Mathematical Theory and Modeling
ISSN 2224-5804 (Paper) ISSN 2225-0522 (Online)
Vol.4, No.11, 2014

A Structural Equation Model of Tertiary Academic Achievement and Individual Private Returns

Allexander Muzenda
Department of Research and Publications, Regenesys Business School; South Africa
E-mail of corresponding author:alexmuzenda02@gmail.com

Abstract: The primary objective of this study was to estimate individual private returns to tertiary academic achievement based on the classical human capital model. Using non-random sampling method, a structured questionnaire was used to collect data from relevant participants. A reduced form Structural Equation Model (SEM) in STATA 12 was applied to estimate individual private returns to tertiary academic achievement. The computed results show that both tertiary academic achievement and college ranking have sizable effects on individual incomes; while tertiary academic achievement further has a significant impact on employment prospects. Congruently, employment prospects and individual incomes exhibit substantial endogenous positive impacts on tertiary academic achievement. The reduced form estimates of the SEM show that grade point average (GPA) and college ranking have significant positive impacts on tertiary academic achievement, employment prospects and individual incomes.
Keywords: tertiary, academic, achievement, private returns, Structural Equation Model

1. Introduction

The theme of individual private returns to tertiary educational achievement occupies the center stage in the realm of private human capital investment. From a macro-perspective, Quang (2012) specifies that the achievement of a tertiary qualification remains a powerful instrument that provides human beings with competent skills and knowledge which enhance economic growth and development. From the realm of labour market dynamics, tertiary academic achievement enhances an individual's prospects for formal sector employment. At global level, education is largely considered as the single most significant instrument of an individual's economic and social achievement. By its very nature, tertiary education provides both direct and indirect benefits for the individual who achieves the tertiary qualification and the society within which the respective individual participates in productive activities. At national level, achievement of tertiary qualifications by the majority citizens significantly contributes towards the government's efforts to alleviate poverty (Kifle, 2007).

In context of South Africa, the government has made remarkable progress towards establishment and mandating certain institutions with the constitutional mandate to ensure quality assurance and quality promotion in higher education. For example, Section 5(1)(c) of the Higher Education Act (1997) mandates the Council on Higher Education (CHE)/Higher Education Quality Committee (HEQC) with the responsibility to promote quality and conduct quality audits in tertiary education institutions in the country.

The rest of this paper is organized as follows: Section 2 provides literature and theoretical framework on the individual private returns to tertiary academic achievement. Section 3 provides the econometric methodology for empirical analysis. Section 4 presents and analyses the results; while Section 5 provides concluding remarks and recommendations.

2. Literature and Theoretical Framework

Borrowing from the human capital framework, individual private investment in tertiary education remains an effective mechanism for knowledge acquisition and enhancement of individuals' productive capabilities. According to Ehrenberg & Smith (2006) and Checchi (2006), an individual's decision to achieve tertiary education borrows from the objective to maximize private returns in form of permanent higher life cycle incomes. Furthermore, Paulsen & Toutkoushian (2006b) suggest that individuals are deemed to have made rational decisions only if their choices of resource allocation between tertiary education achievement and consumption on other goods maximize their individual utility subject to their unique preferences.

According to the random utility model, a rational individual spends towards acquisition of tertiary education achievement if the expected level of utility from tertiary education achievement exceeds utility from the consumption on other goods. Therefore, the decision making process operates as a comparison of utility values specified by the formulation:

$$u_{it} \equiv \upsilon\left(p_t, y_i, \varepsilon t\right) \qquad \text{---------- (1)}$$

Where: u_{it} denotes the utility value attained by individual i in tertiary education (t), depending on price (p_t) and individual income (y_i). The parameter ε_{it} is the error term that varies over alternatives and individuals. Provided the error term is additive, a rational individual chooses the alternative t (tertiary education) over alternative g (other goods) if:

$$u = (p_t, y_i) + \varepsilon_{ig} \geq u(p_g, y_i) + \varepsilon_{ig} \quad \text{---------- ------ (2)}$$

Where: $u(\bullet)$ is the deterministic term and ε_{ig} is the stochastic term of the utility function $\upsilon(\bullet)$.

Extending further from equation (2), tertiary education is deemed lucrative if the present discounted value of its benefits exceeds the present discounted value of its direct costs plus the consumption forgone during the period of tertiary education (Paulsen & Toutkoushian, 2008).

$$\sum_{t=\phi}^{T} \frac{E_t^{ter} - E_t^h}{(1+i)^t} > \sum_{t=1}^{\phi} \frac{C_t}{(1+i)^t} + \sum_{t=1}^{\phi} \frac{E_t^h}{(1+i)^t} \quad \text{---------- (3)}$$

$$\sum_{t=\phi}^{T} \frac{E_t^{ter} - E_t^h}{(1+r)^t} = \sum_{t-1}^{\phi} \frac{C_t}{(1+r)^t} + \sum_{t=1}^{\phi} \frac{E_t^h}{(1+r)^t} \quad \text{---------- (4)}$$

The symbol i in equation (1) represents the market interest rate used to discount the value of future streams costs and benefits; r (equation (2)) signifies the internal rate of return on private investment, which equals the interest rate that equates the present discounted value of the benefits of tertiary education; $(E^{ter} - E_t^h)$ denotes the incomes differential between tertiary and high school education; C_t denotes direct cost of education and ϕ is some value.

3. Econometric Methodology

3.1 Data

The data used for this study was collected from two levels; individual level and academic institutional ranking level. The non-probability sampling technique was used to collect data on participants using a standardized questionnaire. The data covered tertiary education achievement, grade point average (GPA), employment prospects, individual income and college ranking. From the total 110 questionnaires distributed, 89.1% were returned fully completed. Data on college ranking was collected based on the perceived ranking of the tertiary institution in respect of research output, infrastructure and academic programmes recognition.

3.2 Econometric Estimation

A Structural Equation Model (SEM) was applied to estimate both structural parameters and reduced form estimates of the systems of equations analyzing the individual private returns to tertiary academic achievement. The systems of equations were formulated as below:

$$\begin{aligned} Y_1 &= \alpha_0 + \alpha_1 Y_3 + \varepsilon_1 \\ Y_2 &= \beta_0 + \beta_1 Y_3 + \beta_2 X_1 + \varepsilon_2 \\ Y_3 &= Y_1 + Y_2 + X_2 \end{aligned} \quad \text{---------- (1)}$$

where: Y_1 denotes employability success; Y_2 represents earnings; Y_3 symbolizes educational attainment; X_1 represents college quality; X_2 symbolizes grade point average (GPA). Variables Y_1, Y_2 and Y_3 are endogenous variables; while X_1 and X_2 are predetermined variables. Representing structural parameters by $\beta's$ in respect of endogenous variables; $\gamma's$ are attached to predetermined variables; while the endogenous and exogenous variables are represented by $Y's$ and $X's$; respectively.

Using the conventional notation; ignoring intercepts, the structural system reduces to:

$$\begin{aligned} Y_1 &= \beta_{13}Y_3 + \varepsilon_1 \\ Y_2 &= \beta_{23}Y_3 + \gamma_{21}X_1 + \varepsilon_2 \\ Y_3 &= Y_1 + Y_2 + X_2 \end{aligned} \quad \text{---------- (2)}$$

Transferring observable variables to the LHS, the standardized structural parameters become:

$$\begin{aligned} Y_1 + 0Y_2 - \beta_{13}Y_3 + 0X_1 + 0X_2 &= \varepsilon_1 \\ 0Y_1 + Y_2 - \beta_{23}Y_3 - \gamma_{21}X_1 + 0X_2 &= \varepsilon_2 \\ -Y_1 - Y_2 + Y_3 + 0X_1 - X_2 &= 0 \end{aligned} \quad \text{---------- (3)}$$

System (3) yields the matrix for the standardized structural model coefficients given by:

$$\begin{bmatrix} 1 & 0 & -\beta_{13} & 0 & 0 \\ 0 & 1 & -\beta_{23} & \gamma_{21} & 0 \\ -1 & -1 & 1 & 0 & -1 \end{bmatrix} \quad \text{---------- (4)}$$

Solving the system above to obtain the reduced form model, the structural system of endogenous variables was solved in terms predetermined variables, structural parameters and disturbances:

$$\begin{aligned} Y_1 &= \frac{\alpha_1\beta_1}{1-\alpha_1-\beta_1}X_1 + \frac{\alpha_1}{1-\alpha_1-\beta_1}X_2 + \frac{\varepsilon_1 + \alpha_1\varepsilon_2 - \beta_1\varepsilon_1}{1-\alpha_1-\beta_1} \\ Y_2 &= \frac{\beta_2(1-\alpha_1)}{1-\alpha_1-\beta_{1\,1}}X_1 + \frac{\beta_1}{1-\alpha_1-\beta_1}X_2 + \frac{\varepsilon_2 + \beta_1\varepsilon_1 - \alpha_1\varepsilon_2}{1-\alpha_1-\beta_1} \\ Y_3 &= \frac{\beta_2}{1-\alpha_1-\beta_1}X_1 + \frac{1}{1-\alpha_1-\beta_1}X_2 + \frac{\varepsilon_1 + \varepsilon_2}{1-\alpha_1-\beta_1} \end{aligned} \quad \text{---------- (5)}$$

Denoting the reduced form structural parameters by $\pi's$ yields:

$$\pi_{11} = \frac{\alpha_1\beta_2}{1-\alpha_1-\beta_1} \qquad \pi_{12} = \frac{\alpha_1}{1-\alpha_1-\beta_1}$$

$$\pi_{21} = \frac{\beta_2(1-\alpha_1)}{1-\alpha_1-\beta_1} \qquad \pi_{12} = \frac{\beta_1}{1-\alpha_1-\beta_1} \quad \text{---------- (6)}$$

$$\pi_{31} = \frac{\beta_2}{1-\alpha_1-\beta_1} \qquad \pi_{13} = \frac{1}{1-\alpha_1-\beta_1}$$

Substituting $\pi's$ into the system (6) provides the reduced form model as:

$$\boxed{\begin{aligned} Y_1 &= \pi_{11}X_1 + \pi_{12}X_2 + \upsilon_1 \\ Y_2 &= \pi_{21}X_1 + \pi_{22}X_2 + \upsilon_3 \\ Y_3 &= \pi_{31}X_1 + \pi_{32}X_2 + \upsilon_3 \end{aligned}} \quad \text{---------- (7)}$$

where : the $\pi's$ denote model's the reduced-form coefficients.

The above computational operations confirm existence of a definite relationship between the structural parameters and the reduced form parameters.

4. Results and Discussion

4.1. Table 1: Structural Equation Model Estimates

Standardized	Coeff.	Std. Err.	z	P > | z |
Employment prospects ←				
Tertiary academic achievement	.8245767	.1484732	5.56	0.000
_cons	.3222701	.6272138	0.71	0.459
Income ←				
Tertiary academic achievement	.5622281	.0699101	7.48	0.000
College ranking	.1582674	.0502374	3.46	0.001
_cons	.7278803	.2678005	2.62	0.007
Tertiary academic achievement ←				
Employment prospects	.8228010	.34283	2.75	0.003
Income	.3981399	.1514423	2.74	0.007
Grade Point Average	.6747775	.1748657	3.92	0.000
_cons	2.652604	.8973497	3.18	0.000

Ceteris paribus, the reduced form model's standardized estimates reveal that tertiary educational achievement has significant positive impacts on employment prospects and income. Nearly 82.46% of employment prospects and 56.22% of income are significantly and positively influenced by tertiary academic achievement. Additionally, almost 15.83% of incomes are significantly influenced by college ranking. Similarly, nearly 82.28% of tertiary academic achievement is positively influenced by employment prospects; while incomes and GPA positively influence tertiary academic achievement by nearly 39.81% and 67.47%; respectively.

4.2. Table 2: Reduced Form Model Estimates

Standardized	Coeff.	Std. Err.	z	P > | z |
Employment prospects ←				
College ranking	.1293981	.0386039	3.28	0.017
Grade Point Average	.3765976	.0426552	6.51	0.000
_cons	2.619854	.2130333	4.73	0.000
Incomes ←				
College ranking	.2542323	.0486995	6.22	0.000
Grade Point Average	.3672410	.0325556	7.61	0.000
_cons	2.412899	.3789929	3.28	0.000
Tertiary Academic Achievement ←				
College ranking	.2121688	.0462764	3.42	0.000
Grade Point Average	.33495429	.0437280	4.36	0.000
_cons	2.423102	.4167853	4.87	0.000

Relative to college ranking, the reduced form model's estimates reveal that Grade Point Average has comparatively more noticeable significant positive impacts on tertiary academic achievement prospects, employment prospects and incomes. Nearly 37.66% of employment prospects, 36.72% of incomes and 33.50% of tertiary academic achievement are significantly positively influenced by Grade Point Average. Similarly, about 12.93% of employment prospects, 25.42% of incomes and 21.21% of tertiary academic achievement are significantly and positively influenced by college ranking in respect of infrastructure and research output.

5. Conclusion and Recommendations

5.1 Conclusion

The aim of this study was to estimate the individual private returns to tertiary academic achievement based on the human capital theory. Using Structural Equation Modelling, the standardized estimates indicate that tertiary academic achievement has a significant positive effect on employment prospects and incomes. In conformity to the findings by Thomas (2003), college ranking has a significant positive effect on incomes. The result that Grade Point Average positively affects tertiary academic achievement conforms to the findings by Zhang (2004). The reduced form model estimates of the predetermined variables show that college ranking has significant positive impacts on tertiary academic achievement (Zhang, 2004), employment prospects and

incomes. Correspondingly, Grade Point Average demonstrates statistically significant and positive effects on employment prospects (Hostetler, 2012), incomes and tertiary academic achievement.

5.2 Recommendations

In light of the substantial positive effects associated with college ranking on employment prospects, incomes and tertiary academic achievement, tertiary education institutions should effectively enhance teaching and learning by improving infrastructure, research output and assessment practices. Such improvements can enhance both learning and recognition of the attained educational qualifications in the labour market for employment purposes.

References:

Checchi, D. (2006). The economics of education: Human capital, family background inequality. New York: Cambridge University Press.

Ehrenberg, R.G., and Smith, R.S. (2006). Modern labor economics: Theory and public policy (9th ed). New York: Pearson.

Hostetler, E. (2012). College grade point average-does it matter?, Available at: http://www.iusbpreface.com/mobile/life/college-grade-point-average-does-it-matter-1.2939532.

Kifle, T. The Private Rate of Return to Schooling: Evidence from Eritrea. Essays in Education, Volume 21, Summer 2007. Available at: http://www.usca.edu/essays/vol212007/kifle.pdf

Paulsen, M. B. & Toutkoushian, R. K. (2006b). Overview of economic concepts, models and methods for institutional research. In Toutkoushian, R. K. and Paulsen, M. B. (Eds.), Applying economics to institutional research, New Directions for Institutional Research No. 132 (pp. 5-24). San Francisco: Jossey-Bass.

REPUBLIC OF SOUTH AFRICA. (1997). Higher Education Act, 101 of 1997, as amended by the Higher Education Act, 23 of 2001, Council on Higher Education, South Africa.

Thomas, S. (2003). Longer term economic effects of college selectivity and control. Research in Higher Education, 44(3):263-299.

Quang, H. V. (2012). Determinants of Educational Expenditure in Vietnam, International Journal of Applied Economics, 9(1):59-72.

Zhang, L. (2004). Advance to Graduate Education: The Effect of College Quality and Undergraduate Majors, Cornell University, ILR School. Available at: http://digitalcommons.ilr.cornell.edu/cgi/viewcontent.cgi?article=1050&context=workingpapers.

The IISTE is a pioneer in the Open-Access hosting service and academic event management. The aim of the firm is Accelerating Global Knowledge Sharing.

More information about the firm can be found on the homepage:
http://www.iiste.org

CALL FOR JOURNAL PAPERS

There are more than 30 peer-reviewed academic journals hosted under the hosting platform.

Prospective authors of journals can find the submission instruction on the following page: http://www.iiste.org/journals/ All the journals articles are available online to the readers all over the world without financial, legal, or technical barriers other than those inseparable from gaining access to the internet itself. Paper version of the journals is also available upon request of readers and authors.

MORE RESOURCES

Book publication information: http://www.iiste.org/book/

IISTE Knowledge Sharing Partners

EBSCO, Index Copernicus, Ulrich's Periodicals Directory, JournalTOCS, PKP Open Archives Harvester, Bielefeld Academic Search Engine, Elektronische Zeitschriftenbibliothek EZB, Open J-Gate, OCLC WorldCat, Universe Digtial Library , NewJour, Google Scholar