IMPACT OF SUB-INDICES ON GLOBAL COMPETITIVENESS INDEX: A PANEL DATA APPROACH OF THE EAST ASIA & PACIFIC REGION COUNTRIES

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ABSTRACT

Competitiveness is one of the most central preoccupations for both advanced and developing countries (Porter, 1990). It is the set of institutions, policies, and factors that determine the level of productivity of an economy, which in turn sets the level of prosperity that a country can achieve. Research on Global Competitiveness Index (GCI) is scanty. There is no such study that examines the impact of all the components on GCI and thus a research gap in this respect. The present study examines the impact of three main sub-indices such as basic requirements, efficiency enhancers and innovation & sophistication on GCI on East Asia and Pacific Region countries'/Economics and thus, different from other studies. To address this issue panel data regression model is applied. There are sixteen cross-sectional countries and seven time periods. Therefore, the study consists of (N x T = 16 x 7) 112 observations. Panel data regression model is applied because panel data, by combining the inter-country differences and intra-country dynamics have advantages over the cross-sectional or time-series data. After various estimation of regression models and statistical testing the study reach to the conclusion about superiority of FEM as compared to the CCM and REM. FEM perfectly estimates the coefficients of the parameters such as BR, EE and IS which are statistically significant and positively affect the GCI in East Asia and Pacific region countries. It may be recommended that panel data regression model whether it may be FEM or REM accurately estimates the model parameters. It contains more degrees of freedom and more sample variability than cross-sectional or time series data.

Key Words: GCI, WEF, Competitiveness, Basic Requirements, Indicators

Gel Code: C1 C10

INTRODUCTION

Competitiveness is one of the most central preoccupations for both advanced and developing countries (Porter, 1990) and "policy makers express serious concerns about it" (Lall 2001). It is the set of institutions, policies, and factors that determine the level of productivity of an economy, which in turn sets the level of prosperity that the country can achieve. The original idea of Klaus Schwab (1979) about Global Competitiveness Index (GCI) is developed by Xavier Sala-i-Martin and published it in first in 2005 in collaboration with World Economic Forum (WEF). The GCI unites 114 indicators that capture concepts that matter for productivity and long-term prosperity. These components are grouped into 12 pillars of competitiveness such as (1) institutions, (2) infrastructure, (3) macroeconomic environment, (4) health and primary education, (5) higher education and training, (6) goods market efficiency, (7) labour market efficiency, (8) financial market development, (9) technological readiness, (10) market size, (11) business sophistication, and (12) innovation and each of them measures a different aspect of it. Again, these 12 pillars are categorized into three sub-indices such as basic requirements (1-4), efficiency enhancers (5-10), and innovation and sophistication (11-12). The three sub-indices are given different weights for the computation of GCI and divides countries based on their stages of development. There is well-known economic theory of stages of development (classical, neoclassical, Keynesian economic theory, development economics, new economic growth theory and new trade theory), GCI assumes that, in the first stage the economy is factor-driven where first four pillars under basic requirements sub-index of a country are developed. The efficiency enhancers sub-index includes those pillars which are important for countries in the efficiency-driven stage and the innovation and sophistication sub-index includes those pillars which are critical to countries in the innovation-driven stage. The present study focuses the impact of three sub-indices on GCI of the East Asia-Pacific countries. East Asia-Pacific is characterized by great diversity and includes three of the World's ten largest economics like China, Japan and Indonesia.

LITERATURE REVIEW

Due to the increasing importance of global competitiveness in the understanding of contemporary economic and development issues, the researchers examine the relationship of the concept with various factors that influence it. It has become common to describe economic strength of an entity with respect to its competitors in the global market economy in which goods, services, people, skills, and ideas move freely across geographical borders (Saboniene 2009; Malakauskaite & Navickas 2010). According to D'Cruz in 1992 defines competitiveness is the ability of firm to design, produce and or market products superior to those offered by competitors, considering the price and non-price qualities. Some researchers (Barney & Hesterly 2001; Snieska & Draksaite 2007) observe that in changing business scenario some factors like business environment, dynamic capabilities, flexibilities, agility, speed, and adaptability are becoming more important sources of competitiveness. National competitiveness is one of the most important preoccupations for both advance and developing nations (Porter 1990) and policy makers express serious concerns about it (Lall 2001). Berger in 2008 identifies four main but very different theoretical constructs for national competitiveness and they have large divergences. According to Berger, another fifth concept of national competitiveness exists based on Porter's diamond model and its extended version. Although the diamond model has been widely applied to examine the competitiveness of different nations. According to Smith (2010), the weak aspects of Porter's model have been pointed out both by scholars of management and economics (Dunning 1992 & 1993; Rugman 1990 & 1991; Rugman & Verbeke 1993; Waverman 1995; Boltho 1996; Davies & Ellis 2000). Although the methodology used by World Economic Forum is very closely related to Porter's diamond model. It defines country competitiveness as the “set of institutions, policies, and factors that determine the level of productivity of a country” (Schwab, 2016).

GCI is not free from limitations. In 2001 Lall points out several methodological, quantitative and analytical problems, and dubs the index misleading due to its arbitrary weighting of variables and use of subjective indicators. Carvalho et al., in 2012 point out high correlation among its variables, and even methodological errors and data manipulation which may lead to objectionable results (Freudenberg 2003). Van Stel in 2005 indicates two of the most serious problems with the GCI namely: (1) the index is not stable over short time periods for developed nations and (2) it is not successful in predicting short and long term economic growth because it combines so many other variables, such as entrepreneurial activity (Xia et al., 2012). However, the authors of the latest Global Competitiveness Report state that “the concept of competitiveness thus involves static and dynamic competitiveness and ......can explain an economy's growth potential” (Schwab 2016).

GCI allows for several analysis levels when evaluating economic performance of the nations. Although, its application start with the firm level and it evaluates performance on the national, regional and global markets (see Hvidt 2013; Fagerberg 1996; Roessner, Porter, Newman & Cauffiel, 1996). In 2011, Silke explains global competitiveness to be the ability of countries to provide high levels of prosperity to their citizens. Measuring the global competitiveness entails quantifying the impact of various key factors that contribute to the creation of conditions for competitiveness. According to Helleiner in 2008, observes that global competitiveness also measures the policies and factors that contribute to sustainable economic prosperity. Hertog in 2011 says that it is significantly influenced by the way in which a nation uses the resources that it has. A more realistic definition is given by Alvarez et al., in 2009 that global competitiveness is the ability of the country to compete in global trade by exporting its products and thus competitiveness is considered in relations to the productivity and the growth of the nation. In 2011 Colton remarks that the concept of global competitiveness has come out as a new paradigm in economic performance studies. It is being used to capture the awareness of the threats and challenges that are caused by competition that occurs at the global level. It also helps to evaluate the performance of the institutions, factors and policies that significantly influence a nation's productivity levels.

Alfaki & Ahmed (2013) evaluate the relationship between global competitiveness and technological readiness in the Gulf region by focusing on the United Arabs Emirates (See also Aleksandra & Magdalena 2016). They observe that UAEs achieve immense success in technological readiness in terms of its Global Competitiveness Index (GCI). In a study by Wysokińska (2003), examines the concept of global competitiveness in terms of productivity levels and sustainable development in CEE and the countries of European Union. He observes that higher productivity leads to improved competitiveness in the global and local markets. Taner, Oncü, & Çivi (2010) also evaluates the performance of GCC nations based on international competitiveness. He concludes that the concept of global competitiveness is very multifaceted because of the wide array of indicators and factors that influence it.

In most of the existing literature, the concept of global competitiveness has been evaluated by looking at how it is influenced by specific economic parameters such as productivity levels (Wysokińska, 2003), trade balances, national economic performance (Taner et al., 2010) and technological readiness (Alfaki & Ahmed, 2013). Although these parameters and variables have been effectively used to examine the factors that influence global competitiveness. The earlier studies basically deal with various definitions about GCI and search for different factors for formulating GCI. Some of the studies examine the impact of few factors like productivity, trade balances, economic growth and GDP etc on GCI. The present study examines the impact of three main sub-indices such as basic requirements, efficiency enhancers and innovation & sophistication on GCI on East Asia and Pacific Region countries'/Economics. Currently, no study has been conducted to evaluate the impact of three sub-indices on GCI of East Asia and Pacific Region Countries.

The paper is organized as follows. The next section deals with details discussion about literature. Section 3 deals with objective. Data & study period is given in Section 4. Section 5 opens up the methodological part. Section 6 analyses the results and the remaining section deals with conclusion and recommendation.

OBJECTIVE OF THE STUDY

The study is designed to achieve whether Global Competitive Index (GCI) depends on the variables such as Basic Requirements (BR), Economic Enhancers (EE) and Innovation & Sophistication?

DATA & STUDY PERIOD

The study uses yearly score of Global Competitive Index (GCI) and its three sub-indices particularly Basic Requirements (BR), Efficiency Enhancers (EE) and Innovation & Sophistication (IS). The study covers East Asia and Pacific Region countries'/Economics. According to the GCI report (2016-2017) there are 17 countries or economics provided by World Economic Forum. Here, 16 countries are considered because data of Lao PDR is not available for all the years. The study period covers from 2010-2011 to 2016-2017 and the annual score of 16 countries regarding GCI and its sub-indices is collected from the website of World Economic Forum (Secondary source).

METHODOLOGY

In order to examine the impact of Global Competitive Index (GCI) on sub-indices particularly Basic Requirement (BR), Efficiency enhancers (EE) and Innovation & Sophistication factors (IS) or in other words how the GCI depends on the BR, EE and IS. To examine this issue panel data regression model is applied. Here, GCI is the countries' competitive performance indicator that depends on the performances of the remaining independent indicators. There are sixteen cross-sectional units (Countries) and seven time periods (2010-2011, 2011-2012, 2012-2013, 2013-2014, 2014-2015, 2015-2016 & 2016-2017). Therefore, the study consists of (N x T = 16 x 7) 112 observations. In other words, the sixteen countries are followed by seven years and sampled annually. If each cross-sectional unit has the same number of time series observations, then such a panel data is called balanced panel. In our case we have a balanced panel, as each country in the sample has seven (7) observations. A prior, GCI is expected to be positively related to BR, EE and IS. Polling, or combining, all 112 observations, the basic model of the determinants of GCI is the following:

$$GCI_{it} = \alpha_{1i} + \beta_1 BR_{it} + \beta_2 EE_{it} + \beta_3 IS_{it} + e_{it} \quad (1)$$

Here i and t refer to cross-sectional and time series aspects of data, respectively. As the number of cross-sectional units (N) is 16 and number of years (T) is 7, we have 112 observations on each variable (NT = 112). As, e_{it} is the disturbance term that is assumed to be independently and identically distributed [$e_{it} \sim$ i.i.d. $(0, \sigma^2)$]. For hypothesis testing, it is assumed that e_{it} is normally distributed and all the explanatory variables of the model are assumed to be non-stochastic, and none of these is correlated with the disturbance term.

ESTIMATION OF PANEL DATA REGRESSION MODEL

To estimate regression equation 1, there are three important approaches, which are Constant Coefficients Model (CCM), Fixed Effects Model (FEM) and Random Effects Model (REM). These models differ with regard to the assumptions that are made about the intercept, the slope coefficients and the disturbance term of model 1. In this study, CCM model is not considered because it is assumed that all coefficients remain unchanged across cross-sectional units, and over time which is not realistic. In other words, the CCM ignores the space and time dimensions of panel data set. In reality, the homogeneity assumption may not be true, and different cross-sectional units may have different values for intercept and / or slope coefficients and thus this model are not considered here. However, this problem can be avoided by fixed effects model (FEM) or the random effects model (REM). These two models seek to make a more rational specification of the model such that the heterogeneity among the cross-sectional units is explicitly recognized, although the methods of doing so are different. In any case, these models are viewed as proper panel data models.

A. Fixed Effects Model

To understand the basic idea behind the FEM, let's start with the research's objective is to examine the impact of GCI on BR, EE and IS by using data collected from World Economic Forum. The estimation of model 1 depends on the assumptions we make about the intercept, the slope coefficients, and the error term. There are several possibilities:

1. Assume that the intercept and slope coefficients are constant across time and space and the error term captures differences over time and countries
2. Slope coefficients constant but the intercept varies over countries
3. Slope coefficients constant but the intercept varies over time
4. Slope coefficients constant but the intercept varies over countries as well as time
5. The intercept as well as slope coefficients vary over countries as well as time

1. All coefficients constant across time and countries

Now start with the 1st possibilities where all coefficients are constant across time and countries and the regression model is stated in equation 1 which is a Constant Coefficients Model (CCM) or pooled OLS regression model.

Where, GCI_{it} = Global Competitive Index of i^{th} country in the time period "t"

BR_{it} = Is the vector of the control variables such as institutions, Infrastructure, macro-economic environment and health & primary education

EE_{it} = Is the vector of control variable such as higher education & training, goods market efficiency, labour market efficiency, financial market development, technological readiness and market size

IS_{it} = Is another vector of control variable that includes business sophistication and R&D innovation

e_{it} = Term of random disturbance

This model assumes that the values of α and β are same for all the countries. This however, seems to be unrealistic. It is considered that α represents the Global Competitive Index when the explanatory variables are zero. Stated differently, α is the benchmark from which a country's GCI develops and this value will be different for different countries. If we ignore this reality and estimate a single GCI function (Equation 1) by using the pooled data, then our estimate will provide incorrect value of the intercept parameter.

2. Slope coefficients constant but the intercept varies over countries (Cross-sectional Units)

One way to take into account the individuality of each country or each cross-sectional unit is to let the intercept vary for each country but still assume that the slope coefficients are constant across countries. The difference in the intercept may be due to countries' performances. Here, the equation 1 is called fixed effects model (FEM). It is also noted that the slope coefficients of the regression equation 1 don't vary across countries. This situation can be solved by the dummy variable technique, particularly, the differential intercept dummies. Now the equation 1 can be written as:

$$GCI_{it} = \alpha_1 D_{1t} + \alpha_2 D_{2t} + \alpha_3 D_{3t} + ... + \alpha_{16} D_{16t} + \beta_1 BR_{it} + \beta_2 EE_{it} + \beta_3 IS_{it} + e_{it} \quad (2)$$

Here intercept is considered as a variable and uses dummy variables to account for differences among the countries with regard to the value of intercept. Thus, there are 16 cross-sectional units, we use 16 dummy variables to avoid dummy variable trap. Here, D_2=1 if the observation belongs to Singapore 0 otherwise; D_2=1 if the observation belongs to Japan, 0 otherwise; D_3=1 if the observation belongs to Hong Kong SAR, 0 otherwise, and so on. Here, the dummy variable is used to estimate the fixed effects, the model is also known as the least-squares dummy variable (LSDV) model or covariance model. Here, BR, EE and IS are known as covariates.

Now a question arises about appropriateness of model. Which model is suitable whether pooled OLS regression model (model 1) or Fixed effect model (model 2)? This can be judged by applying the restricted F-test. Here, the null hypothesis (H_0) may be written as under:

$$H_0: \alpha_1 = \alpha_2 = ...= \alpha_n$$

To test the validity of the H0, the F* may be computed as under:

$$F^* = \frac{(R^2_{FEM} - R^2_{CCM}) / (N-1)}{(1-R^2_{FEM}) / (NT - N - K)} \sim F\ (N-1, NT-N-K) \quad (3)$$

Where, R^2_{FEM} is the computed value from Fixed Effects Model (Unrestricted Model)

R^2_{CCM} is the computed value from Constant Coefficient Model (Restricted Model)

N is the number of intercepts in FEM which is equal to cross-sectional units

NT is the total number of observations

K is the number of explanatory variables in the FEM

For the testing of the null hypothesis the decision rule is:

If $F^* > F_\theta$ (N-1, NT-N-K), i.e., computed F* is greater than the table value of F at a chosen level of significance θ and degree of freedom (N-1) for the numerator and (NT-N-K) for the denominator, then reject the null hypothesis and may be concluded that, compared with CCM, the FEM is more appropriate in the context of our panel data set. This also means that the fixed effects are present and the intercepts of cross-sectional units are statistically significantly different from each other.

3. Slope coefficients constant but the intercept varies over time

The study uses dummy variables to account for country effect. In addition to fixed effect, time effect is examined. It is assumed that GCI function changes over time because of factors such as government policy, technological changes etc that may affect temporal changes in the variables. In this case, the model would have no significant country differences but might have autocorrelation owing to time-lagged temporal effects. The residuals of this kind of model may have autocorrelation in the process. In this case, the variables are homogeneous across the countries. Such time effects can be easily accounted for if time dummies are introduced. The study considers seven years, from 2010-2011 to 2016-2017 and introduces 7 time dummies to avoid fall into dummy variables trap and the model can be written as under:

$$GCI_{it} = \gamma_1 T_{2010-11} + \gamma_2 T_{2011-12} + \gamma_3 T_{2012-13} + \gamma_4 T_{2013-14} + \gamma_5 T_{2014-15} + \gamma_6 T_{2015-16} + \gamma_7 T_{2016-17} + \beta_1 BR_{it} + \beta_2 EE_{it} + \beta_3 IS_{it} + e_{it} \quad \textbf{(4)}$$

Where, $T_{2010-11}$ takes a value of 1 for observation in the year 2010-2011 and 0 otherwise; $T_{2011-12}$ takes a value of 1 for observation in the year 2011-12 and 0 otherwise and so on.

Now, the study compares between model 2 and model 4 about appropriateness and thus, restricted F* test is applied which is given in equation 3.

4. Slope coefficients constant but the intercept varies over countries as well as time

To consider this possibility, model 2 and model 4 are combined as under:

$$GCI_{it} = \alpha_1 D_{1t} + \alpha_2 D_{2t} + \alpha_3 D_{3t} + ... + \alpha_{16} D_{16t} + \gamma_1 T_{2010-11} + \gamma_2 T_{2011-12} + \gamma_3 T_{2012-13} + \gamma_4 T_{2013-14} + \gamma_5 T_{2014-15} + \gamma_6 T_{2015-16} + \gamma_6 T_{2016-17} + \beta_1 BRit + \beta_2 EE_{it} + \beta_3 IS_{it} + e_{it} \quad (5)$$

Here, all the countries and time dummies are same as discussed in model 2 and model 4. Now come to comparison about which model is suitable whether model 1 or model 5? To examine their suitability restricted F* test is applied and conclusion is drawn in result section.

5. The intercept as well as slope coefficients vary over countries as well as time

Here, it is assumed that the intercepts as well as the slope coefficients that both vary according to the country and time. This is to say that the GCI functions of all the countries are all different according to the time. This can be done by extending the LSDV model (Model 2) to take care of this situation. Now, consider model 2 where individual dummies are introduced in additive manner. But in this context, how interactive or differential slope dummies can be accounted for the differences in slope coefficients. This can be done by multiplying each of the country dummies by each of the explanatory variables and time dummies by each of the explanatory variables that can be written as under:

$$GCI_{it} = \alpha_1 D_{1t} + \alpha_2 D_{2t} + \alpha_3 D_{3t} + ... + \alpha_{16} D_{16t} + \beta_1 BR_{it} + \beta_2 EE_{it} + \beta_3 IS_{it} + \gamma_1 (D_{1t} * BR_{it}) + \gamma_2 (D_{1t} * EE_{it}) + \gamma_3 (D_{1t} * IS_{it}) + \gamma_4 (D_{2t} * BR_{it}) + \gamma_5 (D_{2t} * EE_{it}) + \gamma_6 (D_{2t} * IS_{it}) + ... + \gamma_{43} (D_{16t} * BR_{it}) + \gamma_{44} (D_{16t} * EE_{it}) + ... + \gamma_{61} (D_{16t} * IS_{it}) + \gamma_{62} (T_{10-11} * BR_{it}) + \gamma_{63} (T_{10-11} * EE_{it}) + \gamma_{64} (T_{10-11} * IS_{it}) + ... + \gamma_{77} (T_{16-17} * BR_{it}) + \gamma_{78} (T_{16-17} * EE_{it}) + \gamma_{79} (T_{16-17} * IS_{it}) + e_{it} \quad (6)$$

In model 6, 45 more variables are added. Here, it is found that γ and α are the differential slope and intercept coefficients respectively that vary with the country. The intercept for country Singapore (Base Company) is α_1. Similarly, the intercept for country Japan would also include an additional intercept, α_2, so the intercept for country Japan would be $\alpha_1 + \alpha_2$ and so on. Similarly, the slope coefficient of Basic requirement (BR) for country Japan would be $(\beta_1 + \gamma_1)$, while the slope coefficient of BR for country Hong Kong SAR would be $(\beta_1+\gamma_4)$ and so on. In this way, the slope coefficients of IS and EE are computed for all the countries suggesting that the slope coefficients of the countries for BR, EE and IS are different from that of Singapore. In this way, both the intercepts and slopes vary with the countries. If all the differential intercepts and all the differential slope coefficients are statistically significant then it may be concluded that the GCI functions of the countries are different from that of Singapore.

B. Random Effects Model

The Random Effects Model (REM) doesn't use dummy variables to capture the presence of individual effect (here, country). If the dummy variables do in fact represent a lack of knowledge about the (true) model, why not express this ignorance through the disturbance term e_{it}? This is precisely the approach suggested by the proponents of the so-called error components model (ECM) or random effects model (REM).

The basic idea is to start with model 1:

$$GCI_{it} = \alpha_{1i} + \beta_1 BR_{it} + \beta_2 EE_{it} + \beta_3 IS_{it} + e_{it} \quad \textbf{(7)}$$

Instead of treating α_{1i} as fixed, here it is assumed that the individual effect is a random variable with a mean value of α_1. Then the intercept of i[th] cross-sectional unit can be expressed as under:

$$\alpha_{1i} = \alpha_1 + \mu_i \qquad i=1,2,............16 \quad \textbf{(8)}$$

Where μ_i is a random error term with a mean value of zero and variance of 2ms. The study considers sixteen countries and they have a common mean value for the intercept ($=\alpha_1$) and the individual differences in the intercept values of each country are reflected in the error term μ_i.

Now substituting equation 8 into equation 7, we obtain:

$$GCI_{it} = \alpha_1 + \beta_1 BR_{it} + \beta_2 EE_{it} + \beta_3 IS_{it} + \mu_i + e_{it} \quad \textbf{(9)}$$

$$= \alpha_1 + \beta_1 BR_{it} + \beta_2 EE_{it} + \beta_3 IS_{it} + \omega_{it} \quad \textbf{(10)}$$

Where, $\omega_{it} = \mu_i + e_{it}$ is the composite error term that has two components, μ_i, which is the cross-section, or country-specific, error component, and e_{it}, which is the combined time series and cross-section error component, sometimes called the idiosyncratic random term because it varies over cross-sectional units as well as over time. As this model considers individual effect (α_{1i}) as a random variable, hence the name Random Effects Model.

The usual assumptions that are made with regard to μ_i and e_{it} are as under:

μ_i ~ N(0, 2ms)

e_{it} ~ N(0,2es) **(11)**

$E(\mu_i e_{it}) = 0$

$E(\mu_i \mu_j) = 0$

(i≠j)

$E(e_{it} e_{is}) = E(e_{it} e_{jt}) = E(e_{it} e_{js}) = 0$

(i≠j; t≠s) Here,).(and)var(2e2itieVar==smsm

These assumptions imply that individual error components are not correlated with each other and are not correlated across cross-section and time series units. Using these properties of μ_i and e_{it}, we can work out the properties of ω_{it}.

$E(\omega_{it}) = 0$ **(12)**

$Var(\omega_{it}) = +$ **(13)**

Now if 2ms= 0, there is no difference between model 1 and model 10, in which case we can simply pool all the (cross-sectional and time series) observations and just run the pooled regression like Model 1.

It is observed that ω_{it} has zero mean and constant variance (homoskedasticity). However, it can be shown that ω_{it} and ω_{is} (t≠s) are correlated; that is, the error terms of a given cross-sectional unit at two different points in time are correlated. The value of such a correlation coefficient (ρ), $corr(\omega_{it}, \omega_{is})$, is as under:

$$\rho = \frac{\sigma_\mu^2}{\sigma_\mu^2 + \sigma_\varepsilon^2} \quad \text{for } t \neq s$$

If we ignore this correlation structure and estimate the Random Effects Model (Model 10) by OLS method, the resulting estimators will be inefficient. The most appropriate method to estimate the REM is the Generalised Least Squares (GLS) method.

C. Choosing Between FEM and REM: The Haussmann Test

In general, REM is considered suitable when the number of cross-sectional units (N) is large and the number of time series observations (T) is small. An intuitive explanation of this is that as the intercept (α_i) in the REM is a random variable, it must be allowed to assume a wide spectrum of values over (-),μμ. This is possible only when N is sufficiently large. Thus, REM doesn't suit a data set satisfactorily with fewer cross-sectional units. In such a situation, FEM that involves a lesser number of dummy variables appears suitable. FEM also enjoys computational convenience compared with the REM.

However, selection between FEM and REM is performed more rigorously by applying the Hausman Test. As pointed out earlier, REM is not preferred if the composite error term (w_{it}) gets correlated with the explanatory variable (s) of the model, which at times becomes a possibility. Hausman adapted a test based on the idea that if there is no correlation between w_{it} and explanatory variable(s), both OLS and GLS are consistent but OLS is inefficient. On the other hand, if such correlation exists, OLS is consistent but GLS is not. Hausman assumed that there are two estimators $b^{\wedge FEM}$ and $b^{\wedge REM}$ of the parameter vector β and added two-hypothesis testing procedures. The hypotheses are as under:

H0: Both $b^{\wedge FEM}$ and $b^{\wedge REM}$ are consistent, but is inefficient

Ha: is consistent and efficient, but is inconsistent

Here, we actually test H0 (random effects are consistent and efficient) against Ha (random effects are inconsistent, as the fixed effects will always be consistent). Hausman takes as the basis for the relevant test statistic. The Hausman test statistic is given by

$$H = \hat{q}'\left[Var(\hat{\beta}^{FEM}) - Var(\hat{\beta}^{REM})\right]^{-1}\hat{q} \sim \chi^2(k) \qquad (15)$$

Where, k is the number of explanatory variable. The decision rule is: If computed value of Chi-square is greater than the theoretical Chi-square value at a chosen level of significance γ and degrees of freedom k, i.e., $\chi^2 > 2l\ c(k)$ we reject H_0 which says that the REM is consistent, and accept the FEM. In contrast, we don't reject H_0 if $\chi^2 \leq (k)$ and prefer the REM.

RESULT & ANALYSIS

The results of the CCM and FEM (coefficients are constant over time & countries) are presented in table one. It is observed that the coefficients of basic requirements (BR), efficiency enhancers (EE) and Innovation & sophistication (IS) are positive but EE variable is not a significant variable to explain the Global Competitive Index (GCI) in the CCM model. However, the probability values of BR and IS are less than five percent and almost zero and thus the estimated coefficients of both the variables are statistically significant and able to explain the GCI. Similarly, it is also found that the coefficients of all the variables are positive and statistically significant and able to explain the GCI in the FEM model. Here, the R^2 value is slightly high as compared to the CCM model. The estimated D-W statistic is quite low based on FEM model, suggests existence of positive autocorrelation in the data.

The superiority of FEM over CCM is judged by applying three tests namely F-test, Chi-square test and Restricted F-test. Here the hypothesis is as under:

H_0: CCM or Pooled OLS Regression model is appropriate

H_a: Fixed Effect Model is Appropriate

Table one also presents test statistics of redundant fixed effect test and restricted F test. It is observed that both computed F (66.992786) and chi-square (276.477328) statistics are statistically significant and the probability values are less than five percent and almost zero. Similarly, the restricted F* (67.018) statistic is greater than the table value meaning that rejection of null hypothesis. Thus, fixed effect model is appropriate model to explain the GCI function.

Table 1 Estimation of CCM & FEM and Redundant Fixed Effect and Restricted F* tests

CCM or Pooled OLS Reg. Model				FEM			Redundant Fixed Effect Test		Restricted F test
Variable	**Coeff.**	**t-stat**	**R^2**	**Coeff.**	**t-stat**	**R^2**	**F-stat**	**χ^2**	**F^***
Constant	0.956068	17.48873* (0.0000)	0.983337	0.283423	2.402357* (0.0183)	0.998589	66.99278 (0.0000)	276.47732 (0.0000)	67.018
BR	0.467635	19.24476* (0.0000)		0.471329	23.70228* (0.0000)				
EE	0.050468	1.295028 (0.1981)	**D-W stat 0.201148**	0.245664	6.638464* (0.0000)	**D-W stat 1.631220**			
IS	0.274550	12.75797* (0.0000)		0.214215	8.227326* (0.0000)				

***significant at 5% level. Values in parenthesis are the probabilities values.**

The study also further checks which model is appropriate to explain GCI function? Fixed effect model or pooled OLS regression model? Here, dummy variables are used to estimate FEM. The result of the FEM based on model 2 is given in table two. It is found that the coefficients of the BR, EE and IS are statistically significant and the probabilities values are less than five percent that meaning that the above variables are significant to explain the GCI. Here, the estimated coefficients of the BR, EE and IS are same for all ways of estimating FEM. Moreover, the estimated coefficients of the countries are also statistically significant, as the probability values are very small except for Australia and Korea, Republic which are insignificant. Even if the intercept values of the sixteen countries are statistically different and these differences may be due to various factors such as institutions, Infrastructure, macro-economic environment, health & primary education, higher education & training, goods market efficiency, labour market efficiency, financial market development, technological readiness and market size, business sophistication and R&D innovation.

Table two also presents three test statistics namely F-test, Chi-square test and Restricted F-test to test the null hypothesis which is as under:

H_0: Pooled OLS Regression model, meaning that all dummy variables are zero or not

H_a: Fixed Effect Model

It is observed that the R^2 value and the D-W d value increases as compared to the pooled OLS regression model means model 1 is mis-specified. The estimated F-statistic (66.99279), chi-square statistic (1004.892) and restricted F* statistic (67.018) are highly significant and the probabilities values are very small meaning that less than five percent. Thus, H_0 is rejected and can accept H_a. Therefore, FEM with dummy variable is appropriate model to explain the GCI function.

Table 2 : Estimation of FEM using country dummy when slope coefficient constant

Variable	Coefficient	t-stat	Prob.	Wald Test		Restricted F test	Countries' Intercept
				F-stat	χ^2	F^*	
BR	0.471329	23.70228*	0.0000	66.99279	1004.892	67.018	
EE	0.245664	6.638464*	0.0000	(0.0000)	(0.0000)		
IS	0.214215	8.227326*	0.0000				
Singapore	0.170493	2.194324*	0.2354	df=(15,93)	df=15		0.170493
Japan	0.183427	6.191571*	0.0000				0.35392
Hong Kong SAR	-0.038905	-2.418884*	0.0175				0.131588
New Zeland	-0.040566	-2.238852*	0.0276				0.129927
Taiwan, China	0.122475	2.355434*	0.1232				0.202968
Australia	-0.014857	-0.859911	0.3920				0.155636
Malaysia	0.136133	5.746764*	0.0000				0.306626
Korea, Rep	-0.039582	-1.631004	0.1063				0.130911
China	0.171253	6.355913*	0.0000				0.341746
Thailand	0.176849	5.264310*	0.0000				0.347342
Indonesia	0.122972	3.328993*	0.0013				0.293465
Philippines	0.194950	4.647964*	0.0000				0.365443
Brunei Darussalam	0.284900	6.908575*	0.0000				0.455393
Vietnam	0.250697	5.857627*	0.0000				0.42119
Cambodia	0.203758	4.002408*	0.0001				0.374251
Mangolia	0.183374	3.558246*	0.0006				0.353867

*Significant at 5% level.

Here, time effect is allowed in the sense that the GCI function varies over time because for the impact of various sub-indices (Model 4). It is observed that none of the time dummies are statistically insignificant and the probability values are very high meaning that higher than five percent. The R^2 value is 0.983603 which is slightly higher than only 0.000266 as compared to R^2 (0.983337) in model 1 and the D-W value is 0.174972 which is lower than the model 1 (0.201148). On the basis of Wald test and restricted F* test the estimates test statistics are statistically insignificant and the probability values are higher than five percent and thus, H_0 is accepted meaning that GCI function has not changed much over time or in other words time effect is not the significant variables to explain the GCI function. It may be concluded that model 2 is an appropriate model to explain GCI function.

Table 3 : Estimation of FEM when intercepts varies over time, slope constant

Variable	Coefficient	t-statistic	Probability	Wald-Test		Restricted F test
				F-stat	χ^2	F*
BR	0.478160	22.81343	0.0000	0.275847	1.655083	0.100579
EE	0.248246	5.611591	0.0000	(0.94711)	(0.9485)	
IS	0.212796	7.895375	0.0000			
γ_1 (2010-11)	0.007554	0.774217	0.4409	df=6, 102	df=6	
γ_2 (2011-12)	0.001393	0.151221	0.8802			
γ_3 (2012-13)	0.012886	1.549896	0.1248			
γ_4 (2013-14)	0.005387	0.633428	0.5281			
γ_5 (2014-15)	0.002123	0.233912	0.8156			
γ_6 (2015-16)	0.001766	0.216845	0.8288			
γ_7 (2016-17)	0.237422	1.503876	0.1362			

***Significant at 5% level. Values in parenthesis are the probability values. R^2 = 0.998645, D-W = 1.612186**

Table 4 presents the estimated coefficients of FEM when intercept varies over countries as well as time but slope coefficient remains constant (Model 5). The coefficients of BR, EE and IS are statistically significant and the probability values are less than five percent that means these variables have significant impact on GCI function and the sign is positive. It is also found that the country dummies of eleven countries are statistically significant and the probability values are less than five percent that means the variables such as basic requirements, efficiency enhancers and innovation & sophistication are the significant variables that explain the GCI function properly for those countries and the remaining countries have insignificant country dummies. Although the time effect is insignificant meaning that GCI function has not changed much over time or in other words time effect is not the significant variable to explain the GCI function. Restricted F* test accepts the null hypothesis meaning that GCI function doesn't change across the countries and over time. Although, the change of GCI function is not uniform for all the countries as well as time as compared to the model 2. Thus, model two is an appropriate model to explain GCI function.

Table 4 Estimation of FEM when intercept varies over countries & time, slope constant

Variable	Coeff.	t-statistic	Prob.	Restricted F test
				F*
Basic Requirements (BR)	0.478160	22.81343*	0.0000	0.001085
Economic Enhancers (EE)	0.248246	5.611591*	0.0000	
Innovation & Sophistication (IS)	0.212796	7.895375*	0.0000	
Constant (Base Country)	0.115833	0.608759	0.5443	
Japan	0.191094	5.946871*	0.0000	
Hong Kong SAR	-0.038525	-2.338568*	0.0217	
New Zeland	-0.036641	-1.752299	0.0832	
Taiwan, China	0.037718	1.563408	0.1216	
Australia	-0.010855	-0.552735	0.5819	
Malaysia	0.143456	4.916471*	0.0000	
Korea, Rep	-0.033458	-1.120427	0.2656	
China	0.178985	5.305005*	0.0000	

Thailand	0.187592	4.453658*	0.0000	
Indonesia	0.135361	2.843698*	0.0056	
Philippines	0.209989	3.946826*	0.0002	
Brunei Darussalam	0.293128	5.514321*	0.0000	
Vietnam	0.265258	4.870402*	0.0000	
Cambodia	0.221329	3.362122*	0.0012	
Mangolia	0.200991	3.038601*	0.0031	
γ_1 (2010-11)	0.007554	0.774217	0.4409	
γ_2 (2011-12)	0.001393	0.151221	0.8802	
γ_3 (2012-13)	0.012886	1.549896	0.1248	
γ_4 (2013-14)	0.005387	0.633428	0.5281	
γ_5 (2014-15)	0.002123	0.233912	0.8156	
γ_6 (2015-16)	0.001766	0.216845	0.8288	
γ_0 (2016-17)	0.022151	1.945467	0.1984	

*Significant at 5% level. Values in parenthesis are the probability values. R2 = 0.983512, D-W = 1.612186

Table 5 presents the estimated coefficients of model six when both intercept and slope coefficient varies across the countries as well time. It is observed that the coefficients of BR, EE and IS are statistically significant and the probabilities values are less than five percent meaning that these variables are the significant variables to explain GCI function as before (Model 2). The differential intercept for the base country (Singapore) is statistically significant and the intercepts of New Zeland, Korea Republic, Philippines, Brunei Darussalam and Cambodia are also statistically significant and thus, they are different from the base country. The differential slope coefficient of BR, EE and IS are statistically significant only for Cambodia. Similarly, the differential slope coefficients of BR are statistically significant for Japan, Taiwan, Korea republic, Indonesia and Vietnam and thus they are different from their base country. In the same way the slope coefficients of IS are statistically significant for Hong Kong SAR, Taiwan, Indonesia and Brunei Darussalam and the slope coefficients of EE for Philippines and Brunei Darussalam are significant and different from the base country. On the same way, the coefficients of differential time dummies for Economic Enhancers (EE) for the year 2011-12, 2012-13 and 2014-15 are statistically significant and in other cases they are not significant. Thus, the interactive time dummies are not the significant variables to explain the GCI function. Here, it is found that the differential intercepts, slope coefficients and differential time dummies of BR, EE and IS for all the countries are not statistically significant and very few of them are significant, the significance is not uniform. Finally, the restricted F* test accepts the null hypothesis of pooled OLS regression model.

Table 5 Est. of FEM when intercept & slope coefficients vary across countries & time

Variable	Coefficient	t-statistic	Prob.	Restricted F* test
BR	0.401442	16.36107*	0.0000	0.104324
EE	0.339191	5.945610*	0.0000	
IS	0.072084	2.394392*	0.0204	
Constant (Base Country)	0.820108	4.109471*	0.0001	
Japan	-0.931670	-0.765060	0.4478	
Hong Kong SAR	-0.809483	-0.604220	0.5484	
New Zeland	-0.926827	-3.113345*	0.0030	
Taiwan, China	-0.872965	-0.907079	0.3686	

Australia	-0.911549	-1.447330	0.1539	
Malaysia	-0.772903	-1.471210	0.1474	
Korea, Rep	-0.829008	-2.116754*	0.0392	
China	-0.585998	-1.228341	0.2250	
Thailand	-0.763716	-1.181826	0.2428	
Indonesia	0.403641	1.215595	0.2297	
Philippines	-0.772698	-2.323694*	0.0242	
Brunei Darussalam	-2.310668	-7.017975*	0.0000	
Vietnam	-0.498636	-1.558617	0.1253	
Cambodia	-0.889571	-5.362644*	0.0000	
Mangolia	0.287536	1.180658	0.2432	
D2*BR	-0.226503	-4.183201*	0.0001	
D2*EE	0.203151	1.461880	0.1499	
D2*IS	0.232584	1.887380	0.0648	
D3*BR	-0.154579	-1.639122	0.1073	
D3*EE	0.090459	0.341996	0.7338	
D3*IS	0.246980	2.680101*	0.0099	
D4*BR	-0.061366	-0.265074	0.7920	
D4*EE	-0.176063	-0.311698	0.7565	
D4*IS	0.457116	1.172759	0.2463	
D5*BR	-0.213984	-3.518563*	0.0009	
D5*EE	0.189118	1.673609	0.1003	
D5*IS	0.223854	2.217726*	0.0090	
D6*BR	-0.042518	-0.235323	0.8149	
D6*EE	0.046636	0.201554	0.8411	
D6*IS	0.178010	0.621512	0.3611	
D7*BR	0.014714	0.113822	0.9098	
D7*EE	0.160732	0.587277	0.5596	
D7*IS	-0.002332	-0.032067	0.9745	
D8*BR	-0.183182	-3.798135*	0.0004	
D8*EE	0.177037	1.502136	0.1392	
D8*IS	0.192347	1.651281	0.1048	
D9*BR	-0.016658	-0.159132	0.8742	
D9*EE	0.137927	0.990941	0.3264	
D9*IS	0.017269	0.121757	0.9036	
D10*BR	0.034241	0.217778	0.8285	
D10*EE	0.110098	0.598477	0.5522	
D10*IS	0.026309	0.141176	0.8883	
D11*BR	-0.183055	-3.227733*	0.0022	
D11*EE	-0.244980	-1.292881	0.2019	
D11*IS	0.370291	2.935254*	0.0050	
D12*BR	-0.059949	-0.671560	0.5049	

D12*EE	0.335664	1.983333*	0.0527	
D12*IS	-0.104522	-1.103528	0.2750	
D13*BR	0.059550	1.904014	0.0626	
D13*EE	0.409238	3.771976*	0.0004	
D13*IS	0.135382	3.265679*	0.0020	
D14*BR	0.156091	3.487603*	0.0010	
D14*EE	-0.027249	-0.269550	0.7886	
D14*IS	-0.016661	-0.290753	0.7724	
D15*BR	0.208251	7.079800*	0.0000	
D15*EE	-0.308391	-3.953236*	0.0002	
D15*IS	0.246022	2.880874*	0.0058	
D16*BR	0.042156	0.221571	0.8312	
D16*EE	-0.134256	-1.523446	0.1235	
D16*IS	0.178312	1.542132	0.1425	
T10*BR	0.043990	1.054083	0.2995	
T10*EE	-0.042531	-0.988955	0.3299	
T10*IS	-0.010196	-0.343848	0.7331	
T11*BR	0.070279	1.876171	0.0695	
T11*EE	-0.068114	-2.025821*	0.0509	
T11*IS	-0.013620	-0.596045	0.5552	
T12*BR	0.050846	1.702026	0.0982	
T12*EE	-0.071405	-2.773601*	0.0091	
T12*IS	0.013439	0.534355	0.5967	
T13*BR	0.013156	0.455554	0.6517	
T13*EE	-0.025625	-1.023194	0.3137	
T13*IS	0.008500	0.371468	0.7127	
T14*BR	0.070980	1.893277	0.0671	
T14*EE	-0.069581	-2.064230*	0.0469	
T14*IS	-0.012945	-0.566088	0.5752	
T15*BR	0.040056	1.557721	0.1288	
T15*EE	-0.045836	-1.589637	0.1215	
T15*IS	-0.000220	-0.019913	0.9842	

***Significant at 5% level. Values in parenthesis are the probability values. R^2 = 0.999885, D-W = 2.121936**

The estimated coefficients of Random Effect Model (Model 10) are given in table six. The estimated coefficients are positive and statistically significant meaning that the probability values are less than five percent. Thus, Basic Requirements (BR), Economic Enhancers (EE) and Innovation & Sophistication (IS) are the significant variables to explain the GCI function. Although, the computed R^2 value (0.955198) of REM is lower than the FEM (0.998589) and the D-W statistic based on REM (1.362411) is also lower than the FEM (1.631220). Thus, autocorrelation problem is associated with the REM because of lower D-W statistic. The presence of cross-section effects is also confirmed based on the non-zero values of cross cross-section random effects. Although, the random effect values of the countries are different from the common intercept value.

Finally, the following hypothesis is formulated to test which model is appropriate?

H_0: Random Effect Model is appropriate

H_a: Fixed Effect Model

Here, Hausman Test is applied to test the null hypothesis. It is observed that the chi-square statistic is 12.779193 which is significant at five percent level and the probability value is very small, less than five percent meaning that the null hypothesis is rejected and can accept the alternative hypothesis. Hence, Hausman test and F-statistics are telling that Fixed Effect Model (FEM) is appropriate as compared to the Random Effect model (REM) in the context of sampled panel data.

Table 6 : Estimation of REM of the GCI function

Variable	Coeff.	t-stat	Prob.	Hausman Test (χ^2 statistic)	Prob.
Intercept	0.536204	5.690795*	0.0000	12.779193	0.0049
BR	0.460915	24.28406*	0.0000	df=3	
EE	0.201148	5.870223*	0.0000		
IS	0.216376	9.066764*	0.0000		
Cross Section Random Effect Value					
Singapore				-0.059616	
Japan				0.094696	
Hong Kong SAR				-0.102962	
New Zeland				-0.125454	
Taiwan, China				-0.055020	
Australia				-0.097821	
Malaysia				0.033679	
Korea, Republic				-0.138498	
China				0.059443	
Thailand				0.050989	
Indonesia				-0.011909	
Philippines				0.049799	
Brunei Darussalam				0.144876	
Vietnam				0.102995	
Cambodia				0.037451	
Mongolia				0.017252	

*Significant at 5% level. Values in parenthesis are the probability values. R^2 = 0.973939, D-W = 1.362411

Now come to the result of fixed effect model (model 2) again. Here, fixed effect model with dummy variable is the appropriate model. It is previously found that the explanatory variables such as Basic Requirements, Efficiency Enhancers and Innovation & Sophistication are the significant variables which are positively influence the Global Competitive Index (GCI) of the East Asia and Pacific region countries/economics. The cross-section fixed effects are non-zero that confirms about presence of fixed effect and the statistical tests also confirm about the superiority of fixed effect model (FEM) discussed above.

Table 7 : Estimation of FEM using country dummy when slope coefficient constant

Variable	Coefficient	t-stat	Prob.	Cross-section Fixed Effect
BR	0.471329	23.70228*	0.0000	
EE	0.245664	6.638464*	0.0000	
IS	0.214215	8.227326*	0.0000	
Constant (Singapore)	0.170493	2.194324*	0.2354	-0.112930
Japan	0.183427	6.191571*	0.0000	0.070497
Hong Kong SAR	-0.038905	-2.418884*	0.0175	-0.151835
New Zeland	-0.040566	-2.238852*	0.0276	-0.153496
Taiwan, China	0.122475	2.355434*	0.1232	-0.080455
Australia	-0.014857	-0.859911	0.3920	-0.127787
Malaysia	0.136133	5.746764*	0.0000	0.023203
Korea, Rep	-0.039582	-1.631004	0.1063	-0.152512
China	0.171253	6.355913*	0.0000	0.058323
Thailand	0.176849	5.264310*	0.0000	0.063919
Indonesia	0.122972	3.328993*	0.0013	0.010042
Philippines	0.194950	4.647964*	0.0000	0.082020
Brunei Darussalam	0.284900	6.908575*	0.0000	0.171970
Vietnam	0.250697	5.857627*	0.0000	0.137767
Cambodia	0.203758	4.002408*	0.0001	0.090828
Mangolia	0.183374	3.558246*	0.0006	0.070443

***Significant at 5% level.**

CONCLUSION & RECOMMENDATION

The present study examines whether variables such as basic requirements, efficiency enhancers and innovation & sophistication affect the global competitive index. Therefore, panel data regression model is applied because panel data, by combining the inter-country differences and intra-country dynamics have advantages over the cross-sectional or time-series data. It has greater capacity to capture the diverse complexity of global competitive index (GCI) than a single cross-section or time series data. After various estimation of regression models and statistical testing the study reach to the conclusion about superiority of fixed effect model (FEM) as compared to the CCM and REM in respect of East Asia-pacific region. FEM perfectly estimates the coefficients of the parameters such as BR, EE and IS which are statistically significant and positively affect the GCI.

Finally, it may be recommended that panel data regression model whether it may be FEM or REM accurately estimates the model parameters. It contains more degrees of freedom and more sample variability than cross-sectional or time series data.

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