Drivers of Higher Education Output: Empirical Study of Saudi Graduating Seniors

Prepared by

Dr/ Sami Ghazzai Alsulami

Islamic University of Madinah

Abstract:

This study adheres to the education production research tradition, and estimates an exogenously interactive model where a measurable education outcome, namely student GPA, is specified in terms of classic resource inputs in a Saudi higher education setting. The objective of the study is to empirically identify the fundamental inputs to the education production process that are critical for Saudi higher education. This is imperative for education policy makers and standard setters in KSA. Toward this end, the contribution of this study to the extant literature is twofold: [1] estimating a parsimonious specification of the education production capital embodiment model within a Saudi higher education setting, and [2] empirically identifying critical inputs to the higher education process in Saudi Arabia at conventional significance levels. Once identified, those critical inputs may be policy managed with the goal of obtaining equal respective ratios of marginal products to input prices. The study is therefore instructed by the 2030 vision of Saudi Arabia and how it can be reflected upon in higher education. This can be materialized via evidence-based policy recommendations that reflect the fundamental economic principle of efficient allocation of resources.

محددات مخرجات التعليم العالي في المملكة العربية السعودية: دراسة تطبيقية لبيانات خريجي الجامعات

تقوم هذه الدراسة على فلسفة دالة انتاج التعليم وتتبنى نموذج متداخل لتقدير نتيجة موضوعية للتعليم العالي من حيث البعد الطلابي وهي المحصلة التراكمية النهائية. وتخصص الدراسة المحصلة التراكمية النهائية من خلال المدخلات الأساسية للتعليم العالي السعودي بينما تهدف إلى تشخيص المدخلات الفاعلة والمهمة بالنسبة لبيئة التعليم العالي السعودي. ويعد هذا التشخيص بمثابة المطلب الحتمي لما يحمله من بالغ الأهمية في تعديل آلية صناعة قرار التعليم العالي السعودي والتوجيه الأمثل للموارد النادرة وذلك عن طريق إدارة الموارد والمدخلات للخروج بنسب متساوية من حيث التكاليف والإنتاجية. وتختزل الدراسة على هذا النحو رؤية المملكة ٢٠٣٠ وتوجهات برامج التحول الوطني فيما يتعلق بكفاءة توظيف الموارد التوزيع الأمثل لها.

الكلمات المفتاحية: خريجي الجامعات– مخرجات التعليم العالي– التعليم العالي السعودي: رؤية ٢٠٣٠.

Introduction:

This study builds on the classic education production model and examines the respective impact of individual classic inputs on a measurable outcome of higher education in Saudi Arabia. In particular, the study specifies and estimates a model of capital embodiment where the endogenous variable is student GPA, and the exogenous variables are student background, student inputs, school inputs, peer characteristics, peripheral influences, and initial endowment. The model allows for exogenous interactions where slopes and intercepts may vary by levels of inputs. Throughout, the objective of the study is to empirically identify the fundamental inputs to the education production process that are critical for Saudi higher education. Once identified, those critical inputs could be managed with the goal of obtaining equal respective ratios of marginal products to prices. This has non-trivial implications for education policy makers and standard setters in SA during a transformation period where the 2030 vision guides almost all aspects to Saudi socioeconomic life. In this fashion, the study complements the positive education research literature in two major ways: [1] estimating an interactive specification of the classic education production model within a framework of capital embodiment of a Saudi higher education setting, [2] reporting and testing parameter estimates, and identifying critical inputs to the higher education process in Saudi Arabia at conventional significance levels.

In the light of the preceding introduction, the following research questions are formulated:

1- What is the impact of student background on student outcome performance given predetermined levels of peer characteristics, student direct inputs, school direct inputs, external influences, and initial endowment?

2- What is the impact of student direct inputs on student outcome performance given predetermined levels of background, school direct inputs, peer characteristics, external influences, and initial endowment

3- What is the impact of peer characteristics on student outcome performance given predetermined levels of background, student direct inputs, school direct inputs, external influences, and initial endowment?

4- What is the impact of school direct inputs on student outcome performance given predetermined levels of background, student direct inputs, peer characteristics, external influences, and initial endowment?

4- What is the impact of external influences on student outcome performance given predetermined levels of background, student direct inputs, school direct inputs, peer characteristics, and initial endowment?

5- What is the impact of initial endowment on student outcome performance given predetermined levels of background, student direct inputs, school direct inputs, peer characteristics, and external influences?

In this fashion the main objective of this study is to empirically identify the resource inputs considered critical for the Saudi higher education data generating process. Those resources inputs are important education policy variables that can be managed by standard setters and policy makers to improve the delivery and administration of Saudi higher education. The minor objective, however, is to determine the possible interactions between the four fundamental resource inputs, how the level of a particular input confounds the way a measurable education outcome would vary with other inputs respectively. Along the same lines, the importance of this study can be explained fully along the lines of the 2030 vision that stresses evidence-driven policy and efficient employment and allocation of inputs and resources. In particular, the level of student expenditure entitlement and its relationship with measurable educational outcomes are paramount for adequate and equitable higher education policy necessary for the prosperity of Saudi education sector. Furthermore, the study is significant for the better accountability of the higher education system and public universities. Without accountability, higher education providers may not have the necessary incentive mechanism to operate according to the best interest of student education outcomes. The study also critically reviews contemporary Saudi higher education system, and sheds light on the potential of private universities. For instance, Alfawaz (2014) advances that formal higher education that stresses dynamic relationships between typical resource inputs of the universities is the key to mitigating the employment challenges in Saudi Arabia. Alghamedi (2016) argues that the reformed higher education system in Saudi Arabia is associated with

improved employability levels in the private sector. Al-khateeb (2020) points the attention to the notion that technologically-driven higher education systems have both opportunities and challenges for Saudi graduates.

In view of the preceding, the study relates to the research agenda of the author in a principal fashion. The author of this study descends from education and economics background respectively. In this fashion, this coauthored study complements the education economics literature where typical economic tools (e.g., efficiency and variation coefficients) are employed to explain the higher education production process in Saudi Arabia. The author of this study is also instructed by the 2030 vision and how it can be translated in higher education. This can be materialized via evidence-based policy recommendations that reflect the fundamental economic principle of efficient allocation of resources.

In view of the above, given the objectives and research questions, this study is designed after a typical positive research, which is instructed by the traditional quantitative paradigm according to the following sections: literature review, research design, and data analysis & results. The research structure follows that of a positive study that identifies significant inputs to a typical measure of higher education output where a model is specified and estimated according to the education production function framework.

Literature Review:

The body of research studying the relationship between education and resources and outcomes follows two distinguishable, but related traditions: [1] Institutional process effectiveness, and [2] education production (Levacic and Vignoles, 2002). Process effectiveness research is chiefly concerned with the extent to which effectiveness scores of various institutional factors may explain education outcomes, and so traditional inputs to the education process are greatly assumed away (Anderietti and Su, 2018). On the other hand, education production research directly studies educational outcomes in terms of classic resource inputs where the main concern is typically resource efficiency rather than process effectiveness (Bishop and Wobmann, 2010; Gilead, 2014; Harris, 2007).

Education production models are greatly instructed by school effectiveness research (Hill and Rowe, 1996; Westrick et al., 2015). The effectiveness research is holistic and attempts to include all relevant

factors contributing to student performance (Duckworth et al., 2019). In fact, investigating the impact of many factors beyond the time series of the student performance itself (e.g., the impact of high school type on student college performance) is rather scant in academic literature for most research tends to be scholastically-oriented where the objective is to explain college performance in terms of high school performance (see Collins et. al., 2000; Jones and Zimmer, 2001; Marks et al., 2001; Machin and Vignoles, 2018). In this regard, this study complements the education production literature and entertains all possible factors identified in the extant literature when explaining contemporaneous college graduation GPA. The study thus follows the tradition of a literature strand where the objective is to predict terminal college performance. For instance, Westrick et. Al. (2015) show that standardized test scores (e.g., American College Testing (ACT) score) and high school grade point average are strong predictors of college performance. Staiculescu and Richiteanu (2018) study the phenomenon of university dropout and contend that student background has a large and significant impact on dropout in both education and training. They also document that most dropouts happen at the first year at the university. Robbins et al. (2004) identifies via a meta-analysis of a large body of the extant literature that the performance of college students may be driven by a variety of factors including social influences, institutional commitment, contextual involvement, psychological forces (self perception and self assessment), academic aptitude, and financial support. Duckworth et al. (2019) argue that as opposed to standardized test scores, high school grade point average is a better predictor of successful college graduation. They explain that high school grades have significantly incremental predictive ability owing to the self discipline and self regulation features entertained by excellent high school students. Marks et. al. (2001) show that students coming out at private universities tend to score significantly higher on admission tests and entrance exams as opposed to those coming out at public schools. They also report that in addition to the type of high school, the school characteristic and contextual descriptors tend to heavily contribute to the academic achievement of college students. Win and Miller (2005) specify a model that explains the performance of college students in terms background and school factors. Employing data pertaining to freshmen at the University of Western Australia, they show that students graduating at

public schools tend to outperform those graduating at private schools. In this concern, Alaudinn and Tisdell (2006) contend that teaching effectiveness tends to mostly explain the quality of education production output. Burke and Sass (2008) support that student peer effects and engagement in extracurricular activities both serve as strong indicators of the quality of formal higher education output. Choi et al. (2012) maintain that private tutoring may play a significant role for both the level and quality of education production. An et al. (2018) show that the level of parental education acts as an intervening mechanism when explaining the level of education output.

Research Design:

This study adheres to the education production research tradition and estimates a model where a measurable education outcome, namely student GPA, is specified in terms of classic resource inputs in Saudi higher education setting. The model allows for multiplicative interactions where parameter estimates and rates for change vary by state levels of inputs. Toward this end, the study contributes to the contemporary literature in two key ways: [1] estimating an interactive specification of the classic education production model within a framework of capital embodiment of a Saudi higher education setting, and [2] reporting and testing parameter estimates, and identifying critical inputs to the higher education process in Saudi Arabia at conventional significance levels. The study in this fashion complements the education production function literature since the theory of education production functions revolves around choosing relevant inputs so as to maximize a single educational output by equating input marginal products for every level of output (Jones and Zimmer, 2001).

Given the objectives and research questions is instructed by the traditional quantitative where archival data is collected via a large enough sample size as reflected by the underlying population of Saudi college graduates of 2018. Whereas the endogenous variable is continuous, the explanatory variables are all categorical. The study then estimates the regression, and analyzes and reports results according to the following subsections: [1] study sample, and [2] model specification.

Study Sample

A random sample of graduating students is collected using a random number generator software. The population of data is available at the ministry of higher education statistics office. The size of the

population of graduating students for the year 2018 is about 350000. We employ the conventional significance level of 5%, a confidence interval error margin of 4, and assume maximum population variability of 50% in order to solve for a sample size of 599 students using Cochran's sample size determination approach. [z2 *(P)*(1-P)/e2] / [1 + (z2 *(P)*(1-P)/Ne2)] where z is a tabulated value, p is population variability, e is desired margin of error, and N is the population size.

The sample inclusion criterion is the combinatory output of a random number generator process that that runs from 1 to 350000. Once a random number is generated, student data pertaining to that number is recovered at the Saudi higher education statistics database. The process is then repeated iteratively until 599 data points are obtained. All data points are recovered without replacement in the sense that once a data point is identified it is immediately dropped before the iteration continues to identify the remainder of points.

Model Specification

The study specifies the following functional form:

Education outcome = f (background, student, school, peer, external, endowment)

According to the generalized least squares specification:

$$Education\ outcome_i = b0 + b1*background_i + b2*student_i + b3*peer_i + b4*school_i + b5*external_i + b6*endowment_i + b7*background_i*external_i + b8*student_i*peer_i + e_i$$

Where education outcome is student GPA, background is student type of high school (i.e., public or private), student is student type of average major-specific study time, peer is student type of learning environment (i.e., female or male), school is student type of school-oriented student-teacher ratio, external is student type of parental education, endowment is student type of school-oriented extracurricular activities, and e is a well-behaved error term with convenient piece-wise statistical properties. Toward this end, traditional assumptions of school utility functions that abstract away from possible endogeneity, social values, and students with special needs are maintained.

Data analysis & results:

The following table summarizes the results of estimating this study's parsimonious specification as per the spreadsheet output in table 1.3 in the appendix, which presents model estimation details along with the explanatory power, parameter estimates, and corresponding p-values:

Table 1.1

Summary of empirical findings

variable	Measure	Reference group	Direction	Parameter estimate	Magnitude at traditional levels
Intercept	NA	NA	positive	2.55	Yes
Background	Type of high school	Public type	Negative	0.31	Yes
Student	Type of major-specific study time	Lower type	positive	0.07	No
school	Type of student-teacher ratio	Higher type	positive	0.29	Yes
peer	Type of gender	Male type	positive	0.833	Yes
External	Type of parental education attainment	Higher type	negative	0.54	Yes
endowment	Type of school endowment per student	Higher type	negative	0.24	Yes
Background given external	Interactive term	High-low, low-high, and low-low	positive	0.11	No
Student given peer	Interactive term	Male-high, female-high, and female-low	Negative	0.38	Yes

All regression coefficients (i.e., parameter estimates) in the preceding table are interpreted in the sense that the derivatives of exogenous variables with respect to the endogenous variable of higher student education outcome would show the extent to which a response

group would deviate from an underlying reference group as defined by the respective dummy variables.

The endogenous variable of student education outcome is measured in terms of degree grade point average (GPA), which assumes the behavior of a continuous random variable with values ranging from 1 to 4 where 1 is 65%, and 4 is 100%. The eight exogenous variables in the study are measured using dummy variables with two categories 0 and 1. The first exogenous variable 'background' defines student's educational background and prior experience, and is measured in terms of whether the student graduated at a private high school (i.e., the type of high school). The second exogenous variable 'student' defines the student's direct contribution toward the outcome performance, and is measured in terms of whether the normal weekly study time per major is above average (the national survey of student engagement). (Majors: engineering, medicine & biological sciences, physical sciences, social sciences & arts, business, and education). The third exogenous variable 'school' sums up the set of school educational inputs and resources, and is measured in terms whether the school's student-teacher ratio is below average. The fourth exogenous variable 'peer' entertains the characteristics of student's peers and the immediate surrounding environment, and is measured in terms of gender. This is relevant for the Saudi setting since public higher education in Saudi Arabia is not coed. The fifth exogenous variable 'peripheral' exhausts all the external (non-school) factors and influences that contribute to student's educational performance, and is measured in terms of whether the parental education level is above average. The sixth exogenous variable 'endowment' defines the indirect and support inputs of the school, and is measured via the overall financial health of the school in terms of whether the endowment per student is above average.

Since all exogenous variables are dummies, the model is estimated piecewise linearly under the umbrella of generalized least squares (GLS) where the objective is to produce efficient and unbiased estimates of the magnitude of group variation with respect to the endogenous variable of graduating student GPA.

The intercept of 2.55 is statistically significant at all levels and is interpreted as the average student performance had all explanatory variables been dropped out. This intercept is indeed very close to the 2.58 sample mean of the exogenous variable (shown in table 1.1, which

presents descriptive statistics in the appendix). This analytically allows for interpreting the regression coefficients as parameter estimates of group variation with the intercept as a base.

Student background matter significantly for terminal academic performance at all conventional significance levels, and students coming out of public high schools tend to score a GPA of .31 points lower than that scored by students coming out of private high schools. The student direct input toward the terminal performance is correlated positively with GPA where students belonging to higher study time tend to score a GPA of 0.07 points higher than that scored by students belonging to the lower study time group. This variable, however, is not statistically significant at conventional levels owing to the fact that the size of the coefficient is not large enough when compared to the standard error of 0.0655. The surrounding environment variable matters significantly for academic performance in Saudi Arabian higher education. Toward this end, female Saudi graduates tend on average to score a GPA of about 0.833 points higher than that scored by their male counterparts. The school input variable measured by average student-teacher ratio matters significantly for graduation GPA in this study with students coming out of lower student-teacher universities scoring on average a GPA of about 0.29 points higher than that scored by students affiliated with higher student-teacher ratio universities. External influences as measured by parental education level correlates significantly positively with student terminal academic achievement with students representing the group of lower parental education scoring on average a GPA of 0.54 points lower than that scored by students representing the group of higher parental education. The variable of school endowment and the contribution of extracurricular activities correlate significantly positively with collegiate academic achievement in Saudi Arabian higher education with students graduating at lower student endowment universities scoring on average a GPA of 0.24 points lower than that scored by students graduating at higher student endowment universities.

For the interactive term that measures peripheral characteristics given background, Students belonging to the group of high parental education type with a private high school background tend to score a GPA of 0.11 higher on average than that scored by other groups. The variable, however, is not statistically significant and is not far away from

zero because of a rather large standard error of .10 relatives to the size of the parameter estimate.

For the interactive term that measures study time given peer characteristics, male students belonging to the lower study time group tend to score on average a GPA of about 0.38 points lower than that scored by other groups.

Conclusion:

The results of this study indicate that the fundamental educational process inputs of student background, peer characteristics (and the surrounding educational setting), direct school inputs, peripheral influences (e.g., parental educational attainment), and indirect school inputs (e.g., extracurricular activities) are empirically critical for Saudi higher education. In line with conventional wisdom and prior documented empirical evidence (see, e.g., Andrietti and Su, 2018), the impact of student direct inputs measured in terms of the normal major-specific study hours significantly depend of the type of peer characteristics (i.e., peer characterstics and the surrounding educational seem to significantly structurally shift the impact of student direct inputs on terminal performance). Furthermore, in line with extant empirical evidence (see, e.g., Ahn et. Al., 2012; Bishop and Wobmann, 2010) and the widespread belief in Saudi Arabia, external influences measured in terms of parental educational level seem to alter the direction of the impact of student background on ultimate outcome performance. However, this alteration is not significant in magnitude and the impact of student background on terminal performance given the type of parental educational level is not far away from zero. In this fashion and for education policy making and standard setting purposes, the empirically identified critical inputs of background, peer influences, school direct inputs, external influences, and school indirect inputs could be managed with the goal of obtaining equal respective ratios of marginal products to prices. This has non-trivial implications for Saudi Arabia during a transformation period where the 2030 vision instructs all aspects to underlying socioeconomic life. However, a point in order, it's chiefly important to qualify the outcomes of this study by variable measurements and the piecewise econometric specification. Though this study is in unison with empirical identification of fundamental educational inputs, the set of viable measures is so large that econometric misspecification due to omitted variable bias is always a possibility. In this regard, future

research may entertain alternative measures of the same identified constructs or employ a meta-analysis of all relevant factors identified in the extant literature.

Limitations:

In view of the preceding discussion and conclusion, this study has two main limitations, the first limitation is due to possible error in measurement and how the study variable is measured. Though we closely followed the extant empirical literature in this regard, there are vast possible measures for the same abstract variable. Here, future research may replicate the study while using different measures. The source of the second limitation, however, is the linear model specification whereas typical education production function models are intrinsically non-linear since rates for change typically depends on the status quo. In this regard, we chose a simpler specification in order to accommodate meaningful interpretations of parameter estimates particularly when dummy variables are extensively involved.

References:

Alauddin. M and C. Tisdell (2006). Student's Evaluation of Teaching Effectiveness: What Surveys tell and what, the University of Queensland, Economic Theory, Applications, and Issues Working Paper No.42. Queensland Australia.

Alfawaz, A. et al. (2014), "Would the Educational Programs help in Solving Saudi Arabia's Employment Challenges?" International Journal of Academic Research in Economics and Management Sciences, 3, 24.

Alghamedi, A. (2016), "Enhancing employment opportunities in the Saudi Arabian private sector", Dissertation. Pepperdine University.

Al-khateeb, B.A.A. (2020), "Technological Skills and Job Employment in Universities in Saudi Arabia. 6th International Conference on Opportunities and Challenges". In Management, Economics and Accounting

An. G., J. Wang, Y. Yang, and X. Du (2018). A study on the effects of students' STEM academic achievement with Chines parents' participative styles in school education. Educational Sciences: Theory & Practices, Vol. 19(1): 41-54.

Andrietti, V. and Su, X. (2018). Education curriculum and student achievement: theory and evidence. *Education Economics*, 26(3), 04-19.

Bishop, J. and Wobmann, L. (2010). Institutional effects in a simple model of education production. *Education Economics*, 18(3), 17-38.

Burke, M.A, and T.R. Sass (2008). Classroom peer effects and student achievement. National Center for Analysis of Longitudinal Data in Education Research Working Paper No. 18, Washington DC.

Choi, A., J. Calero, and J.O. Escardibul (2012). Private tutoring and academic achievement in Korea: an approach through PISA-2006, KEDI Journal of Educational Policy, Vol. 9(2): 299-302.

Collins, C., Kenway, J., & McLeod, J. (2000). *Factors Influencing the Educational Performance of Males and Females in School and their Initial Destinations after Leaving School*. http://www.dest.gov.au/NR/rdonlyres/F0270F6E-B2C3-4CF4-833D-4C8029EA7D6E/4093/Gender_Report.pdf: Commonwealth Department of Education, Training and Youth Affairs.

Duckworth, A., Taxer, J., Eskreis-Winkler, L., Galla, B., and Gross, J. Self control and academic achievement. *Annual Review of Psychology,* 70(1), 373-399.

Gilead, T. (2014). Education and the rationale of cost-benefit analysis. *British Journal of Educational Studies* 62 (4):373-391.

Harris, D. N. (2007). Diminishing marginal returns and the production of education: An internal analysis. *Education Economics*, 15(1), 31-53.

Hill, P.W., & Rowe, K.J. (1996). Multilevel modeling in school effectiveness research. *School Effectiveness and School Improvement*, 7 (1), 1-34.

John T. Jones and Ron Zimmer, (2001). Examining the impact of capital on academic achievement. *Economics of Education Review*, 20(6), 577-588

Levacic, R. and Vignoles, A. (2002). Researching the link between student resources and school outcomes in the UK: A review of issues and evidence. *Education Economics*, 10(3), 313-331.

Machin, S. and Vignoles, A. (2018). *What's the Good of Education?: The Economics of Education in the UK*. Princeton, NJ: Princeton University Press.

Marks, G., McMillan, J., and Hillman, K. (2001). Tertiary Entrance Performance: The Role of Student Background and School Factors. *LSAY Research Reports*, 11(1), 1-92.

Myers, N. Ahn, S., and Ames, A. (2012). A review of meta-analysis in education: methodological strengths and weaknesses. *Review of Educational Research*, 82(4), 436-476.

Staiculescu, C. and Nastase, E. (2018). University dropout. Causes and solutions. *Mental Health Global Challenges XXI Century*, 20(3), 71-76.

Steven B. Robbins, Kristy Lauver, Huy le, Daniel Davis, and Ronelle Langley (2004). Do psychological and study skill factors predict college outcomes? A meta-analysis. *Psychological Bulletins*, 130(2), 261-288

Win, R. and Miller, P. (2005) "The Effects of Individual and School Factors on University Students' Academic Performance. *Australian Economic Review*, 38(1), 1-18.