Post-Secondary Education and Non-Linear Income Growth

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Abstract. The paper examines the potential income growth in response to increasing levels of post-secondary educational attainment in the United States. Using statewide data, the analysis indicates that as greater post-secondary attainment is achieved, the influence on income growth is positive and non-linear.

Keywords: educational attainment, income, education, income growth, educational policy

1. Introduction

The link between education and income has come under increased scrutiny as societies struggle with budgets and competing policy considerations. While interest has been renewed, the topic has a long history in research. Adam Smith (1977) observed the significance of a skilled workforce in driving productivity. The acquisition of skills and the corresponding increase in human capital has been an area of continual research. These efforts only accelerated after the emergence of modern growth theory (Solow, 1957; Romer, 1990) as a connection is shown between productivity increases and higher long-term economic growth. Prominent economist spent their careers examining the

linkages between the human capital and economic growth, wage growth, and higher standards of living (Mincer, 1958: Shultz, 1961; Becker, 1964). While dissenting views remain, current research continues to show relationships between human capital and economic growth (Knight and Sabot, 1990; Gemmel, 1996).

Gains in productivity are the mechanism which translates educational investments into higher human capital stocks and economic growth (Mankiw, Romer and Weil, 1992; Cohen and Soto, 2007; Hanushek and Wobmann, 2007; Gilead, 2012). Economies with low skills and a poorly educated populace must increase educational investments in an effort to gain economic growth (McClelland, 1966). Education provides the poor with economic opportunity and a method to achieve significant increases in standard of living (Blanden and Machin, 2004).

The development of human capital, through educational investment, is a major determinant of economic growth. Barro (2001) studies the effect of education and economic growth and shows that economic growth is positively related to average years of school attainment, as measured by males achieving secondary or higher levels of education. Barro (2001) and Ranis et al. (2000) also show the relationship between education and economic growth are co-dependent and self-reinforcing. Advances in economic growth fuels better education, which further fuels increases in economic growth. Beyond the increases in economic growth, education and increases in human capital provide benefits which include positive social returns and externalities (Sianesi and Van Reenen, 2003; Bils and Klenow, 2000).

As economies around the globe become more knowledge-based, the importance of education increases. Education is critical in a post-industrial economy (Dickens et. al, 2006). Once educational investments are made and the economy grows, individuals are rewarded with higher incomes and increasing standards of living (Krueger and Lindahl, 2001; Alam 2009).

The findings associating education and economic growth are not completely uniform. A minority of research finds no significant relationship between human capital and economic growth (Benhabib and Spiegel, 1994; Pritchett, 2001). Holmes (2013) finds no relationship between higher education and GDP growth, while Jiminez (1986) finds no link between public educational expenditures increasing the incomes of poor.

Understanding the link between education and income in the United States is of particular importance due to the funding of post-secondary education. In the United States, a significant portion of post-secondary education is funded by the individuals consuming the education. Individuals are willing to carry a large share of the cost because of the income incentive. Individuals acquire education to increase their income potential, which at the same time provides greater human capital for economic development and higher standards of living. This is not to suggest that all educational endeavors are profit- seeking activities, but that that in general, education is seen as a way to lift an individual's standard of living.

Educational investment driven by income potential is widely accepted and incorporated in human capital literature. The individual incentive for education is predicated on the financial risk assumed in obtaining an education based on the cost and expected income return (Levhari and Weiss 1974; Williams 1979; Snow and Warren 1990). The expectation of a higher income return will induce further educational attainment and increase human capital. These efforts foster higher levels of economic development and societal welfare (Levhari and Weiss 1974; Williams 1979; Snow and Warren 1990).

Some research has shown evidence of a reduction in the rate of income growth associated with higher educational achievement (Schmitt, 2005; Schmitt and Jones, 2012). If income growth associated with education slows, there is the risk of a reduction in the rate of growth in educational attainment and subsequent growth rate. This study adds to previous research by examining

income levels associated with post-secondary education at the statewide level.

2. Data

The study includes statewide data (50 states plus Washington D.C.) collected from 2001 through 2010. While additional years of the data were sought, the source provided only limited data. State Gross Domestic Product (GDP) data are collected from the Bureau of Economic Analysis (BEA)1 website, and are represented in nominal terms. The state income data are extracted from the Bureau of Labor Statistics (BLS)2 website, and represents the average annual pay in nominal dollars. The state demographic terms of gender and race are also collected from the BLS3 website. These data represent the percentage of the civilian workforce which are men and the percentage of the civilian workforce which are white. The educational data are from the American Community Survey (ACS) program of the U.S. Census4 and represent the percentage of the population which has a Bachelor's degree or higher.

Table 1

Descriptive Statistics (statistics of observations, not weighted for population size)					
	Obs.	Mean	Std. Dev.	Min.	Max.
Income ($ nominal)	510	38,924.3	8,078.6	25,195 [1]	80,200 [2]
State GDP ($ mil. nominal)	510	246,748.3	298,970.8	18,744 [3]	1,900,463 [4]
% Workforce Men	510	53.1	1.9	48.3 [5]	57.2 [6]
% Workforce White	510	83.1	13.2	20.0 [7]	98.4 [8]
% Pop. With Bachelors Degree or Higher	510	27.0	5.5	15.1 [9]	50.0 [10]

[1] Montana, 2001

[2] Washington D.C., 2010

[3] Wyoming, 2001

[4] California, 2008

[5] Washington D.C., 2007

[6] Utah, 2008

[7] Hawaii, 2007

[8] Maine, 2001

[9] West Virginia, 2005

[10] Washington D.C., 2010

The study evaluates the impact of education on statewide income. In this

manner, the study is significantly narrower in scope than the previously cited studies. The first step on this path of research is to determine if the potential exists for a non-linear relationship with control variables and determine its possible shape. If non-linear nature is observed, future research can begin to ascertain casual links, sources, and implications of this effect. This study only attempts to understand if the potential exists for the relationship between income and education to be non-linear which may have been assumed in the prior research, but is not specifically identified.

At the statewide level, income is evaluated with respect to levels of post-secondary education. Statewide demographics data are included as independent variables. State GDP and lagged state income are added as control variables. The available data is insufficient to attempt causality. Given the limitations, influences not specifically accounted for in the model are captured by demographic and control variables, and an attempt is made to better understand the correlation between income and education.

3. Methodology

A regression model is constructed to test influences on statewide incomes. As a balanced panel data set, the data is analyzed using a fixed effects model to control for yearly and state specific influences. As yearly influence is controlled as a matter of model selection, nominal terms are appropriate for the independent variables. State incomes are examined as the dependent variable while influences such as state GDP, lagged incomes, state gender ratio, state racial ratio, and educational attainment are used as independent variables.

A linear relationship between education and income is not imposed on the model. Rather, the potential for non-constant returns to education is assessed. The educational term (% population with bachelor's degree or higher) is squared and cubed within the model. The choice of a cubic function is chosen as it allows for a generally increasing trend, consistent with prior studies, while

also allowing for points of inflection and altered rates of income growth with respect to educational attainment.

The basic structure of the fixed effect models is as followings:

Figure 1

$$Q_{i,t} = \beta_0 + \sum_{v=1,t}^{7} \beta_v (X_{v,i,t}) + \varepsilon$$

i = State; t = Time (year); v = Independent Variables

Q: Income

X: State GDP, Lagged Income, % Civilian workforce male, % Civilian workforce white, % Population with bachelor's degree or higher, (% Population with bachelor's degree or higher X 100)^2, (% Population with bachelor's degree or higher X 100)^3
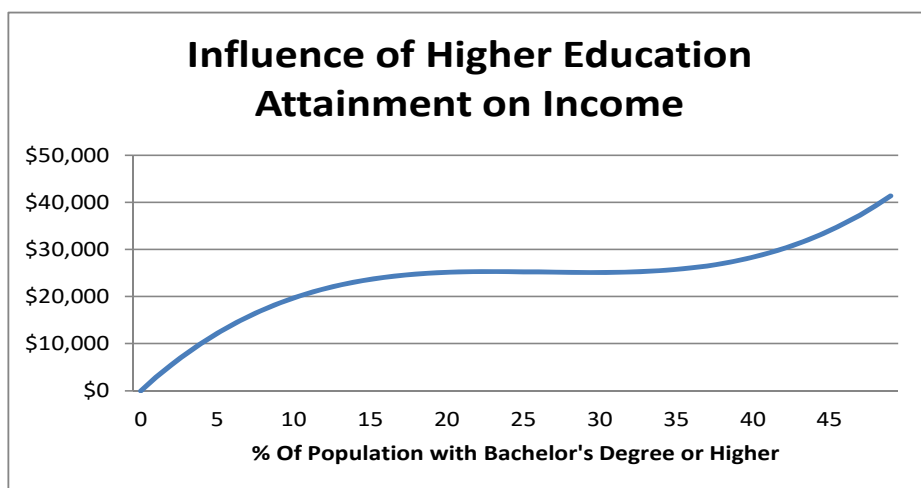
4. Results

The detailed results are provided in Table 2 of the Appendix. The results confirm the importance of the control variables. State economic output is correlated with income levels as indicated by the coefficient of the state economic being positive and highly significant. The coefficient of state GDP is small. However, when the coefficient is applied to the entire nominal state GDP, the influence on income is large. The income of prior years is also shown to be correlated with current income. The coefficient of the lagged income variable is positive and highly significant. Prior year income and state GDP are both large influences on current income levels.

The coefficients of both the gender and race variables are insignificant. It is important to note that these variables are statewide characteristics. The variation found in these variables is relatively modest, which makes finding

significance difficult. Additionally, as a statewide variable, these results should not be extrapolated to individual results. Considerable research has been conducted on the potential for individual income bias and is well beyond the scope of this study.

The major finding is the significance and alternating signs of the educational variable coefficients. The coefficient of the educational variable is positive and significant. The coefficient of the squared educational variable is negative and significant. Finally coefficient of the cubed educational variable is again positive and significant. The alternating signs of educational variables provide a strong indication of a non-linear income growth with respect to the educational attainment. This influence is graphically illustrated in Figure 2 (scaled 0 to 50% educational attainment).

Figure 2

The overall trend of higher education on income growth is positive, thus being consistent with early research. However, the results further indicate that the influence is not constant and that rates of income growth influence vary across the attainment spectrum of post-secondary education5. The results

indicate larger income benefits at the early stages of attainment of post-secondary education. However, income growth slows in the middle ranges (approximate 15% and 35%) of educational attainment. After this period, income levels again begin to accelerate. While this non-linear phenomenon may have been assumed prior, this study identifies the effect and illustrates its influence.

5. Conclusions

The results suggest a non-linear correlation between income and post-secondary educational achievement. Additional research is needed to confirm the results and help establish the exact shape and structure of this effect. If the educational influence on income growth is non-linear, periods of diminished income growth is likely. This finding allows for potential consistency of seminal works linking education and income with recent studies showing slow income growth related to education.

   The results suggest the need for flexibility in education policy. To maintain consistent increases in educational attainment, more efforts are required during periods of slowing income growth. As income growth slows, incentives are altered and educational attainment growth might suffer. A rigid educational policy, rather than flexible policy, is likely to have periods of inefficiency and ineffectiveness in a changing incentive landscape.

   Finally, the source of non-linearity must be tested and better understood. It is possible that the economy needs an adjustment period as it shifts towards a knowledge base in order to accommodate and absorb greater numbers of higher educated individuals. This type of structural economic transformation may require time and represent the period of diminishing income growth. Additional research is required to ascertain the source of this non-linear effect.

Endnotes

[1]Bureau of Economic Analysis (BEA) website. www.bea.gov. (http://www.bea.gov/iTable/iTable.cfm?ReqID=70&step=1) Data extracted July 11, 2012. Data is statewide GDP in nominal millions of dollars.

[2]Bureau of Labor Statistics (BLS) website. www.bls.gov. (http://data.bls.gov/pdq/querytool.jsp?survey=en). Data extracted July 12, 2012. Data is statewide wages in nominal dollars (QCEW program). The data is retrieved under conditions: total all industries, total covered (all public and private), all establishment sizes, and average annual pay.

[3]Bureau of Labor Statistics (BLS) website. www.bls.gov. (http://www.bls.gov/lau/ptable14full2011.pdf). Data extracted July 18, 2012. Data is statewide percentage of civilian labor force that is male, and the percentage of civilian labor force which is classified as white.

[4]U.S. Census Bureau (www.census.gov). (http://factfinder2.census.gov). 1 year estimates. Data extracted July 19, 2012. Data is statewide percentage of civilian, noninstitutional population with a Bachelor's degree or higher.

[5]Washington D.C. has a smaller population size than many states and yet is given equal weight in the study. Additionally, it maintains a highly educated population with high relative wages. As a potential outlier, the results were completed a second time without the inclusion of these data points. The results remained consistent.

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Appendix

Table 2

	Dependent:		Income	
	Fixed Effects			
	# of Obs.		459	
	F(57,393)		2366.96	
	Prob>F		0.0000	
Variable	Coef.	Std Error	t	p value
gdp	0.00238	0.00060	3.96	0.000 ***
lagged income	0.85715	0.02577	33.26	0.000 ***
men %	5.048	14.853	0.34	0.734
white %	0.743	13.855	0.05	0.957
education	659.075	318.337	2.07	0.039 **
education ^2	-23.275	10.250	2.27	0.024 **
education ^3	0.27492	0.107	2.57	0.011 **
Intercept	-2691.69			

Statistical Significance: 1% ***, 5% **