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# A MULTIPLE REGRESSION ANALYSIS OF ECONOMIC OUTPUTS AS A FACTOR IN TIMSS SCORE IN SCIENCE AMONG SELECTED COUNTRIES IN ASIA

**Frank Angelo Pacala**
*Presidential School of Qarshi*
*Ministry of Public Education of Uzbekistan*
frankpacala@gmail.com

**ABSTRACT**

Trends in International Mathematics and Science Study (TIMMS) is one of the leading organizations that measures the academic competence of students around the world in terms of science and mathematics. This paper studied the idea that high economic output of a country leads to higher average scores TIMMS or vice versa. The independent variables were Gross Domestic Product (GDP) per capita, GDP real, GDP growth, Expenditure on Education, employment rate, and net trade in goods and services while the dependent variable was the TIMMS average score. Using multiple regression analysis (MRA), these independent variables were correlated to the dependent variable while making sure that the assumptions of MRA are observed. It was found out that the economic outputs were not a factor in TIMSS score.

***Keywords***: TIMMS; economic outputs; multiple regression analysis; science education; Asia.

## INTRODUCTION

One of the most important measures of country's' basic education success in science and maths is the ranking of the Trends in International Mathematics and Science Study (TIMSS). TIMSS is usually taken by fourth and eighth grades from all surveyed countries. The result and ranking of every country are important parameter on how they will direct all their policies toward the improvement of their nation's science and mathematics education.

It is a common perception that those countries with higher economic development outputs will have higher international test ranking. Hence, the ranking of a country in TIMMS is sometimes added in the national productivity output. In China, the result of ranking is included in the Human Capital Index (HCI). Angrist, Iqbal, and Kraay (2020) reported that the HCI is an expectation of education and health of every child when they reach 18 years of age. It is important to the Chinese society that one attain a high mark and ranking in all science and mathematics international tests including that of TIMMS. In New Zealand, the result of the TIMMS is a basis for the system-wide evaluation framework of the educational areas which is part of the national development agenda of the archipelago (Caygill, 2012).

As countries utilized the ranking of TIMSS in their national development policy, it is imperative to take a look on how the economic outputs (e.g., employment rate and GDP) of a country affect the TIMSS result. Tienken (2018) mentioned that economic

development has a direct relation to international test. He added that when a child reach eighth grade, for instance, that would be a big contributor to the future workforce because the child now has higher sets of competencies and skills.

This paper focused on these variables in the selected countries of Asia whom are part of the 2019 TIMSS survey. These nations were Singapore, South Korea, Japan, China (Hongkong Special Administrative Region - SAR), Philippines, Iran, and Pakistan. Three countries are lower-middle income (Philippines, Iran, and Pakistan) and five countries are high income (Singapore, South Korea, Japan, and Hongkong SAR) based on their Gross Domestic Product per capita as of 2018 (O'Neill, 2022). Moreover, this paper tried to figure out which if the economic outputs of a country in Asia affect its average score TIMSS. In this way this paper proved if the myth of economic prowess is significant or not significant to the score in TIMSS.

This research answered this question: "Is there a significant relationship between the Gross Domestic Product (GDP) per capita, GDP real, GDP growth, Expenditure on Education, employment rate, and net trade in goods and services to the average score in TIMSS in Science among selected countries in Asia?"

## RESEARCH METHOD

To answer the above primary question, this research utilized a quantitative research design following an archived research method and correlational method. Archival method is used to analyze data already gathered by government institutions, previous research outputs, business and industry and etc. The role here of the correlational method is to determine the degree of relationship between the economic outputs of selected Asian countries and their TIMSS score in 2019.

There are seven countries used in this research as shown in Table 1. These countries were chosen randomly. All Asian countries were written in a piece of paper and seven were pick using a lottery method. The countries chosen from low-income country, middle income country and high income in order to have proper representation.

**Table 1**

*The Economic Outputs of Selected Asian State/Region*

| State/Region | GDPR | GDPPC | GDPGR | ER | PGEE |
|---|---|---|---|---|---|
| HongKong | 394,507,000.00 | 49,660.60 | -5.4 | 56 | 20.3 |
| Iran | 231,041,000.00 | 2,756.70 | -3.3 | 37 | 23.1 |
| Japan | 5,124,619,000.00 | 39,285.20 | -3.6 | 60 | 17.3 |
| Pakistan | 341,730,000.00 | 1,537.90 | 4.5 | 48 | 11.6 |
| Philippines | 394,086,000.00 | 3,548.80 | 5.7 | 55 | 17.5 |
| Singapore | 396,986,000.00 | 72,794.00 | 7.6 | 66 | 19.5 |
| South Korea | 1,820,500,000.00 | 34,757.70 | -0.4 | 61 | 14.8 |

*Note*: All data on the table is from World Bank.

*Legend*: GDPR = Gross Domestic Product Real, GDPPC = Gross Domestic Product Per Capita, GDPGR = Gross Domestic Product Growth Rate, ER = Employment Rate, PGEE = Percentage of Government Expenditure of Education

Moreover, the data utilized were secondary data from World Bank found in the internet and also from related literatures. The independent variables were interval data (GDP per capita, GDP Real, GDP Growth, and net trade of goods and services) and ratio data (employment rate and percentage of expenditures on Education). The economic data from World Bank are from the reports submitted by member countries to the general secretariate (World Bank, 2021)

The dependent variable is the country's TIMSS average score which is an interval data as shown in Table 2. The TIMSS score were gathered from the 2019 results and the independent variables were from 2018 World Bank data.

**Table 2**

*2019 TIMSS Average Scores among Selected Asian State/Region*

| State/Region | Average Score |
|---|---|
| HongKong | 531 |
| Iran | 441 |
| Japan | 562 |
| Pakistan | 290 |
| Philippines | 249 |
| Singapore | 595 |
| South Korea | 588 |

The data were treated using multivariate technique called multiple regression analysis (MRA). An MRA is used to determine a prediction of a continuous dependent variable based from two or more independent variable (Tranmer & Elliot, 2008). In this analysis, there should be two or more independent variables and should be either ratio or interval while there should be one dependent variable and should be as well ratio and interval. The data were also subjected to normality test. This test measured if all the data were normally distributed which can be shown with the normal curve graph.

Moreover, the data were treated using the test of homoscedasticity. Yang, Chu, and Chen (2019) argued that multiple regression analysis must consider taking the data for test of homoscedasticity. This will allow the research hypothesis to reduce the emerging of type 1 error.

All in all, this research considers the MRA as the best tool to be used and this paper fit this all the requirements of MRA.

All these data were analyzed using Statistical Package for Social Sciences (SPSS) version 21.

## RESULT AND DISCUSSION

**Figure 1**

*Histogram*

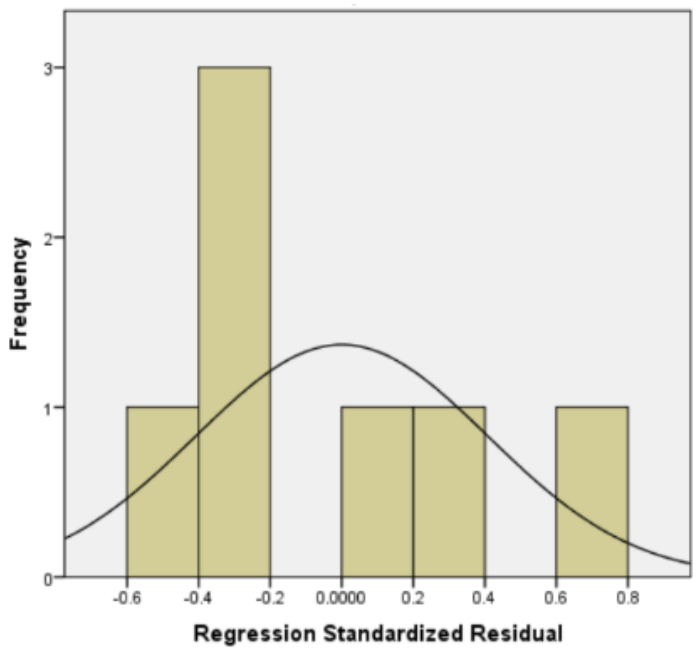
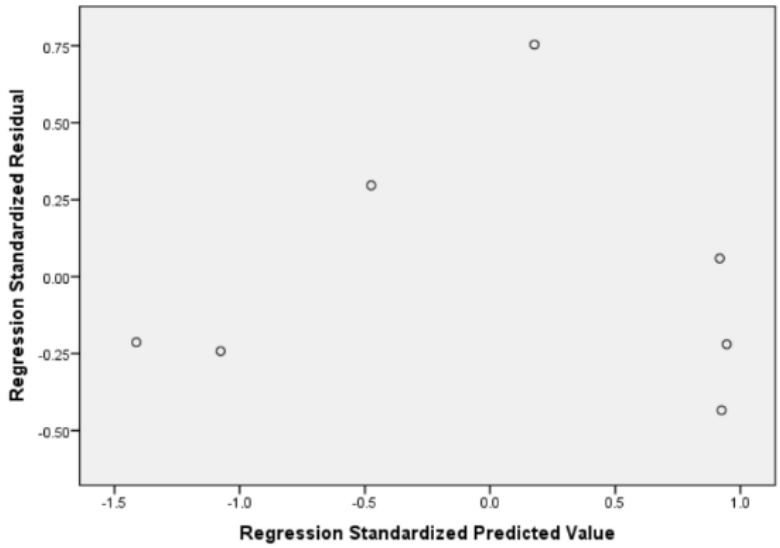



Figure 1 below shows the normality of the data by using a histogram. As shown, there is a bell shape graph which indicates that the data follows the normal curve. This shows that the normality of data as requirement for MRA is followed by this paper.

**Figure 2**

*Test for Homoscedasticity*



As shown in the figure 2, the data does not present a cone shape. There is no clear pattern of the data. This means that the scatter plot suggests that the data follows homoscedasticity.

**Table 3**

*The Regression Coefficients, Tolerance Levels, and the Variance Inflation Factor (VIF)*

| Model | | Unstandardized Coefficients | | Standardized Coefficients | | | Collinearity Statistics | |
|---|---|---|---|---|---|---|---|---|
| | | B | Std. Error | Beta | t | Sig. | Tolerance | VIF |
| 1 | Constants | 603.60 | 922.16 | | .66 | .63 | | |
| | GDPR | 1.77E-8 | .00 | .22 | .41 | .75 | .48 | 2.09 |
| | GDPPC | .006 | .01 | 1.06 | 1.17 | .45 | .17 | 5.90 |
| | GDPGR | -6.19 | 15.91 | -.22 | -.39 | .76 | .43 | 2.33 |
| | ER | -5.00 | 15.31 | -.34 | -.33 | .80 | .13 | 7.50 |
| | PGEE | -2.44 | 20.52 | -0.06 | -.12 | .93 | .49 | 2.06 |

The table above presents the multicollinearity tests of the independent variables. The tolerance and VIF levels were below 10 which means that there no excessive influence coming from the predictive variables over the dependent variable. Plotts (2011) cited that in order for the multicollinearity test to be successful, the VIF should not be greater than 10. This is a proof that this paper follows the multicollinearity requirement of MRA.

It can be viewed also that among the independent variables none presents a significant relationship to the dependent variable. All variables have a p value less than 0.05 which means that there is no significant relationship in each of these independent variables to the TIMSS average score. This implies that the economic outputs were not predictor of the average score of the 2019 TIMSS results in science.

Moreover, it is noted that for every increase in the GDPPC there is an increase of 0.006 in TIMSS average score in science. For every increase in the GDPR there is also an increase of $1.772 \times 10^{-8}$ to the average score in the said subject. All other predictive variables will decrease the average score.

From all of these, the regression equation is: TIMSS average score = $603.596 + 1.772 \times 10^{-8} x_1 + 0.006x_2 - 6.189x_3 - 5.003x_4 - 2.435x_5$

Where: $x_1$ = GDPR, $x_2$ = GDPPC, $x_3$ = GDPGR, $x_4$ = ER, and $x_5$ = PGEE

**Table 4**

*Model Summary*

| Model | R | $R^2$ | Adjusted $R^2$ | Change Statistics | | | | | Durbin-Watson |
|---|---|---|---|---|---|---|---|---|---|
| | | | | $R^2$ Change | F change | df1 | df2 | Sig. F Change | |
| 1 | 0.93 | 0.86 | 0.16 | 0.86 | 1.23 | 5 | 1 | 0.59 | 1.34 |

The multiple correlation coefficient (R) is 0.93 and the coefficient of determination ($R^2$) is 0.86. The $R^2$ of 0.86 implies that the model explains 86% of the variation in the dependent variable. This is seconded by the Durbin-Watson value of

1.34 which signifies a positive autocorrelation. Hassan (2019) emphasized that the Durbin-Watson value should not be less than 1 and greater than 3 so that there will be no concern in multivariate analysis such as the multiple regression analysis.

Furthermore, the significant F change is less than the p value of 0.05 which means that the overall F change is not significant. This implies that, in general, the economic outputs do not guarantee a high mark in TIMSS in the area of science.

The data analysis of the economic output as factor in TIMSS average score was found not significantly correlated based from the result of the multiple regression analysis. The myth that wealthy countries will have a good standing in TIMSS is not true. A more correct way of thinking is that international tests like TIMSS is a predictor of economic growth and not the other way around. This perspective is supported by Hanushek, Jamison, Jamison, and Woessmann, L. (2008) and Feniger and Atia (2019) whom concluded, in their research that tests of international mathematics and science were found significantly affecting the Real GDP and GDP per capita of a country under surveyed. It is now the direction of this research to write a research article about the effect of TIMSS score to the economic output of countries and probably in a wider sample of states or nations.

The use of MRA in this research was proven effective to determine the homoscedasticity and normality of the data. Not all data may follow the normal distribution. This research was lucky that the archival data from the World Bank website followed normal distribution by giving a normal curve graph. If it was not normally distributed, it was futile to use the MRA. Moreover, the homoscedasticity test gives a residual constant value. The graph shown that there was no clear pattern. In effect, this research has taken into account all the assumptions of MRA and proved that archival data can be analyzed using MRA, given that all assumptions are passed.

## CONCLUSIONS AND RECOMMENDATIONS

The conclusion derived from this paper is that the economic outputs of a country is not correlated to the TIMSS average score. Although the data were only from World Bank and TIMSS-PIRLS and not on the field realities, these data were from the national governments submitted to the World Bank and TIMSS PIRL conducted these tests on the ground. Also, the sample countries were not representative of all Asian countries surveyed by TIMSS. Therefore, the conclusion, as far as the countries sampled are concerned is a valid conclusion.

This research proved that archival data such that of the World Bank and TIMSS scores can be used for MRA as long as the assumptions are meet like normality and test of homoscedasticity.

The literature suggests that international tests are predictors of economic outputs so this paper suggest to turn the study in this direction for verification purposes and served as basis for Asian perspective. It will more fitting if a world-wide

investigation of this hypothesis be made to solve once and for all the effect of TIMSS score to economic development.

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