APPENDIX A

A CONSTRUCTION OF COMPOSITE INDEX

Constructing a composite index involves four steps, namely variable selection; normalization; weighting and aggregation; and validation (McGranahan et al., 1972). It is important to note that the construction of composite indicator do not necessarily follow in this sequence. It is a concurrent effort during which selection can be altered, weights adjusted and variables rescaled in order to arrive at final index estimates. Moreover, validation of composite index should be concerned as in-depth analysis, excepting statistic testing.

1. Variable Section

Variable selection must be guided by theoretical framework for evaluating relevant variables (Adelman and Morris, 1972; Diener and Suh, 1997). Multivariate analysis such as Principal Component Analysis (PCA) is used to investigate the overall structure of variables. The purpose of this analytical technique is to determine the number of latent variables underlying the data, to condense the data, and to define the content and meaning of the component or latent variables accounting for the variation in the data. Hence, the degree of correlation structure of data is used for variable selection. Highly correlation indicates that they highly share common component and may be relevant variables.

2. Normalization

In general, normalization is required prior to any data aggregated as each measure could have different measurement unit.[1] Re-scaling will be used for converting variables to a common scale in range from 0 to 1 because *RULE* is assessed within this rage. Rescaling normalizes indicators to have an identical rage (0, 1). The re-scaling form is given by;

[1] This step can be performed in many ways, such as ranking, re-scaling, standardization(z-scores), etc. See detail in Nardo et al., 2005

$$x_i^* = \frac{x_t - \min(x)}{\max(x) - \min(x)}$$

where x_t^* = Re-scaling variable at time t

x_t = Actual variable at time t

$\min(x)$ = Minimum value of x_t for all t

$\max(x)$ = Maximum value of x_t for all t.

3. Weighting and Aggregation

Weighting and aggregation is central to the construction of a composite index in order to combine each individual measure in a meaningful way. In this study, Principle Component Analysis (PCA) approach is employed to find the proper weight of sub-indicators. Basically, the PCA approach is a technique used to reduce multidimensional data sets to lower dimensions for analysis. The relationship between sub-indicators is examined to extract the common component of these sub-indicators.

Mathematically, the principal components are obtained using the eigenvalues and eigenvectors of the $\mathbf{X}'\mathbf{X}$ matrix, where $\mathbf{X}$ is the $m \times n$ matrix of m annual observations on n sub-indicators. Thus, $\mathbf{F} = \mathbf{XA}$ where $\mathbf{A} = [a_1, a_2, ..., a_k]$ are the eigenvectors corresponding to the eigenvalues $\lambda_1, \lambda_2, ..., \lambda_k$ respectively, and $\lambda_1 > \lambda_2 > ... > \lambda_k$ (In this case $k = 4$). The eigenvector with the highest eigenvalue is selected as the principal component of the data set. Ignoring the component in lesser significance will lose some information. But if the eigenvalues are small, the information would be marginal.

4. Validating of Composite Indicators

The constructed composite index is needed to be validated in order to examine its robustness and its consistency of what actually happen in reality. Only through continued validation and adjustment resulting from constructive debate can indices be improved. Unrealistic composite index would lead the reconsideration of selection, and weighting and aggregation steps in order to improve the quality of the final

estimates (Ul Haq, 1995). The most important thing of validation is the ability to explain the information from combined various sub-indicators without losing too much information.

Beck et al. (1999) suggests that they are also concerned about the stock-flow problem because private credit *(P)* and liquid liabilities *M* are rations of a stock variable and a flow variable (GDP is flow variable). To address this problem, they are deflated the end-of-year financial balance sheet items *FD* by end-of-year consumer price indices (CPI) and deflate the GDP series by the annual CPI. Then, They are computed the average of the real financial balance sheet item in year t and t-1 and divided this average by real GDP measured in year t. The end-of year CPI is either the value for December or, where not available, the value for the last quarter. The formula is the following.

$$\frac{0.5*\left(\frac{FD_t}{CPI_{e,t}}+\frac{FD_{t-1}}{CPI_{e,t-1}}\right)}{\frac{GDP_t}{CPI_{a,t}}}$$

where e indicates $\text{end}-\text{of}-\text{period}$ and a represents average for the period.