

## Appendix: The New Globalization Index: The Methodology

An integrated methodology is presented for the development of composite globalization indicators based on principal component analysis (PCA). Three indices are then generated to measure the overall globalisation performance.

The central idea of PCA is to reduce the dimensionality of a data set consisting of a large number of interrelated variables, while retaining the variation present in the data set as much as possible. This is achieved by transforming the PCs, which are uncorrelated and which are ordered so that the first *few* retain most of the variation present in *all* of the original variables, to a new set of variables (Jolliffe 2003). PCA can be done by eigenvalue decomposition or singular value decomposition of a data covariance matrix, usually after standardizing the attribute data. The results of a PCA are usually discussed in terms of component scores (the transformed variable values corresponding to a particular case in the data) and loadings (the weight by which each standardized original variable should be multiplied to get the component score) (Shaw 2003).

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This appendix is due to Ilaria Benedetti PhD.

Composite globalisation indicators were constructed using PCA with a matrix of  $p$  indicators  $\times$   $n$  years. In the application of the PCA method, all the values need to be signed as positive or negative in order to make them unidirectional.

The data are then normalized to zero mean and unit variance, to calculate eigenvalues and the amount of variance explained by each PC. Normalization is required prior to any data aggregation as the indicators in a data set often have different measurement units. We used standardisation  $z$ -scores. This method converts indicators to a common scale with a mean of zero and standard deviation of one. Indicators with extreme values thus have a greater effect on the composite indicator

$$I_{qc}^t = \frac{x_{qc}^t - x_{qc}^t - \bar{c}}{\sigma_{qc}^t - \bar{c}}$$

Before applying PCA, we investigated the correlation among dimensions of the data. A lack of correlation in the principal components is a useful property. It indicates that the principal components are measuring different “statistical dimensions” in the data.

After extraction the researcher must decide how many factors to retain for rotation. Both overextraction and underextraction of factors retained for rotation can have deleterious effects on the results. The default in most statistical software packages is to retain all factors with eigenvalues greater than 1.0. There is broad consensus in the literature that this is among the least accurate methods for selecting the number of factors to retain (Velicer 1990).

Another method of deciding the numbers of factor to retain is determined by the accumulative amount of variance that can reach up to 70%. The value of the eigenvectors and loadings of variables with PCs can then be computed. The loading of the PCs can be calculated through

$$l_{kj} = \sqrt{\lambda_k} e_{kj}$$

where  $l_{kj}$  is the loading of the PCs,  $\lambda_k$  is the eigenvalue of the component  $k$ , and  $e_{ij}$  is the eigenvector.

The next decision is which rotation method to adopt. The goal of rotation is to simplify and clarify the data structure. In this case, we used orthogonal rotation because it produces uncorrelated factors and more easily interpretable results. Rotation cannot improve the basic aspects of the analysis, such as the amount of variance extracted from the items.

The purpose of the next sections is to demonstrate the construction of various index mentioned above. PCA is used to analyze the globalization indicators using Stata software. Tables A.1 to A.2 show the analyzed results including correlation matrix, eigenvalues, eigenvectors, accumulation of variance, and the loadings of correlated indicators.

## Global Index

In order to construct the globalization index we took into account the aspects related only to the definition of globalization: world demand (*wds\_1*), trend values for migrants and refugees<sup>2</sup> (*imm\_ref*) and foreign investment flows (*fdiinfl*), due to the high correlation with other index.

**Table A.1** Correlation matrix

```
. corr afpfgdp nfay s_mig_ref fdiinfl ca migref
(obs=36)
```

	afpfgdp	nfay	s_mig_ref	fdiinfl	ca	migref
afpfgdp	1.0000					
nfay	-0.9410	1.0000				
s_mig_ref	0.9749	-0.9437	1.0000			
fdiinfl	0.6654	-0.6303	0.6725	1.0000		
ca	-0.6180	0.6484	-0.5965	-0.6929	1.0000	
migref	0.9752	-0.9438	1.0000	0.6719	-0.5957	1.0000

The results are presented in Table A.2.

$$GI = g[Wds, (\sigma Migr + Ref); fdiinfl]$$



Table A.3 Correlation matrix

```
. corr afpfgdp nfay s_mig_ref fdiinfl ca migref
(obs=36)
```

	afpfgdp	nfay	s_mig_ref	fdiinfl	ca	migref
afpfgdp	1.0000					
nfay	-0.9410	1.0000				
s_mig_ref	0.9749	-0.9437	1.0000			
fdiinfl	0.6654	-0.6303	0.6725	1.0000		
ca	-0.6180	0.6484	-0.5965	-0.6929	1.0000	
migref	0.9752	-0.9438	1.0000	0.6719	-0.5957	1.0000

Table A.4 Scores of correlation matrix and global shock index

Factor analysis/correlation	Number of obs =	36
Method: principal-component factors	Retained factors =	2
Rotation: orthogonal varimax (Kaiser off)	Number of params =	6

Factor	Variance	Difference	Proportion	Cumulative
Factor1	1.91337	0.13696	0.4783	0.4783
Factor2	1.77640	.	0.4441	0.9224

LR test: independent vs. saturated:  $\chi^2(6) = 157.67$  Prob> $\chi^2 = 0.0000$

Rotated factor loadings (pattern matrix) and unique variances

Variable	Factor1	Factor2	Uniqueness
wds_1	0.1329	-0.9718	0.0379
migref	0.9012	0.2745	0.1125
pcA_	0.4927	0.8648	0.0093
fdiinfl	0.9169	-0.0931	0.1506

The extraction method produced two factors extraction with total variance explained for 0.9225%.

As shown in the lowest part of the table, world demand and the first composite indicator previously created (global index A, so-called pcA\_), correlate with the first factor retained, but their influence has a different direction: world demand correlates negatively with the first factor retained, and instead global index A correlates positively with the first factor retained.

Furthermore, migrant and refugees (mig\_ref) and foreign investment flows (fdiinfl) are positively correlated with the second factor retained.

Combining the two factors with their specific weight we obtain the composite indicator of globalization, a so-called global shock index. On the whole, migrants and refugees, global index A and foreign investment flows all have a positive impact on globalization, whereas world demand has a negative effect on the global shock index. Figure 3 shows the index created.

## Global Impact Index

In order to construct the last global index we took into account aspects related to globalization's definition and shock variables: inequality index (gini), social expenditure (socialspendy), OECD per capita GDP at constant prices (gdpoecd), output (outputw), unemployment rates (uoecd), labour income share (wagey). The results of the analysis are presented in Table A.2.

$$GSI = g[\text{gini}, \text{socialspendy}; \text{gdpoecd}; \text{outputw}; \text{uoecd}; \text{wagey}]$$

## Note

1. Trends value for immigrants and refugees are calculated with a regression  $\text{imm} + \text{ref} = a_0 + a_1 t_{t=1}$  for 1980.

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