Heterogeneous returns to education over the wage distribution: Who profits the most?∗

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ABSTRACT

This study presents evidence of heterogeneous returns to education over the wage distribution. The authors use instrumental variable quantile regression and data from the Swiss Labor Force Survey to identify the causal link between education and wages at different quantiles of the conditional distribution of wages. The results provide evidence that there is no unique causal effect of schooling and that for each individual the effect may deviate from those extensively documented by ordinary least squares or two-stage least squares. In particular, while ordinary quantile regression estimates increasing returns in the quantile index, once the endogeneity of schooling is taken into account the authors instead observe higher returns at lower quantiles of the wage distribution. Interpreting the quantile index as a measure of unobserved ability, the results suggest that higher-ability individuals have higher wages, but the slope of their wage-education profile is flatter than that for lower-ability individuals.

1. Introduction

Although a positive relationship clearly exists between schooling and wages (Dickson and Harmon, 2011), the question of whether education affects individuals differently over the wage distribution is much less thoroughly understood (Wang, 2013). Moreover, in reference to a distributional setting, the literature has not investigated whether different types of education result in differing returns, or whether one type of education—vocational or academic—leads to a return premium rather than the other at some point of the wage distribution. These questions are particularly critical because the lack of information on educational tracks may lead to costly decisions for both individuals and governments (Bettinger and Baker, 2013).

To address these gaps, in this study we first causally estimate the returns to education over the wage distribution. The analysis reveals potential heterogeneous effects of education on wages, answering the question of whether the returns are increasing, decreasing, or u-shaped across the conditional quantiles. Second, we compare the returns to one extra year of academic education with the returns to one extra year of vocational education to investigate whether one track results in a return premium at any point in the wage distribution. Such a comparison is lacking in the literature because most countries do not manage extensive vocational education and training systems that allow one to acquire the same quality of education over the same number of years as in the academic track or because the academic track is more prestigious or preferred over the vocational one (Bettinger et al., 2010).

The analyses that we propose address the following two major issues that are common for estimations of returns to education: the endogeneity of education attainment (Harmon et al., 2006) and heterogeneity in the returns to education (Henderson et al., 2011). While theoretical research considers both issues simultaneously, empirical work often only addresses one issue at a time (Arias et al., 2001; Card, 2001). To overcome endogeneity problems, most scholars use instrumental variable estimation (Angrist and Krueger, 1991; Dickson, 2013; Harmon and Walker, 2000; Trester et al., 2002). However, in addressing heterogeneity issues, the literature has not converged towards a standard method (Lemieux, 2008). This lack of convergence has arisen from the fact that no standard definition of heterogeneity exists and different approaches examine different forms of heterogeneity.

In this paper, we are interested in how the effects of education vary across the conditional wage distribution, i.e., the distribution of wages within a group of people with the same characteristics. This type of heterogeneity can be analyzed through quantile regressions (Bitler

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et al., 2006). In the quantile regression (QR) framework, we can assess the impact of schooling on each quantile of earnings, conditional on specific values of the other covariates considered. Using this approach, we estimate the within-group heterogeneity in returns to education where the groups are defined by the covariates included in the model. This sort of heterogeneity is directly related to theoretical models of human capital investment (Arias et al., 2001; Hartog et al., 2001) and can be studied in an instrumental variables setting, thereby also addressing the issues of endogeneity (Chernozhukov and Hansen, 2013). Other types of heterogeneity concern return differentials based on observable characteristics, such as gender (Harmon et al., 2003; Henderson et al., 2011), or the presence of unobserved heterogeneity in the average returns to schooling (Koop and Tobias, 2004). These other forms of heterogeneity are not the focus of the present study.

The use of QR in returns to education studies has been limited for several years because the endogeneity problem in QR models has not been solved. However, recent studies by Chernozhukov and Hansen (2008, 2013) propose an instrumental variable quantile regression (IVQR) approach that addresses both heterogeneity and endogeneity simultaneously. Although the IVQR method has been applied in many research fields in economics (Atella et al., 2008; Autor et al., 2012; Eren, 2009; Lamarche, 2011; Maynard and Qi, 2009; Webby et al., 2009), it is relatively new to the returns to education literature.

Exploiting a major education reform introduced in Switzerland in the 1970s, we use IVQR to causally estimate returns to education over the conditional quantiles of earnings, and we compare our results with standard QR and mean regression estimates to determine whether taking endogeneity into account changes the results and conclusions. Then, we distinguish between educational paths to draw comparisons between and within academic and vocational education. In this second comparison, we focus on the conventional QR results because a strong instrumental variables strategy for studying vocational and academic education separately has not yet been developed.

Our results provide evidence of a high level of heterogeneity in causal returns to education, underscoring the importance of identifying systematic differences across conditional quantiles of earnings and not only the effects at the mean. We present the novel empirical finding that while ordinary QR estimates increase returns in the quantile index, once the endogeneity of schooling is considered, higher returns at the lower quantiles of the conditional wage distribution are observed. Our estimates have the following specific interpretation: low-earning individuals earn more than low-earning individuals with marginally less education (and the same observable characteristics), whereas high-earning individuals earn almost the same as high-earning individuals with marginally less education (and the same observable characteristics). This is the nature of the interpretation of conditional quantiles, which does not necessarily imply that individuals with low wages generally have higher wages than they would have had with less education.

We also find significant levels of heterogeneity within the academic and vocational tracks, and comparing these two paths shows that academic education does not always yield higher returns. In the upper half of the conditional wage distribution, individuals with an academic background have higher returns than individuals with a vocational background. However, at the lower quantiles of the conditional wage distribution, vocational education leads to higher returns than academic education, suggesting that determining which type of education has larger returns is not as easy as it might appear from descriptive statistics or mean regressions.

The remainder of this paper proceeds as follows. Section 2 provides an overview of the theoretical background related to our research questions. Section 3 introduces the data set used and presents some descriptive statistics. Section 4 describes the econometric models in greater detail. Section 5 presents the results, and Section 6 presents the conclusions.

2. Background

In this section, we briefly present a theoretical background and empirical evidence to explain the mechanisms of individual education choices and provide a structure for our empirical analysis. We follow the theoretical model developed by Card (1999); as its most interesting feature, this model considers both heterogeneity in returns and the endogeneity of education attainment in the wage equation simultaneously.

Following Card, we assume that an individual chooses his level of education to maximize the following utility function defined over wage and years of education:

\[ U(w, S) = \ln(w) - f(S) = \ln[g(S)] - f(S) \]

where \( g(S) \) and \( f(S) \) are increasing convex functions that represent the benefits and costs of schooling, respectively. Condition \( w = g(S) \) captures the observable relationship between wages and schooling, i.e., the level of wages available at each level of education. The first order condition for the optimal level of schooling is:

\[ g'(S)/g(S) = f'(S) \]

At the optimum, the marginal rate of return to education equals the marginal cost. The individual heterogeneity of an optimal education choice arises from the following two sources: differences in the cost of education, which is represented as the variation in \( f(S) \), and differences in the monetary benefit of education, which is represented as the variation in \( g'(S)/g(S) \).

To make the model operational, we assume that (log-)wages is a linear function of schooling that may vary across individuals. Card and Krueger (1992), Heckman and Polachek (1974), and Hungerford and Solon (1987) present evidence suggesting that wages are log-linear with respect to schooling. Most importantly, in relation to our case, Park (1994) finds log-linearity to be a good approximation of the wage-schooling relationship for several quantiles of the wage distribution. We thus apply the following functional form to the heterogeneity components:

\[ MB_i = g'(S)/g(S) = b_1 - k_1 SMC_i = f'(S) = k_1 + k_2 S_i \]

where \( b_1 \) and \( r_i \) are random variables with some joint distribution across the population \( i = 1, 2, \ldots \) and \( k_1 \) and \( k_2 \) are non-negative constants. To derive an equation for the natural logarithm of wage, we integrate the expression for the marginal rate of return to education with respect to \( S_i \):

\[ \ln(w_i) = a_i + b_i S_i - \frac{1}{2} k_1 S_i^2 \]

where \( a_i \) is an individual-specific constant of integration.

The purpose of this study is to determine how to most closely reflect the individual return to education as theorized in the Card model. Although the Card model is a generalized version of Mincer’s equation (Mincer, 1974), Card’s model cannot be estimated directly because this would involve estimating the individual return to education. Therefore, Card’s model must be approximated using a Mincer-like equation (Arias et al., 2001; Ashenfelter and Rouse, 1998). In our paper, we use conditional (IV)QR to estimate a Mincer-like equation and thereby most closely reflect individual returns among people with the same characteristics. Indeed, the most salient feature of Card’s model is that individual heterogeneity potentially affects both the intercept of the wage equation (through \( a_i \)) and the slope of the wage-education relation (through \( b_i \)).
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