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Good schools make good neighbors: Human capital spillovers in early 20th century agriculture

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ABSTRACT

Formal schooling has a significant impact on modern agricultural productivity but there is little evidence quantifying the historical importance of schools in the early development of the American agricultural sector. I present new data from the Midwest at the start of the twentieth century showing that the emerging public schools were helping farmers successfully adapt to a variety of agricultural innovations. I use a unique dataset of farmers containing detailed geographical information to estimate both the private returns to schooling and human capital spillovers across neighboring farms. The results indicate that public schools contributed substantially to agricultural productivity at the turn of the century and that a large portion of this contribution came through human capital spillovers. These findings offer new insights into why the Midwest was a leader in the expansion of secondary education.

1. Introduction

The emergence of the modern American public education system has been studied extensively. The work of Goldin and Katz (2008) and others has demonstrated the importance of gains in the educational attainment of the national workforce to the growth of the US economy. While there is little dispute about the significant returns to schooling in the first half of the twentieth century and the increasing importance of human capital in a wide range of industries, there is one aspect of the expansion of the educational system and human capital investments that has largely escaped attention, the role of education in the agricultural sector. Despite the Midwest serving as the locus of the high school movement, little attention has been paid to the historical links between education and agriculture. This paper assesses the importance of formal schooling in early-twentieth century agriculture by quantifying both the private returns to education for farmers and human capital spillovers across farms.

The early 1900s was a period in which public education was expanding at a rapid pace and a period which, while preceding the dramatic biological advances in agriculture of the 1930s and 1940s, witnessed a wide range of important agricultural innovations. Public schools offered a channel to disseminate information on innovations from the growing agriculture programs at land-grant colleges, providing farmers with a new way to accumulate productive human capital. Investment in formal schooling had the potential to lead to significant private returns for farmers. Beyond the private returns to education, there was a very public aspect to education at the time. The ways in which a farmer's education translated into more productive practices were highly observable by neighbors. An educated farmer's successful practices could be copied by his neighbors, making the social returns to a farmer's schooling larger than simply his private returns.

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I use a newly constructed dataset containing income, education and a variety of detailed spatial data for a sample of Iowa farmers to estimate the income gains both from an increase in a farmer's own education and from increases in the educational attainments of his neighboring farmers. The detail of the data allows for estimates of human capital spillovers not just between neighbors but also within and across various social networks. The results demonstrate that there were large returns to formal schooling for farmers and that adjacent neighbors shared in those gains.

These estimates of the private returns to education and human capital spillovers for farmers reveal that even prior to the major agricultural innovations of the mid-twentieth century, formal schooling played an important role in increasing farmers' earnings. The substantial private and public returns to education suggest that there were large social gains from the Midwest's aggressive introduction of public graded schools and high schools in the early twentieth century. These findings shed new light on the forces underlying early public school expansion in the United States and on the potential importance of public schooling in modern developing countries with large agricultural sectors.

2. Human capital, schooling and agriculture

Human capital plays an important role in modern agriculture, helping farmers use a chosen set of inputs efficiently and improving a farmer's ability to choose between different sets of inputs, outputs and technologies. The existing literature offers mixed evidence of just how valuable human capital is, particularly human capital acquired through formal schooling. In a survey of 22 different studies conducted around the world, Jamison and Lau (1982) find that the returns to an additional year of schooling varied from negative 3% to positive 6%.[1]

These studies typically find that a farmer's formal schooling has little effect on the ability to use a given set of inputs efficiently (Huffman, 1999). Where studies do find high returns to formal school are situations in which a farmer must choose between different sets of inputs, outputs and technologies. In these settings, schools provide a channel through which the latest agricultural science can be disseminated. Beyond this direct effect of schools increasing a farmer's stock of knowledge, studies suggest that more educated farmers are more likely to seek out new information even after their schooling is completed. Wozniak (1993) examined innovations in livestock feeding in Iowa and found that more educated farmers were more likely to contact extension agents for information about new technologies. Bindlish and Evensen (1997) find a similar result when looking at extension programs in Kenya and Burkina Faso. In both countries, more educated farmers were more likely to participate in extension services and seek out information from other farmers, leading to educated farmers learning about and adopting new technologies earlier than the less educated farmers. The authors suggest that educated farmers have a greater appreciation for new information and higher expectations of the benefits of that information.

These studies are consistent with the framework put forth by Welch (1970) in which increased education has worker effects and allocative effects on productivity. The worker effects in the context of agriculture consist of the increased productivity of an educated farmer using a given set of inputs and technologies more efficiently. As Welch notes, while it is conceivable that more education could make a farmer better able to operate a tractor or pick crops, most of the benefits from education in agriculture will come from allocative effects, the abilities of an educated farmer to choose a better combination of inputs and production technologies in order to achieve greater production.[2]

In the studies cited above, education translated into these allocative effects on productivity by exposing farmers to new technologies. However, additional formal schooling not only helps farmers learn of new technologies, it also makes them more likely to experiment with and successfully adopt new technologies. Evidence from the adoption of crossbred-cow technology in Tanzania, the introduction of hybrid rice in China, and the use of growth hormones and feed additives in Iowa all demonstrate a positive relationship between a farmer's level of education and his probability of adopting new technologies (Abdulai and Huffman, 2005; Lin, 1991; Wozniak, 1993).

The magnitude of the productivity gains arising from these roles of education in helping a farmer acquire and successfully utilitize new information will be highly dependent on the level of change and innovation in the agricultural sector. This is a point emphasized by Schultz (1975) in his discussion of the role of education in dealing with disequilibria. Schultz argues that better educated workers are more capable of efficiently reallocating resources in response to changing economic conditions. Agricultural studies dominate the evidence Schultz cites in support of the view that education becomes increasingly important in periods of disequilibria. More recent evidence can be found in the work of Foster and Rosenzweig (1996) in which returns to schooling rose with increases in the rate of technological advances during the Green Revolution in India. In cases where there is a great deal of uncertainty in either the benefits of the new technologies or in the optimal way to use them, the ability to experiment and adapt to technologies takes on added importance. Munshi (2004) studies technology adoption during India's Green Revolution and finds that experimentation by farmers on their own land was quite important for rice growers, where significant heterogeneity in growing conditions existed and unobserved characteristics were important, but less relevant for wheat production where useful information could be obtained through social networks, something that will be discussed in the next section. Formal education, to the extent that it improves the ability to acquire information and experiment, takes on additional importance when both

[1] For an overview of these and other studies estimating the return to schooling for farmers, see Jamison and Lau (1982), Huffman (2001) and Huffman and Orazem (2007).

[2] Section 4 will argue that there was a strong role for allocative effects in Iowa at the turn of the century due to major advances in agricultural technology. The large returns to education for farmers presented in Section 6 therefore seem to be consistent with Welch's conclusions. However, because earnings for farmers are observed but inputs, outputs and production technologies are not, I cannot rule out that some portion of those returns to education are actually coming through worker effects.