SCHOOL EFFICIENCY MODEL: AN APPLICATION OF DATA ENVELOPMENT ANALYSIS AND THEIL INEQUALITY IN URBAN AND RURAL AREAS, SABAH

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DECLARATION

I declare that this project of study is my own product except quotations, equations, summaries and references that are which have been duly acknowledged.

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ABSTRACT

Education plays an important role in economics and national development of a country. It helps to reduce poverty, enhance quality of life, and improve health condition. Education also helps to reduce the social and ethnic disparity among population in a country. From economic perspective, level of education and the distribution among groups in a country are affecting income distribution, and also the economic growth. The inefficiency in education caused wastage of resources. Besides that, inequality in education among population increase education gaps between groups. This make large portion of revenue being occupied by the well-educated minority and the illiteracy majority continuously live in the poverty. Therefore, the understanding of efficiency and education inequality is crucial. In developing countries, the disadvantage of education quality in rural area has been the main focus in many literatures as rural areas produce weaker students' performance. This study focused on estimating the efficiency of schools in urban and rural areas and identifying the effects of parents' education, quality of schools principal and private tutoring on schools' efficiency. Apart from efficiency, education inequality was measured for schools, districts and urban-rural areas. Education inequality was further decomposed to between-group and within-group inequality. The efficiency of secondary schools was measured by using Data Envelopment Analysis, while the educational inequality was estimated by employing the Theil index. By using secondary schools in Sabah as case study, the empirical result shows that there is a significant difference of school efficiency between the urban and rural areas. School efficiency in urban area is mainly affected by the initial ability of student and private tutoring that conducted. On the other hand, initial ability, parent education and the role of schools principal have significant impact on efficiency in rural area. It is observed that the overall education inequality has decreased from 2009 to 2013. However, from the decomposition of Theil index, the between-urban-rural inequality has widened. Similar result is observed for between-districts-inequality. Therefore, it is proposed that schools and policy makers take appropriate action to schools in rural areas to become more efficient and thus prevent gap widen in between-rural-urban inequality.

ABSTRAK

MODEL EFFISIENSI SEKOLAH: APLIKASI DATA ENVELOPMENT ANALYSIS DAN KETIDAKSAMAAN THEIL DI KAWASAN BANDAR DAN LUAR BANDAR, SABAH

Pendidikan memainkan peranan penting dalam ekonomi dan pembangunan negara. Ia membantu mengurangkan kemiskinan, meningkatkan kualiti hidup, dan meningkatkan tahap kesihatan masyarakat. Pendidikan juga membantu mengurangkan jurang perbezaan sosial dan etnik di kalangan penduduk di sesebuah negara. Dari perspektif ekonomi, tahap pendidikan dan taburan pendidikan di kalangan kumpulan dalam negara memberi kesan terhadap agihan pendapatan dan juga pertumbuhan ekonomi. Ketidakcekapan dalam pendidikan menyebabkan pembaziran sumber. Di samping itu, ketidaksamaan dalam pendidikan juga membentuk jurang pendidikan antara pelbagai kumpulan. Ini menyebabkan sebahagian besar pendapatan dimiliki oleh kumpulan minoriti yang berpendidikan tinggi. Keadaan ini kemudiannya akan membawa kepada menularnya kemiskinan dalam negara. Oleh itu, pemahamanan keefisiensian sekolah dan ketidaksamaan dalam pendidikan adalah penting. Di negara-negara membangun, kelemahan prestasi pendidikan di kawasan luar bandar telah menjadi fokus utama dalam banyak kajian. Kajian ini memberi tumpuan kepada menganggarkan efisiensi sekolah di kawasan bandar dan luar bandar dan mengenal pasti sama ada tahap pendidikan ibubapa, kualiti pengetua, kualiti pelajar dan pengambilan tuisyen swasta memberi kesan terhadap keefisiensi sekolah. Selain efisiensi, ketidaksamaan dalam pendidikan juga diukur bagi sekolah-sekolah, daerah-daerah dan kawasan bandar serta luar bandar. Ketidaksamaan dalam pendidikan diuraikan kepada ketidaksamaan antara kumpulan dan ketidaksamaan dalam kumpulan. Kecekapan sekolah menengah telah diukur dengan menggunakan Data Envelopment Analysis, manakala ketidaksamaan pendidikan dianggarkan dengan menggunakan Theil indeks. Untuk kes studi di Sabah, keputusan empirikal menunjukkan terdapatnya perbezaan yang signifikan bagi efisiensi sekolah kawasan bandar dan luar bandar. Kecekapan sekolah di kawasan bandar terutamanya dipengaruhi oleh keupayaan awal pelajar dan pengambilan tuisyen swasta. Sebaliknya, keupayaan awal pelajar, pendidikan ibu bapa dan peranan pengetua sekolah memberi kesan yang lebih besar ke atas efisiensi di kawasan luar bandar. Diperhatikan bahawa ketidaksamaan pendidikan secara keseluruhannya telah menurun dari 2009 hingga 2013. Walau bagaimanapun, apabila Theil indeks diuraikan, ketidaksamaan di antara bandar dan luar bandar menjadi semakin meluas. Hasil yang sama diperhatikan bagi ketidaksamaan antara daerah. Oleh itu, adalah dicadangkan bahawa pembuat dasar dan juga pihak pentadbir sekolah boleh mengambil tindakan yang wajar agar sekolah-sekolah di luar bandar menjadi lebih efisien dan seterusnya mengelakkan jurang prestasi yang besar di antara sekolah-sekolah bandar dan luar bandar.

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LIST OF ABBREVIATIONS

BCC - Banker-Charnes-Cooper model

CCR - Charnes-Cooper-Rhodes model

CRS - Constant Returns to Scale

DGP - Data Generating Process

DEA - Data Envelopment Analysis

DMU - Decision Making Unit

DRS - Decreasing Returns to Scale

EPRD - Eduaction Planning and Research Department

GE - General Entropy

GPS - *Grad Purata Sekolah* (Average School Grade)

IRS - Increasing Returns to Scale

JPN - *Jabatan Pendidikan Negeri Sabah* (Sabah Education Department)

MG - Mean Grade

NC - Non-controllable

OECD - Organisation for Economic Co-operation dan Development

PBS - *Pentaksiran Berasaskan Sekolah* (School Based Assessment)

PCG - Per Capita Grant

PIRLS - Progress in International Reading Literacy Study

PISA - Program for International Student Assessment

PMR - *Penilaian Menegah Rendah* (Lower Secondary Schooll Assessment)

PPSMI - *Pengajaran dan Pembelajaran Sains dan Matematik dalam Bahasa Inggeris* (Teaching of Science and Mathematics in English)

PTE - Pure Technical Efficiency

RTS - Returns to Scale

SE - Scale Efficiency

SES - Socio Economic Status

SPM - *Sijil Pelajaran Malaysia* (Malaysian Certificate of education)

TE - Technical Efficiency

TIMSS - Trends in International Mathematics and Science Study

UNESCO - United Nations Educational, Scientific and Cultural Organization

UPSR - *Ujian Pencapaian Sekolah Rendah* (Primary School Assessment Test)

VRS - Variable Return to Scale

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CHAPTER 1

INTRODUCTION

1.1 Introduction

The relationship between education and economic growth has been well debated amongst researchers and policy makers (Delgado, Henderson and Parmeter, 2014; Hawkes and Ugur, 2012; Hanushek and Woessmann, 2007; Psacharopoulos and Patrinos, 2004). Improvements in education can cause significant impact on a country economic and social. UNESCO (2011) reported that 12 percent of people in poor countries can be lifted out from poverty when all children gain access to education. As such, basic education has become a compulsory agenda in many of these countries.

In economics, the education industry has two characteristics which make it a fundamental for a study of efficiency: i.e. size and rising costs. Education represents one of the largest industries in Malaysia, which estimated total expenditures of about RM41.4 billion in 2016 (Kementerian Kewangan Malaysia, 2015). During the same period, estimated academic employment is over 42.2 thousand with the number of student enrolments of about 5 million. Beyond its sheer magnitude, the education industry has experienced a steep increase in costs. For instants, in 1970 education expenditure is RM44 million, in 1980 education expenditure has increase to RM558 million, RM1.6 billion in 1990, RM7.1 billion in 2000 and RM12 billion in 2010. One possible explanation for the raising costs might be qualitative increases in educational outputs.

However, in some studies, there are conditions where schools although supplied with the same resources, fare much better than others (Yocum, 2012; OECD, 2013). Students in these schools achieve better academic performance.

Early conclusions suggest that these schools are simply more efficient than others. However, the accepted economic method for efficiency measurement uses revenue as an output. When considering increases in production, firms use market prices as weightage in efficiency measurement. In education, there is no market price involved which is normally used as weightage, in the output. Here, there is a need to use a methodology which is more flexible and does not require strong assumptions on the production frontier.

Besides efficiency, the different performance levels among schools in the same area or between other areas need to be taken into consideration too. In economics, the income differences within the same community where there are people who have annual incomes in the millions and others only in the thousands, can usually be attributed into inequality. The same cannot be expected when it comes to education. In education, the measurement of inequality is less clear (Cruces, Domench and Gasparini, 2014) due to the different variables used. What can be observed is that, certain kinds of education make it more likely for a student to become an engineer or a company director. These are simply better than that given to students who end up earning much less. Here, there is a need for a better indicator.

With increased awareness amongst nations towards the importance of education, more money is being spent towards it (UNESCO, 2006). The demand for improving the performance of schools has increased as measured in terms of levels of student academic achievement. The assessment of school efficiency in the education system could show performance of schools. While schools are supplied with limited resources and budget, the management is expected to wisely spend the money and correctly allocate resources for maximum production. This condition is crucial in rural areas, where resources are more limited. Students in rural areas perform poorly, and this makes the gaps of education inequality wider. These differences have been the concern of the nations and as well as the policy makers.

1.2 Education in Urban and Rural Areas

Generally, "urban areas" refer to the city, while "rural areas" refer to the countryside. The classification of urban-rural areas could be based on the economic activities, occupations, education levels, access to infrastructure and population size (Hugo *et al.*, 1997). Urban areas gain the advantages in all dimensions, whereas in rural areas, activities are mostly at basic levels, normally in agriculture and farming.

Education in rural areas has been a concern in many literatures as rural areas produce weaker student performances. This may be related to the fact that some of these rural areas have sparse and scattered population (Pritchard, 2003). This is worsened if the area is located far from the city. This will normally make most of the schools in rural areas lack facilities and with poor quality non-enthusiastic teachers. Besides, in developing countries, working conditions in urban areas are much better (Hanushek, 1997). Rural schools normally serve fewer students and receive less attention from the government. This is because education funding is frequently based on school enrolment.

In Malaysia, particularly in Sabah, there are limited researches related to rural schools. World Bank (2010) reported a disparity of students' achievement in Mathematics at year 9 (15 years old) between urban and rural areas. There is a lack of resources, included shortage of teachers in English, mathematics and science. Due the small size of most of the rural schools, many teachers in rural schools are expected to cover several grades at the same time and teaching subjects which are not their major (Ardi Marwan, Bambang Sumintono and Nora Mislan, 2012).

Several urban-rural researches in developing countries relate the poor academic performance in rural areas to a lack of school condition including educational facilities and teacher quality. However, it was found that this is not the root factor. In a latter study, it was found that the differentials in urban-rural performance can be well explained by the differential of parents' household socioeconomic status (SES) (Hanushek and Woessmann, 2007) especially parents' education level. Students who study in urban schools have higher socioeconomic

status, including education, occupation and enjoy better quality public service. Rural schools, which tend to have students with lower economic status than their urban counterparts, are generally more disadvantaged in operations compared to students in urban schools.

1.3 Data Envelopment Analysis (DEA)

This study utilizes a micro-level economic approach, called the Data Envelopment Analysis (DEA). DEA is a methodology based in linear programming. It is used to evaluate efficiency of entities (including programs and organizations), by utilizing resources as inputs to produce outputs. It is a frontier analysis and evaluates efficiency through peer benchmarking.

DEA was first introduced by Charnes, Cooper and Rhodes in 1978. This early model has constant returns to scale (CRS) assumption. It can measure how great the Decision Making Unit (DMU) in transforming inputs to produce outputs. DEA has few advantages that other efficiency measurement methods do not have. These advantages make DEA as popular tool in efficiency measurement. This is due to the characteristics of DEA which can accommodate different conditions of sample:

i. DEA do not require any initial assumption of weight for variable (Charnes *et al.*, 1981; Schwartz and Stiefel, 2001). In the measurement of education efficiency measurement, market cost is absence which is utilized as weights. In DEA, the weightages for every school are freely assigned through the system. Through the calculation of DEA, schools have different weightages in the inputs and outputs. Thus, utilizing DEA in efficiency measurement is more suitable.

ii. Parametric methods measure school efficiency relative to the average. In DEA, the construction of a frontier model is depend on the sample (Adams, 2008; Schwartz and Stiefel, 2001; Welsh, 2011). Through DEA, outliers of the sample are observed as well. In schools, outlier might provide some important information for the school performance.

iii. DEA can be ultilized different orientation of the data. By DEA, efficiency could be measured as input-oriented, where the quantity of output is remained while minimizing the input. DEA also can be used based on output-orientation; where the amount of inputs is constant, while the output is maximized. These differences happen when the distance from the efficient frontier is measured either horizontally or vertically. The vertical distance from the frontier measures input-oriented efficiency or the efficiency with which inputs are converted into output. The horizontal distance measures output-oriented efficiency or the amount by which inputs could produce the same output.

iv. DEA does not require strong assumptions on the production frontier. Schools do not have entry and exit options manifest in the competitive markets. Schools, unlike in the conventional market, would not face bankruptcy. Besides, the technique should be adjusted to the characteristics of the uncertainty of schools. Therefore, DEA with these characteristics is suitable as it is more flexible and does not require strong assumptions on the production frontier.

In the economic theory of production, output-oriented efficiency is defined as 'in a set of outputs with the given amount of inputs, it is not possible to increase the quantity of any output without decreasing the quantity of at least one other output' (Kirjavainen and Loikkanen, 1998). An output-oriented approach maximizes outputs by making the inputs constant. In input-oriented approach, the efficiency occurs when outputs are fixed and there is no possible way to decrease the quantity of any input without increasing at least one other input. In other words, inputs are minimized by keeping the outputs constant. The output oriented approach is more appropriate if one is considering the ability to avoid waste by producing as many outputs as input usage allows. Thus, in education, output oriented DEA approach is preferable when the proposition of inputs is assumed unchanged.

1.4.1 Data Envelopment Analysis Bootstrap

Data Envelopment Analysis Bootstrap is pioneered by Simar (1992) and Simar and Wilson (1998). By having bootstrapping, the real sampling distribution could be approximated, which mimics the data-generation process. Through this procedure, the pseudo-sample is constructed. Iteration process in the bootstrap yields an approximation to the real distribution. In the naive bootstrap, re-sampling directly from the original dataset will generate an inconsistent bootstrap estimation in the confidence intervals. Simar and Wilson (1998) overcome this problem by proposing smoothed bootstrap procedure, and improved by Simar and Wison (2007). This process determines the statistical properties of the non-parametric estimators in the multiple-inputs and multiple-outputs context. By this way, the DEA efficiency scores can be expressed within confidence intervals. This approach can allow more comprehensive and robust analysis of efficiency and productivity.

1.4 Theil Inequality Index

Theil inequality index is an inequality measurement based on Generalized Entropy measures (Sen, 1997). This measure fulfills the six requirements of a good inequality measurement (Cowell, 2005), where the explanation is based on an example of measuring education inequality by using examination grades:

i. Mean independence. This indicates that when all grades of students doubled, the measure would not change.
ii. Population size independence. If the population changed, the measure of inequality should not change.
iii. Symmetry. If two persons swap grades, it should have no change in the inequality measurement.
iv. Pigou-Dalton Transfer sensitivity. The transfer of grades from poor academic performing students to good academic performers reduces measured inequality.
v. Decomposability. The inequality may be broken down by population groups or districts or in other dimensions.
vi. Statistical testability. The significant changes in the index should be able to be tested over time.

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