As new firms enter a city and the size of the city increases, production costs for other firms in the city are lowered because more specialized labor markets are created and specialized firms are allowed to operate more efficiently. For example, these cost reductions entice other firms to either move to or start up in large cities, leading to further cost reductions because of increased agglomeration.

However, urbanization brings not only greater efficiency but also problems, such as congestion, that eventually balance or outweigh the gains in efficiency that increased urbanization allows. And since costs from congestion eventually offset further agglomeration economies, those economies will not be a source of *continuing* growth for any city. In the long run, as a city becomes more congested, traffic and pollution increase, rents rise, and growth slows down. Thus, economists concluded that in the long run, the link between agglomeration economies and congestion leads to differences in the level of productivity across places but that the *growth* rate of productivity will be the same across places.

New View. Recently, some economists have questioned the traditional view that productivity eventually grows at the same rate across places. Comparisons across countries suggest an important link between productivity growth and increased education. Within a nation, the higher density of population and employment in cities promotes educational spillovers that keep productivity in cities growing indefinitely at a rate greater than that outside cities. If so, rising educational attainment may promote continuing rapid economic growth.

The new view of productivity growth focuses on the development of human capital.[3] Human capital refers to people's stock of knowledge and productive skills. Education is one way individuals add to their human capital.

[1]Unless otherwise indicated, the expression "city," "urban," "urban areas," "metropolitan area," and their adjectives are being used to designate a metropolitan statistical area (MSA). MSAs are geographic areas that combine a large population nucleus with adjacent communities that have a high degree of economic integration with the nucleus.

[2]An externality exists when the economic activity of one firm affects, negatively or positively, the economic activity of another. For example, a positive externality occurs when a beekeeper's bees pollinate a nearby apple orchard. The apple orchard produces more fruit, and the bees are able to get nectar to make honey. Therefore, both beekeeper and apple grower benefit.

For a fuller discussion of agglomeration economies, see Gerald A. Carlino (1987 and 1993).

[3]For more on the new view of productivity growth, see Satyajit Chatterjee, "Making More Out of Less: The Recipe for Long-Term Economic Growth," Federal Reserve Bank of Philadelphia *Business Review*, May/June 1994.

People sacrifice some consumption today while they go to school to improve their human capital. In return, they will receive higher lifetime wages, which will allow them to consume more goods and services in the future. Firms are willing to pay higher wages to educated workers because as people acquire more knowledge, they become better workers, which leads to an increase in output. In addition, formal education may also strengthen a worker's ability to learn on the job, setting the stage for a greater or more rapid accumulation of specific job-related skills. Thus, the current productivity of a worker and his income depend partly on his experience and partly on his education. Economists refer to the accumulation of human capital on the job as learning by doing.

Economists argue that individuals continue to invest in education until the expected return from an additional year of education is balanced by the additional cost of obtaining that year of education. This calculation incorporates only the private returns from education. But as individuals accumulate knowledge, they also contribute to the productivity of many other individuals with whom they have contact either directly or indirectly. Thus, the accumulation of knowledge by any one individual has a positive effect on the productivity of others. This effect is referred to as knowledge spillovers.

Many economists think knowledge spillovers are particularly prevalent in cities, where communication among individuals is extensive. The concentration of people and firms in cities creates an environment in which new ideas travel quickly. Economists have identified two types of knowledge spillovers thought to be important for city growth. The first depends on the concentration of firms in the same industry, and the second on the diversity of firms in a given city.

MAR Spillovers. In 1890, Alfred Marshall developed a theory of knowledge spillovers that was later extended by Kenneth Arrow (1962) and Paul Romer (1986); thus, the name, MAR spillovers. According to this view, the concentration of firms in the same industry in a city helps knowledge travel among firms and facilitates the growth of the industry and of the city. Employees from different firms exchange ideas about new products and new ways to produce goods: the larger the number of employees in a common industry in a given city, the greater the opportunity to exchange ideas. For example, many semiconductor firms have located their research and development facilities in the Silicon Valley because the area provides a nurturing environment where semiconductor firms can develop new products and production technologies. In a 1992 article, Edward Glaeser, Hedi Kallal, José Scheinkman, and Andrei Shleifer noted that Silicon Valley's semiconductor firms learn from one another because "people talk and gossip, products can be reverse engineered, and employees move between firms."

A 1992 article in *Business Week* provides numerous examples of "high-tech hot spots" of rapid growth based on the innovation of new products. Examples include development of lasers in Orlando, Florida; the manufacturing of computers and computer chips in Austin, Texas; the development of biotechnology research and medical technology software in suburban Philadelphia; and the development of medical instruments in Minneapolis.[4] According to this article, "America's most innovative big companies, including Corning, Hewlett-Packard, Intel, and Motorola, have located key facilities in the new-growth areas. The goal is to harvest ideas and talent from universities or startups, a key advantage in a global economy where the first to market wins."

Examples are not limited to the United States. In 1990, Michael Porter cited the Italian ceramics and ski boot industries and the German

[4] *Business Week*, October 19, 1992, pp. 80-88.

printing industry, among others, as examples of geographically concentrated industries that grew rapidly through the continual introduction of new technologies. A recent article in the *Wall Street Journal* cited similar examples in the Emilia-Romagna region of northern Italy. In this region, small, mostly family-run businesses have prospered because of the "highly interwoven nature of the enterprises there....Competitors and suppliers cluster together in small geographical areas."[5] For example, there's the "food valley" around Parma, textile producers at Carpi, and manufacturing of motorcycles around Bologna. According to the article, these businesses have developed ties with local schools and universities that provide "just the right training needed by local firms. Academics and business executives collaborate on research and development ...Technical workers with new ideas...start their own companies, each specialized in a niche."[6] All these factors combined have led to innovations that enable these companies to thrive and compete in the international marketplace.

Many cities, however, such as Akron (tires), Pittsburgh (steel), and Detroit (autos), have declined or stagnated in spite of the advantages that specialization entails.

Jacobs Spillovers. In 1969 Jane Jacobs developed another theory of knowledge spillovers, which stressed the importance of diversity within a city. Jacobs believes that the most important type of knowledge transfer does not depend on the concentration of an industry in a given city but is related to the diversity of industries in a city. In Jacobs's view, industrial variety is more important than specialization for city growth, since an exchange of different ideas in more diversified settings takes place. That is, an industrially diverse urban environment encourages innovation. Such areas contain people with varied backgrounds and interests, thereby facilitating the exchange of ideas among people with different perspectives. This exchange can lead to the development of new products and innovations in methods of production. Jacobs contrasts Manchester, England, in the mid-1850s, which specialized in textiles and eventually declined, with Birmingham, England, which was more diverse and eventually prospered.

There are numerous examples of specific spillovers from one industry to another in large cities. Jacobs notes that a San Francisco food processor with a small but growing business introduced equipment leasing when he was unable to find financing for the equipment he needed to expand production. Edward Glaeser and associates (1992) point out that New York City grain and cotton merchants in need of financial institutions started the financial services industry in that city. While these are interesting examples of knowledge spillovers across industries, economists have recently attempted to find more general empirical support for both the MAR and the Jacobs view of spillovers.

WHAT'S THE EVIDENCE?

According to the theory on knowledge spillovers, differences in education across cities result in differences not only in the level of productivity but also in the growth rate of productivity. A growing body of research examines the importance of educational spillovers on productivity growth, both across countries and across cities within a given country. (See *Educational Spillovers: The Cross-Country Evidence*.) We'll look at the evidence across cities in the United States because educational spillovers are thought to be stronger in cities and because the cross-city findings are easier to interpret than are cross-country results.

Several recent studies have attempted to

[5]Maureen Kline, "Tiny Business Enclave in Italy Stares Down Adversity," *Wall Street Journal*, August 18, 1994.

[6]Kline, *Wall Street Journal*, August 18, 1994.

Educational Spillovers: The Cross-Country Evidence

Recent studies have employed various measures of education to proxy for initial human capital. While some studies have found that education has a positive effect on a nation's growth, the evidence is far from conclusive.

Studies That Found a Positive Effect. Robert Barro found that rates of primary and secondary school enrollment in 1960 significantly affected output growth for a sample of 98 countries during 1960-85. Barro's results are not compelling, however, because he also found that enrollment rates for 1950 and 1970 did not significantly affect growth during this period.

Ellis Tallman and Ping Wang focused on the growth experience of Taiwan to examine the effects of human capital on output growth. They developed an index of labor quality (human capital) by weighting workers according to the level of schooling completed (primary school only; primary and secondary school; and primary, secondary, and higher education). They found that using measures of labor quality improved their ability to account for economic growth in Taiwan during the 1965-89 period.

Studies That Found No Positive Effect. In a sample of 69 countries, Paul Romer (1990) looked at whether the literacy rate in 1960 affected growth over the next 25 years. He found that literacy did not significantly affect output once he accounted for the rate of investment in physical capital.

Ross Levine and David Renelt examined correlations between growth and a variety of variables, including human capital measures, typically employed in cross-country studies. They reported that one could find a positive and significant relationship between educational variables and economic growth. However, once the effects of other variables, such as growth of domestic credit, are taken into consideration, the relationship is not statistically significant.

provide evidence of the importance of educational spillovers for cities.[7] A 1993 study by James Rauch establishes the existence of educational spillovers for metropolitan areas in the United States. Rauch looked at how differences in the average level of schooling across metropolitan areas affect otherwise identical workers. Rauch found that a higher average level of human capital in metropolitan areas has external effects that lead to greater productivity. Using data from the 1980 census, he estimates that in metropolitan areas, each additional year of average education increases productivity anywhere from 2 to 3.6 percent.[8]

In another study, Edward Glaeser and David Maré studied two longitudinal samples that tracked male heads of households from 1968 to 1983.[9] They considered the effects on productivity of formal schooling and on-the-job experience for workers living in cities as opposed to those living outside. Glaeser and Maré found mixed evidence that residing in a city raises the return to schooling, but they did find higher returns to work experience in cities, suggesting that spillovers from learning by doing may be

[7]Robert Lucas (1988) was the first to suggest that the average level of human capital within a city could magnify the impact of individual human capital and lead to increased productivity in cities.

[8]Rauch controlled for gender, race, ethnicity, years of schooling, years of work experience, and occupation. One limitation of Rauch's study is that it provides evidence that the *level* of productivity depends on average years of schooling in metropolitan areas. Rauch does not consider the effect of average years of schooling on productivity *growth rates* in metropolitan areas.

[9]Glaeser and Maré employ data from the Panel Study of Income Dynamics Survey, as well as the National Longitudinal Survey of Youths. In the Glaeser and Maré study, the term city refers to the central city of a metropolitan area.

important. For example, they observed that the wage gap between inexperienced workers and workers with between 20 and 25 years' experience is 12.4 percent higher in cities.

The studies by Rauch and by Glaeser and Maré tried to show that educational spillovers exist in cities. Other studies have looked instead at whether spillovers are best explained by the MAR or the Jacobs theory. A study by Edward Glaeser and associates looked at the employment growth of the six largest industries in each of 170 metropolitan areas during the period 1956-87 and found that within-city industrial diversity is positively associated with employment growth of industries in that city, while the concentration of an industry within a city does not foster employment growth. They interpreted these findings as support for Jacobs's theory that knowledge spillovers seem to be important among rather than within industries.

While the work of Glaeser and associates tends to dismiss the importance of the geographic concentration of a firm's own industry, a 1994 study by J. Vernon Henderson uncovered evidence to the contrary. Henderson looked at employment growth in five different manufacturing industries (transportation, instruments, primary metals, machinery, and electrical machinery) at the county level during 1977-87. Henderson found that, in general, these manufacturing industries benefit both from own-industry concentration (MAR effects) and from the diversity of industrial concentration (Jacobs's effects).

Limitations. One problem with the studies by Glaeser and associates and Henderson is that they used industrial concentration and industrial variety in cities as proxies for educational spillovers. However, industrial concentration and industrial variety within a city may be positively associated with growth of employment because they encompass factors other than educational spillovers that lower production costs. For example, the concentration of similar firms in a city allows any one firm to dip into a common pool of specialized workers or products. Industrial diversity demonstrates how firms benefit from the greater variety and services that large cities offer. In other words, many factors other than knowledge spillovers account for the concentration of economic activity in cities. To the extent that industrial concentration and variety reflect the traditional view of agglomeration, these variables will not be useful in identifying the effects of educational spillovers for city firms.[10]

Another limitation of the studies by Glaeser and associates and Henderson is that they look at employment growth in different cities rather than productivity growth. The problem with using employment growth as a proxy for productivity growth is that employment growth in a city will ultimately be halted by congestion even though productivity continues to grow. If productivity growth does benefit from the geographic concentration of knowledge in cities, the faster growth of productivity in cities would be reflected in relatively faster wage growth for city workers and relatively faster growth of profits for urban firms. Within a given country, people and firms will migrate from areas with slow growth rates of wages and profits to cities where wages and profits are growing faster. But migration into cities with faster-than-average productivity growth pushes up residential and commercial rents in those areas. Congestion costs also increase with population. At

[10]A study by Adam Jaffee, Manuel Trajtenberg, and Rebecca Henderson (1993) avoided some of these problems by looking at data on patents sorted by geographic location as evidence of the extent to which knowledge spillovers (via research and development) are geographically localized. They found that U.S. patents were more likely to come from the same state and city as earlier patents than one would expect based only on the pre-existing concentration of research and development activity. They also found that location-specific information disperses slowly from place to place, making geographic access to that knowledge important to firms.

some point the additional costs of increased city size will exceed the additional benefits of larger size. At this point, population and employment stop growing. But productivity can continue to grow in cities, and productivity grows in cities as a result of ongoing educational spillovers. All this suggests that the appropriate measure of growth is related to the growth in output of goods and services per worker and not to employment growth.

There is no direct evidence on whether output per worker increases faster in cities than in nonurban areas. But several recent studies have looked at differences in the growth of per capita income across the United States over the past six decades.[11] These studies found that while the level of per capita income differs across states, per capita income appears to grow at the same rate across states in the long run. These findings do not support the view that educational spillovers lead to permanently faster-than-average productivity and income growth in cities. Per capita income appears to be growing at the same rate in highly urbanized states (such as Massachusetts, where 96 percent of residents live in metropolitan areas) as in the least urbanized ones (such as Wyoming, which has only 15 percent of its population in metropolitan areas).

CONCLUSION

Because education generates spillovers, the additional social benefit of education exceeds the additional private benefit for any given individual. People will ignore these external benefits and, from society's point of view, underinvest in education. This underinvestment provides an important justification for public subsidies to education. Such subsidies encourage people to invest more in education, thereby enabling cities and the nation to reap the social benefits of additional education in terms of higher productivity.

But does investment in education and training lead to permanently faster growth in cities? The bulk of the evidence suggests that knowledge spillovers among workers do increase productivity in cities. But there is no evidence that knowledge spillovers lead to permanently faster-than-average population and employment growth in any given city. Nonetheless, the general concentration of people and firms in urban areas may facilitate the exchange of knowledge among workers and across firms that is so important for sustaining productivity growth in cities and the nation.

[11] See the studies by Gerald A. Carlino and Leonard Mills (1994) and Robert Barro and Xavier Sala-i-Martin (1992).

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