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PRODUCTIVITY AS ECONOMIC MEASURE OF EFFICIENCY

Productivity is an economic measure of efficiency that summarizes value of outputs relative to the value of inputs used to create the outputs

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ABSTRACT

This paper aims to demonstrate that productivity is an economic measure of efficiency which normally summarizes value of outputs relative to value of inputs. The paper defines various terms used in the concept of productivity. It also explores various components of efficiency as it is used in the concept of productivity and economic efficiency. Furthermore, the paper explores various methods and techniques that used to measure productivity and economic efficiency. It also highlights various uses of productivity measures as it relates to economic efficiency. The paper concludes by arguing that productivity is an effective tool that can be used to measure economic efficiency of a firm or a nation.

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I. INTRODUCTION

The concept of productivity as measure of efficiency has attracted attention in numerous organizations, organizations as well as individuals over the past recent years. At its basic level, productivity measures the relationship between output and input in any production process (Coelli et al, 2005). Therefore, productivity is simply expressed in an input versus output formula for evaluating the production activities. Productivity does not just define output volume, but defines output realized in relation to the various resources employed. In the organizational context, efficiency and productivity mirrors the overall performance of the organization. This can result in decreases or increases in wealth of the shareholders. In this respect, economists, governments, as well as other professionals are greatly concerned with measuring and defining concepts of efficiency and productivity (Hollingsworth, 2008).

Productivity can be best equated as follows: Productivity = Output(s)/Input(s). Though terms efficiency and productivity are mainly used interchangeably, they do not have the same meanings. However, these two terms are closely related (Bartelsman & Mark, 2000). Efficiency is mainly defined by comparing outputs and inputs, and the highest level of productivity from each level of input is termed as the ideal or efficient situation. Efficiency normally reflects ability of an organization to obtain greatest output from certain sets of inputs. An efficient firm is the one that is realizing greatest output from certain set of inputs (Horrace & Schmidt, 2000). Productivity is the measures of production efficiency and efficiency of production implies capability of production to create incomes, and can be measured by subtracting real input value from real output value (Sigala et al, 2005).

This paper will utilize information obtained from the available existing literature pertaining to productivity as economic measure of efficiency which summarizes value of outputs relative to

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the value of inputs. The paper defines the concept of productivity and efficiency in context of economics. Furthermore, the paper is going to rely on numerous assumptions in order to show that productivity is an ideal tool that can be used to measure efficiency of a firm. These assumptions include that production process is represented mainly by production functions at various levels of the firm or the economy. Functions of production entail maximum producible output relative to sets of the existing inputs. The other assumption is that producers normally behave efficiently, in that, they maximize revenues and minimize costs. The other assumption is that markets participants are usually price takers and markets are competitive.

II. OVERVIEW OF PRODUCTIVITY AS ECONOMIC MEASURE OF EFFICIENCY

According to Coelli et al (2005), productivity is ratio between output and factors of production that made the output possible. Horrace and Schmidt (2000) on the other hand define productivity as ration of output to input. The ration is normally easy to calculate if unit utilizes input to generate a single product. In contrast, of production unit utilizes numerous inputs to generate numerous outputs, the outputs and inputs have to be combined so that productivity may remain ration of those two scalars (Kim & Schmidt, 2000).

Despite the fact that efficiency is different to productivity, most of the existing literatures do not provide enough differences between the two terms. For example, Bartelsman and Mark (2000) define both efficiency and productivity as the ration between input and output. Rather than defining efficiency as ration of outputs over inputs, it can be arguably described as distance between quantity of output and input, as well as the quantity of output and input that defines an ideal frontier, or the best possible frontier of a given firm in its industry or cluster (Murillo-Zamorano, 2004).

However, it is worth noting that productivity and efficiency are two interchangeably and cooperating concepts. Measures of efficiency in most cases are more accurate as compared to the measures of productivity mainly because they normally involve comparison of the most possible

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efficient frontier, and hence measures of efficiency can complete the measures of productivity, based on fraction of outputs over inputs (Hollingsworth, 2008).

Productivity is generally defined as inclusive measure of how effectively and efficiently a firm achieves its major objectives (Sickles et al, 2002). It normally the relationship between the inputs used and outputs obtained during a certain period of time. Productivity is construed as willingness and ability of an economic unit to generate the maximum possible output using certain technology and inputs (Horrace & Schmidt, 2000). The greater the output per input unit, the greater is the productivity. In order to compute productivity, it is important to identify the inputs and outputs obtained as well as used.

III. USE OF PRODUCTIVITY MEASURES

Productivity is an ideal tool in monitoring and evaluating the performance of a firm, particularly a business organization. When focuses at specific problems and issues, measures of productivity may be a powerful. In other words, productivity measures may be used as yardsticks of using resources effectively (Coelli et al, 2005). Managers are increasingly concerned with firm's productivity because this relates to creating improvements in organizations. Effective utilization of productivity measures gives a manager direction of how productivity of a firm can be improved, by either increasing numerator of a certain measure or reducing the denominator (Jayamaha & Mula, 2011).

In addition, managers are as well concerned with how measures of productivity are related to competitiveness. For example, if two organizations have same output level, but one needs less input to have a higher productivity level, the firm may be able to increase its market share by charging lower prices or to enjoy a greater profit margin by charging the same price (Bartelsman & Mark, 2000). Furthermore, productivity measures may be utilized to compare performance of a firm against other firms operating in the same industry. Productivity measures can also be used to compare performance of different departments in the same firm or to measure efficiency of

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different departments of a firm compared to measures achieved in earlier times (Sickles et al, 2002)

Furthermore, productivity measures may be used to evaluate efficiency and performance of the overall industry as well as productivity of entire country. There are mainly aggregate measures that are determined by combining measures of productivity of various industries, companies and also other segments of a given economy (Kim & Schmidt, 2000).

IV. MEASURING EFFICIENCY

Index number techniques

Scope of evaluating technical efficiency may be assessed by comparing various productivity ratios among group of firms at a point within a given time (Kim & Schmidt, 2000). The focus here entails analysis of productivity performance of a firm within a certain period of time in order to compare performance within a group of firms at a certain single point over time (Bartelsman & Mark, 2000). This is also referred to as cross-sectional analysis. Empirical evaluation of technical efficiency is normally framed as a benchmarking exercise (Murillo-Zamorano, 2004).

Technical efficiency of a firm can be assessed in terms of its performance relative to other firms operating in the same industry. Technical efficiency is normally defined based on production technology of a certain firm. Practically, production technology of a firm cannot be observed easily (Coelli et al, 2005). In most cases, we often have observable input and output data to work with. The approach utilized to measure efficiency of a firm implicitly assumes that the top performing firms within the industry are utilizing their common or existing production technology in the optimum possible manner, in that they are functioning at best possible level on the frontier. However, it is important to state that there is no clear manner to assess efficiency of a firm utilizing partial productivity ratios mainly because various ratios generate different rankings of performance (Hollingsworth, 2008). Therefore, it may be difficult to identify which firm is inefficient and the degree for potential improvement.

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Mathematical and Statistical techniques

The common used methods in measuring productivity of a firm include the stochastic frontier estimation and least squares regression, as well as mathematical programming method of data envelopment analysis (Horrace & Schmidt, 2000). Mathematical and statistical programming techniques usually do not need price information to compute technical efficiency especially where firms have multiple outputs or multiple inputs. Statistical approach typically requires explicit production function specification and assumes that existing relationship between outputs and inputs is inexact because of measurement error as well as other several factors (Jayamaha & Mula, 2011). Mathematical programming approach on the other hand does not assume a certain functional form though it allows the input and output information to determine shape of the possible efficiency frontier. It presupposes a deterministic or exact relationship between outputs and inputs that makes it to be sensitive to error of measurement (Salim, 2006).

The use of ordinary least squares regression (OLS) to estimate production function of an industry generates a measure of efficiency, which is influenced mainly by average practice instead of best practice. OLS method identifies the line of best fit mainly through the data set of input and input ratios for various firms operating in the same industry (Coelli et al, 2005). Generally, there will be discrepancy between output showed by regression line for certain level of input and the observed output in that level. By assumption, the difference will be entirely attributed to differences of systematic efficiency (Murillo-Zamorano, 2004). Efficiency of the firms will hence be ranked in accordance to such differences. The most efficient firm thus will be the one with the greatest possible positive difference.

Stochastic frontier analysis (SFA)

This is a more advanced statistical method of measuring economical efficiency of a firm. This technique presupposes that gap between observed and predicted performance can be divided into parts for random noise and inefficiency (Bartelsman & Mark, 2000). Stochastic frontier is utilized to identify the predicted performance and efficiency for the best firm, allowing for error of measurement. The other firms may be below the frontier and hence may be deemed to be

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inefficient as compared to the best performing firm. For such firms, SFA presupposes that a percentage of the gap between predicted and actual best performance is the measurement error (Salim, 2006). However, empirical measure using SFA normally require use of certain special computer software that may include the FRONTIER.

Data Development Analysis (DEA)

The Data Development Analysis (DEA) is commonly used to construct a production frontier, in order to measure efficiency and productivity relative to the developed formula. DEA is generally used to evaluate efficiency of a certain firm, within a certain industry, compared to various other firms operating within the same industry (Horrace & Schmidt, 2000). Therefore, DEA is an ideal measurement tool. Most researchers normally use DEA to evaluate efficiency in private sector organizations, public organizations as well as non-profit making organizations. Indices of productivity for each firm are evaluated on basis of outputs and inputs of the firm. That index is referred to as DEA score. From DEA score, productivity as well as efficiency is measured for the overall organization or even for unit in the organization. Evaluation unit is called the Decision Making Unit (DMU) (Jayamaha & Mula, 2011).

There are numerous DEA models that can be applied to measure efficiency of a firm or even a country. The commonly used models include: BCC, CCR, and Malmquist index. CCR model is used when all DMUs are running at optimum scale, which can as well be subject to imperfect competition, financial conditions or external constraints among many others (Bartelsman & Mark, 2000). This model is input oriented and is normally based on constant returns to scale (CRS). It is appropriate for measuring efficiency of multi-output and multi-input units. The BCC model on the other hand incorporates the CRS hypothesis and the variable returns to scale (VRS). In measuring technical efficiency, VRS model can as well incorporate effect of scale efficiency (Coelli et al, 2005). The Malmquist index can be utilized to measure not only the multi-inputs and multi-outputs, but as well for multi-period and single field analysis.

DEA utilizes mathematical programming to develop a production frontier encompassing a set of various linear segments. Frontier normally relates to best production at a certain point in time

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(Murillo-Zamorano, 2004). Points that separate the segments are usually from the best performing firms within a given sample. The production frontier normally "envelopes" firms that have the best or optimal output/input ratios. Stochastic frontier in comparison is estimated utilizing a regression technique from the best performing and efficient firms within a sample (Hollingsworth, 2008). Distance of inefficient firm from the frontier is generally the measure of inefficiency of the firm. Various methods can be applied to DEA and SFA efficiency scores to adapt to the influence of the environment, in which the firms are operating in (Sigala et al, 2005). However, just like stochastic frontier, empirical application of DEA also requires use of certain special computer software.

Economic efficiency components

Economic efficiency is all about maximizing collective or aggregate wellbeing of members of a certain community. Generally, economists argue that economic efficiency normally requires satisfaction or realization of three main components (Salim, 2006). These three components include productive efficiency, allocative efficiency and dynamic efficiency.

Productive efficiency

Productive efficiency is normally realized when output is generated at the minimum possible cost. This usually occurs when no more output can be generated based on the available resources. That is, when economy of a nation or a firm is on its production possibility frontier (PPF) (Bartelsman & Mark, 2000). In the figure below, a shift from A all through to D can be said to be improvement in the productive efficiency. Productive efficiency encompasses technical efficiency, which can be described as degree to which productive efficiency is technically feasible to decrease any input without reducing the output, as well as without increasing other input (Sickles et al, 2002). Therefore, when extra input is used or extra output is generated, ratio of inputs to outputs can be developed only if outputs and inputs are aggregated into two scalars. If for this purpose prices are used, then technical efficiency combines into productive efficiency.

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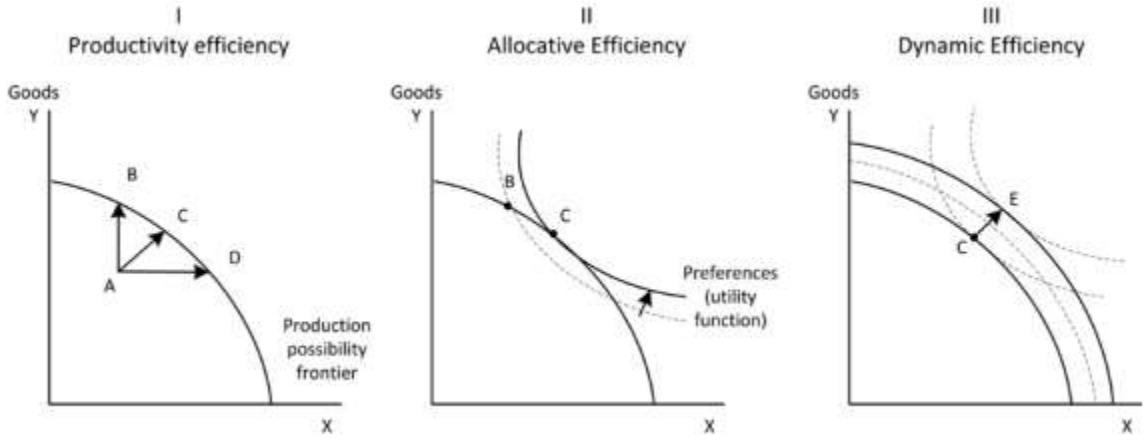
Allocative efficiency

This is concerned with ensuring that a firm or the community realizes the greatest returns from the available scarce resources. Resources of a country can be used in numerous different ways. The most efficient or the best allocation of resources utilizes them in the manner that contributes greatest to the wellbeing of the community. In figure II below, a shift from B to C indicates improvement of allocative efficiency since higher utility level can be realized by matching better the mix of output to the preferences (Coelli et al, 2005).

Dynamic efficiency

This implies the allocation of resources with the course of time, including allocations intended to improve the economic efficiency as well as to produce more resources (Horrace & Schmidt, 2000). This can also refer to finding better ways of generating products and services as well as finding better products. In figure III, this is shown as a shift out on the PPF, with consumption increasing as economy shifts from C to E (Jayamaha & Mula, 2011). This move can arise either from innovation or from growth in resources including labor and capital. Improvements of dynamic efficiency normally results in improvement in living standard over time.

Figure 1 (Coelli et al, 2005)



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Concept of productivity

Concept of productivity may be interpreted in various ways. Generally, productivity growth refers to the growth in output volume relative to increase of inputs used. But measure of productivity normally varies depending on how outputs and inputs are calculated (Hollingsworth, 2008). The commonly used criterion is the multifactor productivity but there are also other ways that are utilized to calculate productivity.

Multifactor productivity

MFP focuses mainly on overall output relative to volume of basic inputs, namely: capital and labor. Volume of output within an industry is regarded as value added of the industry, which is the overall value of sales minus cost of the inputs. Labor and capital inputs as well as value added output can be measured by quantity and volume indexes that fine-tune the total value of the changes mainly in the prices (Coelli et al, 2005). Therefore, MFP does not mirror changes in prices, particularly because of changes in concepts of trade or even changes in domestic preferences. Generally, volume indexes can be adjusted to mirror changes especially in quality of inputs and outputs, which can as well be mirrored in price. In practical sense, those adjustments are normally limited only to where quality may be measured reliably (Kim & Schmidt, 2000).

Total factor productivity (TFP)

This concept is somehow the same as MFP, though it utilizes volume indexes on basis of the total value of output as well as total cost of capital, labor and intermediate inputs (Horrace & Schmidt, 2000).

Labor productivity

Labor productivity is normally used to measure change in output volume relative to change in labor inputs volume. Generally, labor inputs are evaluated in terms of sum of hours worked; though quality adjusted input indexes of labor have as well been constructed (Salim, 2006). Labor productivity growth estimates utilizing quality adjusted inputs of labor can be lower when labor quality is growing.

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Capital productivity

Capital productivity measures any changes in the output volume relative to change in capital inputs volume. However, it is important to state that measuring capital volume accurately may be challenging since quality changes are not usually uniform within different forms of capital and rates of utilization as well as obsolesce and rates of depreciation can vary across industries and also over time (Bartelsman & Mark, 2000).

Firm productivity

Firm productivity is commonly referred to as profitability of the firm. While firm productivity should mean change in the output of a firm's output relative to inputs volume used by the organization, this term is sometimes incorrectly used to imply to the change in value of outputs of a firm relative to cost of inputs used by the firm (Sickles et al, 2002).

Support for the argument

It is arguably that productivity is the best tool that can be used to measure efficiency of a firm or a nation. Productivity is often utilized to measure efficiency, in order to help in economic forecasting and planning, as well as a means of evaluating the uses in which various resources and activities are being put. For example, efficiency of any given industrial operation may be measured by gauge of output per machine or per worker, and this yardstick can provide basis for premium payment or supplemental for workers (Horrace & Schmidt, 2000). When pay of the workers is solely based on the piecework, labor productivity may hence be the main determinant. Furthermore, it is important to state that productivity can serve as standard for evaluating and grading any team of workers conducting common tasks, differentiating the less from the more productive workers (Jayamaha & Mula, 2011). Productivity standards when applied to machines or equipments can show when a machine or equipment is performing poorly as well as when it needs to be serviced. Moreover, in forecasting, estimates of productivity are very important when it is essential to be capable of projecting performance of a certain economy at future time, given the feasible size of workforce (Coelli et al, 2005). This is normally common in planning mainly

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in the developing world especially to the nations that are seeking to increase their own productivity. Information regarding productivity target levels, combined with expectations about growth in labor force as well as appropriate understanding of relationship between output per worker and capital per worker, can help in estimating the proper amount of capital investment required in order to achieve that target (Kim & Schmidt, 2000).

In addition, estimates of the possible yearly gain in labor productivity alongside the estimates of possible increase in output can allow policymakers to estimate the number of jobs that will be available at a certain date in future. It is also worth noting that productivity is a good analytical tool that can be used to evaluate possible resources allocation among various uses. Extent to which different resources flow to different uses depends on their productivity, among a number of other things, in each of such uses (Bartelsman & Mark, 2000). Over time, changes in productivity change the pattern of the use, causing quantities of the resources needed in specific uses to also change. The resultant trends often depend on numerous things.

For example, let take the increase in labor productivity. Since this will imply a decrease in requirement of labor per unit of output, it will hence tend to decrease demand for workforce or labor. However, this will as well mean a cheapening of labor in relation to the cost of various other competing production factors (Hollingsworth, 2008). Therefore, this will tend to substitute factor of labor for certain other factors. If labor cost has been representing a large percentage of the total cost, labor productivity increase will hence contribute greatly towards a decrease in price of that product, therefore expanding sales as well as reducing demand for labor. The overall result will however depend on sum total of those separate effects (Salim, 2006). By all means, it is common to realize that expansionary effects prevail, and most economists see this as the likely outcome. In this respect, the concept of productivity and information of the productivity trends normally helps to have understanding of output and resource flows (Sickles et al, 2002).

V. CONCLUSION

Therefore, it is arguably that productivity is economic measure of efficiency that normally summarizes value of outputs relative to the value of inputs that are used to create the outputs.

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The paper has explored numerous ways through which productivity can be used to measure the economic efficiency of a firm or a nation. It has also explored various techniques that are used to measure economic efficiency as well as productivity. It has also describes the components of productivity as well as components of efficiency and argued that productivity is can be a measure of economic efficiency. However, the paper has used the information from existing available literature and hence it suggests for further research to be conducted on this area in order to come up with more information regarding this issue.

REFERENCES

[1] Bartelsman, E. J. & Mark, D. (2000). Understanding Productivity: Lessons from Longitudinal Microdata. *Journal of Economic Literature*, 38(3) 569-595.

[2] Coelli, T. J., Rao, D. P., O'Donnell, C. J. & Battes, G. E. (2005). *An Introduction to Efficiency and Productivity Analysis*. Lodnon: Springer.

[3] Hollingsworth, B. (2008). The measurement of efficiency and productivity of health care delivery. *Health Economics*. 17(10) 1107 – 1128.

[4] Horrace, W. C. & Schmidt, P. (2000). Multiple Comparisons with the Best, with Economic Applications. *Journal of Applied Econometrics*. 15(1) 1 - 26.

[5] Jayamaha, A. & Mula, J. M. (2011). Productivity and Efficiency Measurement Techniques: Identifying the Efficacy of Techniques for Financial Institutions in Developing Countries. *Journal of Emerging Trends in Economics and Management Sciences*. 2(5) 454 - 460.

[6] Kim, Y. & Schmidt, P. (2000). A review and Emperical Comparison of Bayesian and Classical Approaches to Inference on Efficiency Levels in Stochastic Frontier Models with Panel Data. *Journal of Productivity Analysis*. 14, 91-118.

[7] Murillo-Zamorano, L. R. (2004). Economic Efficiency and Frontier Techniques. *Journal of Economic Surveys*. 18(1) 33 – 76.

[8] Salim, R. A. (2006). Measuring Productive Efficiency Incorporating Firms' Heterogeneity: An Empirical Analysis. *Journal of Economic Development*. 31(1) 135 – 147.

International Journal of Business Quantitative Economics and Applied Management Research
ISSN: 2349-5677
Volume 2, Issue 11, April 2016

[9] Sickles, R. C., Good, D. H. & Getachew, L. (2002), Specification of Distance Functions Using Semi- and Non-parametric Methods with an Application to the Dynamic Performance of Eastern and Western European Air Carriers. *Journal of Productivity Analysis*. 17(1/2) 133-55.

[10] Sigala, M., P., Lockwood, J. A. & Airey, D. (2005). Productivity in Hotels: A Stepwise Data Envelopment Analysis of Hotels' Rooms Division Processes. *Service Industries Journal*. 25(1) 61-82.