*International Journal of Academic Research in Business and Social Sciences*
*2016, Vol. 6, No. 12*
*ISSN: 2222-6990*

# Efficiency and Productivity Changes of the Malaysian Community Colleges

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DOI: 10.6007/IJARBSS/v6-i12/2505 URL: http://dx.doi.org/10.6007/IJARBSS/v6-i12/2505

**Abstract**
The main aim of this study is to develop theoretical framework that can investigate the measurement of productivity changes in higher education sector particularly in the Malaysian community colleges institutions from 2007 to 2010. By measuring technical efficiency and productivity changes among community colleges in Malaysia, this study aims to address three main research questions related to the college community sector: a) What is the mean efficiency score of college community institutions in Malaysia? b) What is the total factor productivity (TFP) change for Malaysia's community colleges institutions? c) Has the implementation of the National Higher Education Strategic Plan (NHESP) led to improvements in the efficiency and productivity of the college community sector? In this study, a non-parametric approach known as Data Envelopment Analysis (DEA) is applied to the inputs and outputs of Malaysian community colleges to analyses empirically their technical efficiency and productivity. Furthermore, this study is also the first that intend to build theoretical frameworks that employ a comprehensive decomposition of the Hicks-Moorsteen TFP index, developed and explore the consequences of NHESP on productivity changes in Malaysian community college over the period of 2007-2010.

**Keywords:** Productivity Changes, Hick-Moorsteen TFP Index, Community Colleges, Total Factor Productivity, Malaysian

## Introduction
The Malaysian government has placed greater emphasis on the productivity of higher education institutions during the last decade. Hence, universities, polytechnics and community colleges have faced new challenges, which, if handled appropriately, could lead to their rapid expansion. The implementation of the NHESP in 2007 was the most important policy change in this area. Kaur and Sirat (2010) argue that the Plan can be considered as Malaysia's key policy initiative towards revolutionizing and transforming the higher education sector. An important policy focus on the government agenda is to turn Malaysia to a major regional hub for higher education. To enhance the image of Malaysian higher education sector, the NHESP aimed at achieving improvements in Information and Communications Technology (ICT) and

internationalization. For this purpose, the government was determined to raise the share of research and development in GDP (Gross Domestic Product) from 1.5% to 4.9% during this Plan (Ministry of Higher Education, 2009). The public universities, polytechnics and college community were the recipients of these national research and development funds. Despite the allocation of large funding into the sector, there has been no empirical study to investigate how the NHESP has influenced the performance of the Malaysian community colleges during 2007–2010.

The Malmquist productivity index is considered as the most prevalent tool in measuring changes in efficiency and productivity of the firms. Johnes (2008), Worthington and Lee (2008), Agasisti and Johnes (2009) and Bradley, Johnes, and Little (2010) are the most recent studies to have applied this useful tool. Despite this evident popularity, there has also been extensive discussion of the arguments for and against using constant returns to scale (CRS) to estimate the Malmquist indices. With non-constant returns to scale the Malmquist index does not precisely measure productivity change (Grifell-Tatjé & Knox Lovell, 1995). The bias in this way is systematic and relies on the magnitude-of-scale economies. Coelli and Rao (2005) highlight the consequence of imposing CRS upon any technology used to estimate distance functions for the calculation of a Malmquist TFP index. They conclude that without the CRS assumption the result may inaccurately measure TFP gains or losses arising from scale economies. Ray and Desli (1997) and Wheelock and Wilson (1999) also argue that the decomposition of the Malmquist index conducted by Färe, Grosskopf, Norris, and Zhang (1994) is problematic. When a firm's location (from one period to another) has remained unchanged, and the scale-efficiency change is only related to a shift in the variable returns to scale (VRS) estimate of technology, there will be no resulting technical change under CRS (Ray & Desli, 1997). They thus conclude that the resulting CRS estimate of technology can be statistically inconsistent.

O'Donnell (2010) proposed a new approach to decompose the multiplicatively complete TFP indices into a measure of technical change and various measures of efficiency change, without making any assumptions about the optimizing behavior of firms, the structure of markets, or returns to scale for a multiple-input multiple-output case. According to O'Donnell (2010), all TFP indices which can be presented in terms of aggregate inputs and aggregate outputs are "multiplicatively complete". It should be noted that completeness is an essential requirement for an economically meaningful decomposition of the TFP change. O'Donnell (2010a) proves that the group of complete TFP indices also includes the Fisher, Konus, Törnqvist and Hicks–Moorsteen indices, but not the popular Malmquist index of (Caves, Christensen, & Diewert, 1982). Apart from special cases such as constant returns to scale, O'Donnell (2010a) states that the Malmquist index of Caves et al. [13] is not complete, implying that it may be an unreliable measure of TFP change. As a result, the popular Färe et al. [11] decomposition of the Malmquist index may also give rise to unreliable estimates of technical change and/or efficiency change.

In the context of the Malaysian higher education system, since the community colleges are not operating at optimal scale and they face imperfect competition, the VRS assumption more appropriate than the CRS assumption. Therefore, in the present study the new decomposition of the Hicks–Moorsteen TFP index is utilized, allowing one to analyze changes in the productivity of firms under the VRS assumption. Moreover, according to Epure, Kerstens, and Diego (2010) another issue with the use of the Malmquist index is that there is a possibility of having infeasible results. Gilbert and Wilson (1998), Glass and McKillop (2000) and Arjomandi, Valadkhani, and Harvie (2011) experienced this difficulty in their studies of the Korean banks, UK building societies, and Iranian banks, respectively. Epure et al. [14] suggest that one can turn to the Hicks–Moorsteen TFP index to address these problems.

**Literature Review**

There has been a rapid expansion during the last few decades in the use of nonparametric approaches in measuring efficiency and productivity changes of higher education institutions. A large number of these studies have been undertaken in developed countries (Warning, 2004; Carrington & Rao, 2005; Emrouznejad, & Thanassoulis, 2005; Joumandy, & Catherine, 2005; Johnes, 2006a; Johnes, 2006b; McMillan & Chan, 2006; Jorgenson & Griliches. 1967; Tajnikar & Debevec, 2008; Abbott & Doucouliagos, 2000; Johnes & Schwarzenberger, 2010; Kempkes & Pohl, 2010). Only a few of the higher education studies pertained to developing countries. For instance, Ng and Li (2000) examined the efficiency of 84 key Chinese higher education institutions in the post-reform period (1993–1995) using data envelopment analysis (DEA). Focusing on the research performance of these universities, they found that their performance has, on average, improved over time. In another study of developing countries, Cokgezen (2009) investigates the technical efficiency of faculties of economics in Turkey in 2004. The results indicated an overall low level of efficiency with some variations across the faculties.

Focusing mainly on efficiency estimates may lead to an incomplete view of the performance of higher education institutions over time. Due to any of the following two reasons changes in distance function values may occur over time: 1) the movement of higher education institutions within the input-output space (efficiency changes); or 2) the progress/regress of the boundary of the production set over time (technological changes). The decomposition of the Malmquist index makes it possible to distinguish amongst changes in efficiency, productivity and technological changes. However, only a few studies have so far attempted to use the Malmquist index for this purpose such as Abbott and Doucouliagos (2003), Flegg, Allen, Field, and Thurlow (2004). Most of these studies have commonly found productivity progress in different sectors but this was mainly attributed to changes in technology and/or efficiency. For example, Flegg et al. (2004) examined changes in the productivity of 45 British universities in the period 1980–1993 and found that positive variations in productivity were due to technological change rather than efficiency change. In a comprehensive study of 35 Australian universities, Worthington and Lee (2008) also identified similar results in productivity growth. Agasisti and Johnes (2009) provided cross-country efficiency and productivity comparisons of English and Italian universities over a four-year period (2002–2005), attributing the overall productivity progress in each country to technological improvements and efficiency growth, respectively. Bradley et al. (2010) investigated 200 further education providers in UK in the period 1999–2003. Their results showed that the sector's productivity growth stem from both technical efficiency and technological changes.

Despite a growing volume of literature associated with the application of the conventional Malmquist index in the context of higher education institutions, there is little documented about the application of the Hicks–Moorsteen index. To the best of our knowledge, there are only four applications of the Hicks-Moorsteen decomposition in the existing literature: O'Donnell (2010), and Hoang (2011), which have used this TFP, index for measuring and decomposing changes in agricultural productivity. Hence, our study is the first attempt to use the Hicks-Moorsteen TFP index to analyze efficiency and productivity changes in the context of higher education.

**The Data**

This study utilizes a four-year panel dataset (2006–2010) for analyzing the performance of Malaysian community colleges after the implementation of NHESP. There are 34 main campuses of community colleges operating in Malaysia and all are considered in this study. The data will be collected from every community colleges main campus and from the Department of Research and Development in the Ministry of Higher Education. As Malmquist index is a distance-based index, non-parametric DEA models are employed to estimate the institutions' efficiency and productivity changes. An important advantage of the DEA approach is that it works well with a small sample size. The small sample size of 34 community colleges in this paper is not sufficient for parametric (econometric) techniques. There are a number of studies in the literature working also with small sample sizes (Tomkins & Green, 1988; Sinuany-Stern, Mehrez & Barboy, 1994; Sarafoglou & Haynes, 1996; Hanke & Leopoldseder, 1998; Haksever & Muragishi, 1998; Korhonen, Tainio, & Wallenius, 2001; Emrouznejad & Thanassoulis, 2005). Another advantage of the non-parametric approach pertains to its capability to accommodate multiple inputs and outputs.

The important issue in the use of the DEA approach relates to the correct selection of inputs and outputs. However, there is no consensus in the literature as to how to specify the inputs and outputs (Johnes & Johnes, 1993; Johnes, 1995; Athanassapoulos & Shale, 1997). According to Lindsay (1982) some characteristics of the higher education institutions such as 'lack of profit motivation, goal diversity and uncertainty, diffuse decision making and poorly understood production technology', differentiate this sector from other industries and complicate the specification of the variables. Carrington and Rao (2005) also state that it is difficult to accurately define the university inputs and outputs as they are diverse and multi-faceted. The choice of inputs and outputs in this study is based on the production approach–higher education which combines labor and non-labor factors of production to produce outputs in the form of teaching. This choice of input-output mix in this paper is somehow similar to previous studies by Madden and Savage (1997), Athanassapoulos and Shale (1997) and Glass, McCallion, McCillop, Rasaratnam, and Stringer (2006). The two inputs included in our analysis, which are fully defined in Table 1, are as follows: 1) National Modular certificates (Sijil Modular Kebangsaan) student enrolments; 2) Community College certificates student enrolment 3) the number of full-time equivalent academic staff members. We include the total student enrolments, instead of the more commonly used full-time equivalent student loads, due to the unavailability of the data. This difficulty was also experienced by Agasisti and Johnes (2009). Our output is the National Modular certificates (SMK) awarded.

Table 1
*Choices of inputs and outputs*

| Variables | Terms | Definition of Variables |
|---|---|---|
| Outputs | Qualifications awarded | The total number of qualifications awarded. |
| Inputs | Student Enrolment | The total number of enrolments. |
| | Teaching Staff | The number of full-time equivalent academic staff members. |
| | Non-teaching staff | The number of full-time equivalent non-academic staff member. |

Two observations are noteworthy at this point. First, student inputs are assumed to be homogenous as there was no easy way to capture the quality. This is consistent with DEA models of previous studies (Flegg & Allen, 2007). Second, we mainly focus on teaching as the most important activities of community colleges. Research outputs are not being included because of the unavailability of the data. We also not incorporated community services output as there is no accepted or easy way to evaluate community and consultation services (Ahn, Charnes, & Cooper, 1998).

**Hick-Moorsteen TFP Index and Its Decompositions**

Considering a firm with multiple inputs and outputs2, O'Donnell (2010) used the usual definition of total factor productivity following Jorgenson and Griliches (1967) and Glass and Donal (2000).

$TFP_{nt} = Y_{nt}/X_{nt}$, where $TFP_{nt}$ indicates the TFP of the $n^{th}$ firm in period *t*, $Y_{nt} \equiv Y(y_{nt})$ and $X_{nt} \equiv X(x_{nt})$, where $Y_{nt}$ and $X_{nt}$ are the aggregate output and aggregate input of the firm concerned, respectively.

According to this definition, one can specify TFP changes as the ratio of an output quantity index to an input quantity index (the ratio of output growth to input growth). O'Donnell (2010) refers to such index numbers as multiplicatively complete.

The Hicks–Moorsteen TFP index is the only multiplicatively complete index that we can estimate without requiring price data. This index is a ratio of Malmquist output and input quantity indices, so named because Diewert (1992) related its origins to Hicks and Moorsteen (1961). The Hicks–Moorsteen TFP index operates as follows:

$$TFP_{HM}^{t,t+1} = \left( \frac{D_o^{t+1}(x^{t+1}, y^{t+1}) D_o^t(x^t, y^{t+1})}{D_o^{t+1}(x^{t+1}, y^t) D_o^t(x^t, y^t)} \frac{D_I^{t+1}(x^t, y^{t+1}) D_I^t(x^t, y^t)}{D_I^{t+1}(x^{t+1}, y^{t+1}) D_I^t(x^{t+1}, y^t)} \right)^{1/2} \quad (1)$$

where $D_o(x,y)$ and $D_I(x,y)$ are output and input distance functions, respectively, defined as $D_O^T(x,y) = \min\{\delta > 0 : (x, y/\delta) \in P^T\}$, and $D_I^T(x,y) = \max\{\rho > 0 : (x/\rho, y) \in P^T\}$, where $P^T$ denotes the period–*T* production possibilities set.

Using DEA, one can calculate these distance functions. O'Donnell (2010) developed a DEA methodology for computing and decomposing the Hicks–Moorsteen TFP index. All DEA problems necessary for computing and decomposing the Hicks–Moorsteen TFP indices are detailed in O'Donnell (2010). As in Hoang (2011) and O'Donnell (2010), DEA is also used in this paper as a nonparametric method which does not make any assumption about the behavior of firms, the functional form of the technology or efficiency distribution. However, DEA makes no allowance for statistical inferences; therefore one should be cautious in the interpretation of its results.

Figure 1 shows O'Donnell's (2010) mapping of multiple-input and multiple-output production points into aggregate quantity space. The curve through points D and C denotes a mix-restricted frontier as it represents the boundary of the set of all technically-feasible aggregate input-output combinations which hold the same input and output mix as the firm operating at point A. Firm A can raise its TFP by expanding outputs until it achieves point C. The vertical distance from point A to point C is referred to as a measure of output-oriented technical efficiency (OTE):

$$OTE_t = \frac{Y_t}{\bar{Y}_t} = \frac{\tan a}{\tan c}. \qquad (2)$$

where $\bar{Y}_t$ is the maximum aggregate output that is technically feasible when using $x_t$ to generate a scalar multiple of $y_t$. Accordingly, the TFP of firm A, and the maximum possible TFP at point *C* (holding the input vector and output mix fixed) can be defined as $Y_t / X_t = \tan a$ and $\bar{Y}_t / X_t = \tan c$, respectively.

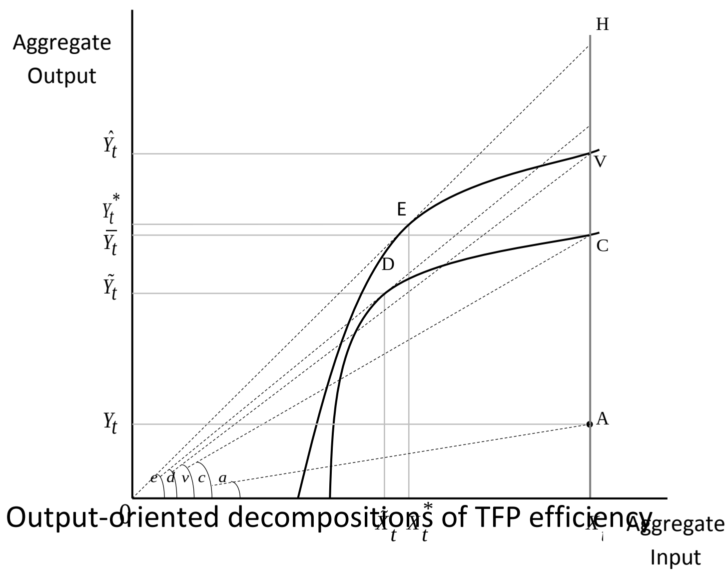


*Figure 1*. Output-oriented decompositions of TFP efficiency

The curve passing through point V is the unrestricted production frontier which is the limit of the production possibilities set when all mix restrictions are relaxed. Now Firm A can expand aggregate output compared to point C and move vertically to point *V* in Figure 1. In this situation, O'Donnell (2010) defined the mix efficiency measure as the difference between the

TFP at a technically efficient point on the mix-restricted frontier, and the TFP at a technically efficient point on the unrestricted frontier. Hence, the pure output-oriented mix efficiency (OME) is written as:

$$OME_t = \frac{\bar{Y}_t}{\hat{Y}_t} = \frac{\bar{Y}_t / X_t}{\hat{Y}_t / X_t} = \frac{\tan c}{\tan v} \quad (3)$$

where $\hat{Y}_t$ is the maximum aggregate output feasible when a firm uses $x_t$ to produce a vector of output.

However, the TFP of Firm A can be maximized only by reaching point E, where a straight line through the origin is tangential to the unrestricted production possibilities frontier. Point E is known as the point of maximum productivity. The residual scale efficiency measure is defined by O'Donnell (2010) as the difference between the TFP at point V and the TFP at point E. The residual output-oriented scale efficiency (ROSE) is the vertical distance from point V to point H or:

$$ROSE_t = \frac{\hat{Y}_t / X_t}{Y^*_t / X^*_t} = \frac{\tan v}{\tan e} \quad (4)$$

According to the definitions provided above, it can be then concluded that:

$$\text{TFP Efficiency } = TFPE_t = \frac{TFP_t}{TFP_t^*} = \frac{\tan a}{\tan e} = \frac{\tan a}{\tan c}\frac{\tan c}{\tan v}\frac{\tan v}{\tan e} \quad (5)$$

Equation (5) is a measure of TFP efficiency which calculates the proportionate increase in TFP as the firm moves from point *A* to point *E.* Figure 1 show that there are many pathways from point *A* to point *E*. Thus, there are many ways to decompose TFP efficiency in Equation (5). Pathway ACVE is employed for $TFPE_t$; another possible way is ACDE, which shows that TFP efficiency can also be written as:

$$TFPE_t = \frac{\tan a}{\tan e} = \frac{\tan a}{\tan c}\frac{\tan c}{\tan d}\frac{\tan d}{\tan e} \quad (6)$$

In relation to the efficiency measures defined in this section (Equations 2 to 4), the following output-oriented decomposition can thus be defined:

$$TFPE_t = \frac{TFP_{nt}}{TFP_t^*} = OTE_{nt} \times OME_{nt} \times ROSE_{nt} \quad (7)$$

This decomposition can be used as a foundation for an output-oriented decomposition of a multiplicatively complete TFP index, and can be rewritten as:

$$TFP_{nt} = TFP_t^* \times (OTE_{nt} \times OME_{nt} \times ROSE_{nt}). \quad (8)$$

A similar equation can be formulated for any other firm like *m* in period *s*. accordingly; the index number that compares the TFP of firm *n* in period *t* with the TFP of firm *m* in period *s* will be given by:

$$TFP_{ms,nt} = \frac{TFP_{nt}}{TFP_{ms}} = \underbrace{\left(\frac{TFP_t^*}{TFP_s^*}\right)}_{Technical\ changes} \times \underbrace{\left(\frac{OTE_{nt}}{OTE_{ms}} \times \frac{OME_{nt}}{OME_{ms}} \times \frac{ROSE_{nt}}{ROSE_{ms}}\right)}_{Efficiency\ changes} \quad (9)$$

The term included in the first parentheses on the right-hand side of this equation represents technical changes, measuring the difference between the maximum TFP possible using the technology feasible a times *t* and *s*. Thus, the sector experiences technical improvement or decline depending on whether $TFP_t^* / TFP_s^*$ is greater than or less than 1. In Figure 1, $TFP_t^* / TFP_s^*$ measures the change in the slope of the line that passes through point *E*. Unlike in the decomposition of the Malmquist TFP index, Färe et al. (1994) calculate the change in the slope of the line passing through point *D*. Hence, O'Donnell (2010) presents that this technical change contains a mixed effect and characteristically differs from firm to firm. The three other ratios on the extreme right hand side of Equation (9) are referred to as measures of technical-efficiency change, mix-efficiency change and (residual) scale-efficiency change. We use Equation (9) to examine various components of technical-efficiency changes. This method has also been employed by Hoang (2011) and O'Donnell (2010) to investigate changes in the agricultural productivity of OECD countries and Australia, respectively. We used the DPIN software written by O'Donnell (2010) to estimate different measures of efficiency and TFP components.

**Results and Discussions**

The findings in this section present Hicks-Moorsteen Index decomposition approach, which is also a distance-based index derived from DEA methodology (2010). The approach used in this study employed the estimation of distance function under the VRS assumptions. Output-oriented efficiency level of Malaysian community college and its components which are pure technical efficiency scale of efficiency and mix efficiency were presented individually in Table 2. This study employed the intermediation approach since there is no profit mechanism in the community college sector. The sample period of study took place from the year 2006 to 2010.

The interpretation of results was uncomplicated as the efficiency score equal to unity (which is 1) indicated that the colleges were on the production set frontier, hence it is considered practically efficient. While a firm is inefficient with an efficiency score less than unity, this may indicate that the firm lies below production frontier. However, a firm with pure technical efficiency (OTE) equal to 1 can be considered unproductive if the value of scale and mix efficiency scores were less than unity.

Table 2 reveals the results of output-oriented efficiency level for each year of the study. In Table 2, it has been observed that only five community colleges (i.e. Bandar Darulaman, Sungai Petani, Bandar Penawar, Kuantan and Mas Gading) scored an OTE equal to 1 in the year

2006. These patterns were followed by three community colleges (i.e. Bandar Darulaman, Sungai Petani and Kepala Batas), five (i.e. Bandar Darulaman, Sungai Petani, Chenderoh, Sabak Bernam and Hulu Selangor), two (i.e. Bandar Darulaman and Sungai Petani) and four (i.e. Bandar Darulaman, Kepala Batas, Sabak Bernam and Selayang), for the year 2007 and onwards, respectively.

The number of efficient colleges declined in 2007 from the previous year. However, the numbers increased after the implementation of NHESP 2007 which was in 2008. The numbers began to decline in 2009 but increased again in 2010. New policies were implemented in the community colleges in 2010. These policies are known as the phase of strengthening community colleges (2010-2011). The new policy implemented may be the cause for the decrease in the number of efficient colleges since the sector underwent changes in its management. This shows that the community colleges provide intermediation services efficiently compared to the rest of colleges. In addition, a majority of the community colleges scored an efficiency level of less than unity. This situation indicates that the community college is heavily influenced by government policies and priorities in terms of awarding the National Modular Certificates to the student’s enrolment.

Table 2 shows that the output-oriented scale efficiency (OSE) and output-oriented mix-efficiency (OME) scores for all 34 community colleges over the period 2006-2010 were equal to 1. OSE score equal to 1 indicates that a community college has an optimum size to provide optimum intermediation services. Besides, there is no requirement for scale optimization since the community colleges have already facilitated higher levels of services provided. As for the OME scores, the results reveal that all community college have efficiently allocated inputs and outputs. The value of OME with less than 1 may indicate that the government policies affect a firm’s input allocation on output productions.

2016, Vol. 6, No. 12
ISSN: 2222-6990

Table 2
*Hicks-Moorsteen indices and its decomposition for individual community colleges (2006-2010)*

| Community College | 2006 | | | 2007 | | | 2008 | | | 2009 | | | 2010 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | OTE | OSE | OME | OTE | OSE | OME | OTE | OSE | OME | OTE | OSE | OME | OTE | OSE | OME |
| Arau | 0.400 | 1.000 | 1.000 | 0.315 | 1.000 | 1.000 | 0.850 | 1.000 | 1.000 | 0.782 | 1.000 | 1.000 | 0.788 | 1.000 | 1.000 |
| Bandar Darulaman | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| Sungai Petani | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 0.937 | 1.000 | 1.000 |
| Kepala Batas | 0.786 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 0.768 | 1.000 | 1.000 | 0.734 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| Bayan Baru | 0.990 | 1.000 | 1.000 | 0.554 | 1.000 | 1.000 | 0.771 | 1.000 | 1.000 | 0.763 | 1.000 | 1.000 | 0.680 | 1.000 | 1.000 |
| Teluk Intan | 0.983 | 1.000 | 1.000 | 0.840 | 1.000 | 1.000 | 0.455 | 1.000 | 1.000 | 0.356 | 1.000 | 1.000 | 0.421 | 1.000 | 1.000 |
| Chenderoh | 0.615 | 1.000 | 1.000 | 0.966 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 0.814 | 1.000 | 1.000 | 0.845 | 1.000 | 1.000 |
| Gerik | 0.784 | 1.000 | 1.000 | 0.247 | 1.000 | 1.000 | 0.270 | 1.000 | 1.000 | 0.796 | 1.000 | 1.000 | 0.697 | 1.000 | 1.000 |
| Sungai Siput | 0.578 | 1.000 | 1.000 | 0.952 | 1.000 | 1.000 | 0.719 | 1.000 | 1.000 | 0.543 | 1.000 | 1.000 | 0.757 | 1.000 | 1.000 |
| Pasir Salak | 0.709 | 1.000 | 1.000 | 0.570 | 1.000 | 1.000 | 0.439 | 1.000 | 1.000 | 0.533 | 1.000 | 1.000 | 0.846 | 1.000 | 1.000 |
| Sabak Bernam | 0.954 | 1.000 | 1.000 | 0.865 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 0.880 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| Kuala Langat | 0.976 | 1.000 | 1.000 | 0.657 | 1.000 | 1.000 | 0.513 | 1.000 | 1.000 | 0.851 | 1.000 | 1.000 | 0.722 | 1.000 | 1.000 |
| Hulu Selangor | 0.690 | 1.000 | 1.000 | 0.696 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 0.718 | 1.000 | 1.000 | 0.385 | 1.000 | 1.000 |
| Hulu Langat | 0.52 | 1.00 | 1.00 | 0.60 | 1.00 | 1.00 | 0.61 | 1.00 | 1.00 | 0.48 | 1.00 | 1.00 | 0.58 | 1.00 | 1.00 |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 6 | 0 | 0 |
| Selayang | 0.66 | 1.00 | 1.00 | 0.13 | 1.00 | 1.00 | 0.56 | 1.00 | 1.00 | 0.73 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| | 0 | 0 | 0 | 2 | 0 | 0 | 5 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 0 |
| Jempol | 0.63 | 1.00 | 1.00 | 0.56 | 1.00 | 1.00 | 0.89 | 1.00 | 1.00 | 0.91 | 1.00 | 1.00 | 0.69 | 1.00 | 1.00 |
| | 9 | 0 | 0 | 2 | 0 | 0 | 1 | 0 | 0 | 9 | 0 | 0 | 8 | 0 | 0 |
| Jelebu | 0.54 | 1.00 | 1.00 | 0.55 | 1.00 | 1.00 | 0.29 | 1.00 | 1.00 | 0.44 | 1.00 | 1.00 | 0.94 | 1.00 | 1.00 |
| | 4 | 0 | 0 | 7 | 0 | 0 | 4 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 0 |
| Bukit Beruang | 0.94 | 1.00 | 1.00 | 0.80 | 1.00 | 1.00 | 0.88 | 1.00 | 1.00 | 0.69 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 |
| | 6 | 0 | 0 | 9 | 0 | 0 | 6 | 0 | 0 | 5 | 0 | 0 | 1 | 0 | 0 |
| Alor Gajah/Masjid | 0.32 | 1.00 | 1.00 | 0.36 | 1.00 | 1.00 | 0.45 | 1.00 | 1.00 | 0.68 | 1.00 | 1.00 | 0.67 | 1.00 | 1.00 |
| Tanah | 3 | 0 | 0 | 9 | 0 | 0 | 2 | 0 | 0 | 8 | 0 | 0 | 3 | 0 | 0 |
| Selandar | 0.62 | 1.00 | 1.00 | 0.74 | 1.00 | 1.00 | 0.45 | 1.00 | 1.00 | 0.80 | 1.00 | 1.00 | 0.93 | 1.00 | 1.00 |
| | 1 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 6 | 0 | 0 | 7 | 0 | 0 |
| Jasin | 0.31 | 1.00 | 1.00 | 0.68 | 1.00 | 1.00 | 0.73 | 1.00 | 1.00 | 0.73 | 1.00 | 1.00 | 0.66 | 1.00 | 1.00 |
| | 0 | 0 | 0 | 9 | 0 | 0 | 2 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 |
| Segamat | 0.97 | 1.00 | 1.00 | 0.74 | 1.00 | 1.00 | 0.90 | 1.00 | 1.00 | 0.89 | 1.00 | 1.00 | 0.79 | 1.00 | 1.00 |
| | 4 | 0 | 0 | 8 | 0 | 0 | 8 | 0 | 0 | 1 | 0 | 0 | 5 | 0 | 0 |
| Ledang | 0.53 | 1.00 | 1.00 | 0.53 | 1.00 | 1.00 | 0.39 | 1.00 | 1.00 | 0.77 | 1.00 | 1.00 | 0.91 | 1.00 | 1.00 |
| | 2 | 0 | 0 | 5 | 0 | 0 | 7 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 |
| Bandar Penawar | 1.00 | 1.00 | 1.00 | 0.30 | 1.00 | 1.00 | 0.43 | 1.00 | 1.00 | 0.67 | 1.00 | 1.00 | 0.80 | 1.00 | 1.00 |
| | 0 | 0 | 0 | 8 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 |
| Segamat 2 | 0.71 | 1.00 | 1.00 | 0.72 | 1.00 | 1.00 | 0.32 | 1.00 | 1.00 | 0.62 | 1.00 | 1.00 | 0.53 | 1.00 | 1.00 |
| | 0 | 0 | 0 | 3 | 0 | 0 | 7 | 0 | 0 | 5 | 0 | 0 | 2 | 0 | 0 |
| Kuantan | 1.00 | 1.00 | 1.00 | 0.83 | 1.00 | 1.00 | 0.84 | 1.00 | 1.00 | 0.79 | 1.00 | 1.00 | 0.66 | 1.00 | 1.00 |
| | 0 | 0 | 0 | 1 | 0 | 0 | 8 | 0 | 0 | 7 | 0 | 0 | 1 | 0 | 0 |
| Bentong | 0.62 | 1.00 | 1.00 | 0.53 | 1.00 | 1.00 | 0.46 | 1.00 | 1.00 | 0.80 | 1.00 | 1.00 | 0.74 | 1.00 | 1.00 |
| | 8 | 0 | 0 | 6 | 0 | 0 | 3 | 0 | 0 | 5 | 0 | 0 | 3 | 0 | 0 |
| Mentakab/Temerloh | 0.35 | 1.00 | 1.00 | 0.33 | 1.00 | 1.00 | 0.37 | 1.00 | 1.00 | 0.72 | 1.00 | 1.00 | 0.52 | 1.00 | 1.00 |
| | 5 | 0 | 0 | 8 | 0 | 0 | 7 | 0 | 0 | 6 | 0 | 0 | 3 | 0 | 0 |
| Paya Besar | 0.53 | 1.00 | 1.00 | 0.30 | 1.00 | 1.00 | 0.45 | 1.00 | 1.00 | 0.63 | 1.00 | 1.00 | 0.70 | 1.00 | 1.00 |
| | 4 | 0 | 0 | 6 | 0 | 0 | 3 | 0 | 0 | 1 | 0 | 0 | 9 | 0 | 0 |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Rompin | 0.679 | 1.000 | 1.000 | 0.539 | 1.000 | 1.000 | 0.290 | 1.000 | 1.000 | 0.702 | 1.000 | 1.000 | 0.967 | 1.000 | 1.000 |
| Kuala Terengganu | 0.865 | 1.000 | 1.000 | 0.645 | 1.000 | 1.000 | 0.804 | 1.000 | 1.000 | 0.739 | 1.000 | 1.000 | 0.750 | 1.000 | 1.000 |
| Kuching | 0.867 | 1.000 | 1.000 | 0.791 | 1.000 | 1.000 | 0.283 | 1.000 | 1.000 | 0.461 | 1.000 | 1.000 | 0.567 | 1.000 | 1.000 |
| Mas Gading | 0.763 | 1.000 | 1.000 | 0.816 | 1.000 | 1.000 | 0.974 | 1.000 | 1.000 | 0.518 | 1.000 | 1.000 | 0.779 | 1.000 | 1.000 |
| Tawau | 1.000 | 1.000 | 1.000 | 0.739 | 1.000 | 1.000 | 0.696 | 1.000 | 1.000 | 0.702 | 1.000 | 1.000 | 0.698 | 1.000 | 1.000 |
| Mean | 0.733 | 1.000 | 1.000 | 0.646 | 1.000 | 1.000 | 0.645 | 1.000 | 1.000 | 0.715 | 1.000 | 1.000 | 0.760 | 1.000 | 1.000 |

Source: Author’s calculations.

Table 3
*Estimates of Output-Oriented Technical, Scale and Mix Efficiency under the Hicks-Moorsteen Method for the industry as a whole (2006-2010)*

| Year | OTE | OSE | OME |
|---|---|---|---|
| 2006 | 0.733 | 1.000 | 1.000 |
| 2007 | 0.646 | 1.000 | 1.000 |
| 2008 | 0.645 | 1.000 | 1.000 |
| 2009 | 0.715 | 1.000 | 1.000 |
| 2010 | 0.760 | 1.000 | 1.000 |
| Mean | 0.700 | 1.000 | 1.000 |

Note: OTE is output-oriented technical efficiency; OSE is output-oriented scale efficiency; OME is output-oriented mix efficiency
Source: Author's calculations

Table 3 indicates that as a whole, the community college sector shows an average pure technical efficiency (OTE) of less than 1. Thus, this informs us that there exists a room for improvement for the industry as a whole. The results in Table 3 also suggest that the colleges as a whole have a high scale efficient average score. The same pattern can be also seen for mix efficiency average score for the sector as a whole. The results indicate that the community college sector has a full mixed efficiency in terms of allocation of inputs and outputs.

**Hicks-Moorsteen TFP Index and Its Components**

The measures of total factor productivity changes (ΔTFP) and its decompositions, technical changes (ΔT) and efficiency changes (ΔE) for individual community colleges have been observed over the pre- (2006-2007) and post –regulation (2007-2010) periods. The summary of estimated total factor productivity indices for the sector as a whole is presented in Table 4 presented the components of the ΔE which are changes in: (i) output-oriented pure technical efficiency (ΔOTE); (ii) the residual scale efficiency (ΔROSE); and finally (iii) output-oriented mix efficiency (ΔOME). Here, the estimated scores which are greater than 1 indicate a positive improvement in the measures, while the ones below 1 are indicative of deterioration in them.

Table 4 shows that the sector as a whole improved positively after the NHESP 2007 implementation. It should be noted that in the pre-NHESP period (2006-2007), the sector experienced negative changes by 10.2 per cent (ΔTFP = 0.898). The sector experienced ΔTFP positive changes in 2007 and onwards. The positive changes were attributable by ΔE scores by 1.252. Hence, we can conclude that the contributor for the high average ΔE score was ΔROSE which also significantly contributed to the ΔTFP. The positive changes of ΔE scores showed that the implemented NHESP 2007 affected the community college sector management in terms of its resource allocation. The positive average score of highly mix-efficient changes showed better management of resource allocation in the sector.

Table 4
*TFP Changes and their components for the industry as a whole between pre and post-NHESP 2007 under the Hicks-Moorsteen Method*

| Year | ΔTFP | ΔT | ΔE | ΔOTE | ΔROSE | ΔOME |
|---|---|---|---|---|---|---|
| 2006-2007 | 0.898 | 0.788 | 1.339 | 0.989 | 1.386 | 1.063 |
| 2007-2008 | 1.324 | 1.282 | 1.102 | 1.200 | 0.982 | 1.063 |
| 2008-2009 | 1.598 | 1.263 | 1.347 | 1.352 | 1.062 | 1.063 |
| 2009-2010 | 1.032 | 0.907 | 1.219 | 1.167 | 1.107 | 1.063 |
| | 1.213 | 1.060 | 1.252 | 1.177 | 1.134 | 1.063 |

Source: Author's calculations

Nevertheless, ΔT also reported an improvement for the community college sector as a whole with positive average scores of 1.060. The improvement in technical changes can be explained by the enhancement of information technology application and e-learning initiatives launched within the community colleges over the study sample period. Johnes (2008) mentioned that the increase of technology usage and e-learning activities may enhance the accessibility of information for students, expand teaching approaches and propel the administrative efficiency.

**Conclusion**

Based on empirical findings, firstly we discussed the results regarding the mean efficiency level. Although the industry is technically inefficient over each year, under Hick-Moorsteen index the industry efficiency level improved starting in the year 2009 to 2010. The overall mean efficiency scores under the two approaches across all community colleges suggested that there is room for improvement in a number of colleges. The industry showed negative technical efficiency level over the pre-NHESP period. On the other hand, the Hicks-Moorsteen output-oriented technical efficiency showed that the OSE average score equal to 1 indicated that a community college had an optimum size to provide optimum intermediation services. Besides, there was no requirement for scale optimisation since the community colleges had already facilitated higher levels of services provided. As for the OME scores, the results revealed that all community college had efficiently allocated inputs and outputs. The value of OME with less than 1 may indicate that the government policies affected a firm's input allocation on output productions.

Secondly, in terms of productivity analysis, the results showed that the sector's changes in TFP level decreased during 2006–2007, and then significantly improved soon after the implementation of the NHESP in 2007–2008 and again slightly declined during 2009–2010. The negative changes in TFP index during 2009-2010 were still higher during the pre-NHESP period. However, the overall TFP changes gained during the entire sample showed a significant improvement. The empirical findings also indicate that no matter which techniques are taken into consideration, the efficiency changes were consistently found to be the major sources of TFP index positive improvement. The second components involved the technological changes.

These results suggest that the current policies, particularly the NHESP, have played important roles in improving performance in this sector. Thus, policy makers in the Ministry of Higher Education should give greater priority to initiating innovative policy and redesigning current policy to further improve and sustain high overall economic efficiency levels in the tertiary education sector provider.

Overall, community colleges in Malaysia have recorded a large improvement in productivity growth, especially after the implementation of the NHESP. One may argue that the implementation of the NHESP beginning in 2007 has probably been the main driving force for enhanced efficiency and productivity growth. This paper is anticipated makes three significant contributions to the literature of efficiency and productivity changes in higher education institutions sector particularly in community colleges. First, this study is the first attempt that examined the issue of efficiency and productivity change by employing the Hick-Moorsteen TFP over the period 2006–2010. Second, based on observation this is the first paper that will measure the community colleges efficiency and productivity growth in response to significant policy changes in the Malaysian higher education sector during 2007. The effect of the NHESP on the performance of Malaysian community colleges over the period of 2006–2010 is investigated. Lastly, no previous study in developing countries has employed Hick-Moorsteen TFP indices method to measure efficiency and productivity changes in higher-education institutions.

**Acknowledgement**

The researchers would like to acknowledge the Ministry of Higher Education (MOHE) for the financial funding of this research via Research Acculturation Grant Scheme (RAGS) [Code no: 2013-0013-106-72].

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