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1 | Introduction

The number of indices ranking nations according to various criteria has risen sharply in the last couple of years, intending to facilitate direct comparison between countries. Virtually every aspect of a country has been ranked from its standard of living to its competitiveness or educational attainments. Without a doubt there are inherent benefits to creating composite country indicators. Much like other indices, ease of comparison and attributing numerical values to abstract concepts can be extremely useful. Clearly, this approach also suffers from shortcomings, but the analytical simplification of summarizing a set of intertwined indicators into a single one (or a few) is appealing. As many indices attempt to quantify abstract concepts, this often allows much more focused discussion on the particular topic. No longer are concepts like competitiveness vague and immeasurable, but they can be defined in a particular way. Indices thus allow for ease of comparison and compress a lot of information into a single headline figure.

Apparently, governments have started taking note of these indicators and often consider them relevant reflections of their economies. As countries can be ranked, their performance can be compared and competitiveness is thus induced, assuming that it is desirable to top these tables. This point is highlighted by the rise of countries like Georgia or Malaysia (9th and 12th respectively in 2012) through the World Bank's "Doing Business" rankings. Intriguingly, this is part of a larger strategy to attract investment into Georgia and Malaysia. Better placement in the table is thus an explicit policy goal and close cooperation with the World Bank led these countries to address particular sub-indicators of the "Doing Business" index (Høyland et al., 2012). The effects of catering to indicators can be manifold. Georgia might genuinely be a very pleasant place for enterprises nowadays, but this comes at the cost of low health and safety standards or weak labor protection. For better or worse, this documents that country indicators do matter in the real world.

Unfortunately, the methodology applied in the construction of existing indices is often not fully transparent or theoretically sound. This applies equally to the selection of variables as to the weighting of the chosen variables. As a consequence, the latent variable to be proxied often remains vague. Given the perceived policy relevance of these indices, such a lack of transparency and scientific method is unacceptable. This paper addresses this shortcoming by proposing a statistically well-founded method for the construction of country indices, based on canonical correlation analysis (CCA), where selection and weighting of indices are performed in a transparent way. The method will be illustrated via the construction of an index reflecting national competitiveness in the world markets. It is composed of an innovative two-step procedure, which first uses principal component analysis to extract factors from a

broad set of indicators and then CCA in order to attribute weightings based on the correlation in the data.

The second section provides an overview of some existing competitiveness measures and their methodologies as well as related literature. Part three describes the methodology and the data to be utilized. The practical implementation of these is discussed in section 4. Estimation results and resulting country rankings are presented in sections five and six. Section 7 provides a sensitivity analysis, while section 8 concludes the paper.

2 | Appraisal of popular indices

Due to the importance and relevance of composite indicators, it is crucial that methodologies are clear and well specified as they exclusively define any latent variable to be proxied. In this regard it is worthwhile to survey some of the more prominent country indices available along with their methodologies.

Doing Business

The "Doing Business" (World Bank, 2013) indicator attempts to "measure business regulations for domestic firms through an objective lens". It relies on a survey of more than 9,600 professionals (mainly lawyers, accountants and government officials) around the world generating a large and unique dataset. Results are categorized under 10 different topics. Within each topic, economies are ranked in each category and the average of the percentile rankings yields the economy's rank for the given topic. Similarly, the final index is a simple average of the percentiles of the 10 topics. Intriguingly, there has recently been some internal controversy surrounding the indicator as calls for its revision or discontinuation grew larger. An internal report describes the indicator as "a pure knowledge project" with a "role to inform policy, not to prescribe it or outline a normative position, which the rankings to some extent do" (Reuters, 2013), as less regulation is suggested to be better than more. This does lead to an interpretation problem as a good ranking may indicate "good and efficient regulation or simply inadequate regulation" (World Bank, 2011).

Global Competitiveness Index (GCI)

The GCI is methodologically quite similar to the "Doing Business" indicator. It also relies on an extensive "Executive Opinion Survey" to generate data for a large number of countries, complemented by data from public databases. More than 100 indicators are then aggregated using mainly equal weights into 12 pillars of competitiveness. These are combined to the final GCI. However, the GCI has a different approach to the topic as it defines "competitiveness as the set of institutions, polices, and factors that determine the level of productivity of a country"(p. 3). Hence, a more holistic perspective is provided relative to the firm-centered "Doing Business".

Index of Economic Freedom

The Index of economic freedom is published annually by The Wall Street Journal in cooperation with The Heritage Foundation and has "tracked the march of economic freedom around the world". It is seen as a tool to promote economic freedom globally, which is assumed to have "important relationships" with "positive social and economic values" (Heritage Foundation, 2013). The index consists of 10 measures of economic freedom, which are grouped into 4 pillars. Averaging the 10 measures yields

the final index measure for a given economy. An extensive methodology section serves to explain the construction of the scores for each measure. The methodologies are quite diverse and while some are rested in numerical transformations, others leave room for subjective judgments.

These examples of popular country indices give insight into some of the problems involved in constructing such indicators. First, this concerns the selection of indicators, which is often not based on a transparent statistical procedure but subject to the (subjective) assessments of the researcher. These assessments, in turn, are often not derived from a consistent theoretical model. As a consequence, the actual concept to be measured by the index remains vague. Confusion grows when direct performance measures like GDP are pooled with measures merely representing potential performance drivers (like institutions and infrastructure), as is the case with the GCI. Second, either all indicators are simply given identical weights irrespective of their relevance or relevance is again identified by prior judgments of the researchers.

Instead, weights should be assigned based on observed patterns of correlation. To exploit correlation among the index variables themselves, statistical research offers tools like Factor Analysis and Principal Component Analysis. They allow determining weights according to the indicators' correlation with one or more common unobservable factors. In this way, indicators exhibiting a low correlation with other indicators and thus a potentially high share of noise in their variation are given small weights. While this leads to well-founded results, it still does not exploit all the information contained in macroeconomic data. A high level of unique variation in one indicator could be an indication for noisiness, but it could also mean that the indicator covers a distinct dimension within the same index. This question however cannot be assessed by relying on partial correlation. A better choice would be to make use of a range of fundamental economic variables that can be expected to stand in close relationship with the envisioned performance measure. One method to achieve this has been established a long time ago and been widely applied within other fields of Social Sciences: Canonical Correlation Analysis (CCA). We use this method to construct an index measuring a country's level of competitiveness on the world market, where weights of index variables are determined according to their linkages to a set of development indicators. In this way, a focus is deliberately set on success driven by the social and economic environment as opposed to (non-influenceable) first-nature factors like natural resources or geography. To the best of our knowledge, this method of index construction has not been applied to a macroeconomic ranking before.

3 | Methodology

The CCA method dates back as far as Hotelling (1936) and is a widely used tool in behavioral and consumer research (see e.g. Pappu et al. (2007), Liu et al. (2009)). Intriguingly, it has so far been neglected in macroeconomic analyses. The basic CCA scenario consists of two latent variables, which are both proxied by linear combinations of multiple observable indicators. A priori the weights within both sets are unknown, but can be determined (up to an arbitrary factor) by maximizing the correlation between the two. Consequently, single indicators which exhibit a relatively strong correlation with the other set are assigned relatively large weights. This allows interpreting which variables are primarily responsible for the shared variance between these sets.

When applying CCA to index construction, it is essential to clearly distinguish between **outcome variables** on the one side and **weighting variables** on the other. Outcome variables enter the index and thus need to reflect the latent variable(s) the index is intended to proxy. Our objective is to derive a multidimensional measure of a country's competitiveness on globally integrated markets. Competitiveness is seen here as a country's ability to profit from the global exchange of goods and factors. This is a multidimensional concept. One sign of high competitiveness would be a large inflow of foreign factors of production, as it allows a country to benefit from the productivity of foreign endowments. Another sign would be a large outflow of own final products, as it indicates a high sales potential for domestic producers. As outcome variables, the following indicators are therefore selected: the country's level of exports, the inflow of foreign capital as well as the level of immigration from abroad.

On the other hand, weighting variables are required to determine the weighting of the outcome variables in index construction. Ideally, these should represent economically meaningful measures with interpretable linkages to the outcome variables. For this purpose, a wide range of second-nature country indicators are used. Indicators determined by, for example, climate conditions are thus deliberately excluded, as they can hardly be affected by policy. The focus is intended to be on indicators that capture economic, political and social factors. This comprises heterogeneous aspects such as the level of indebtedness, skill of the workforce or the quality of infrastructure.

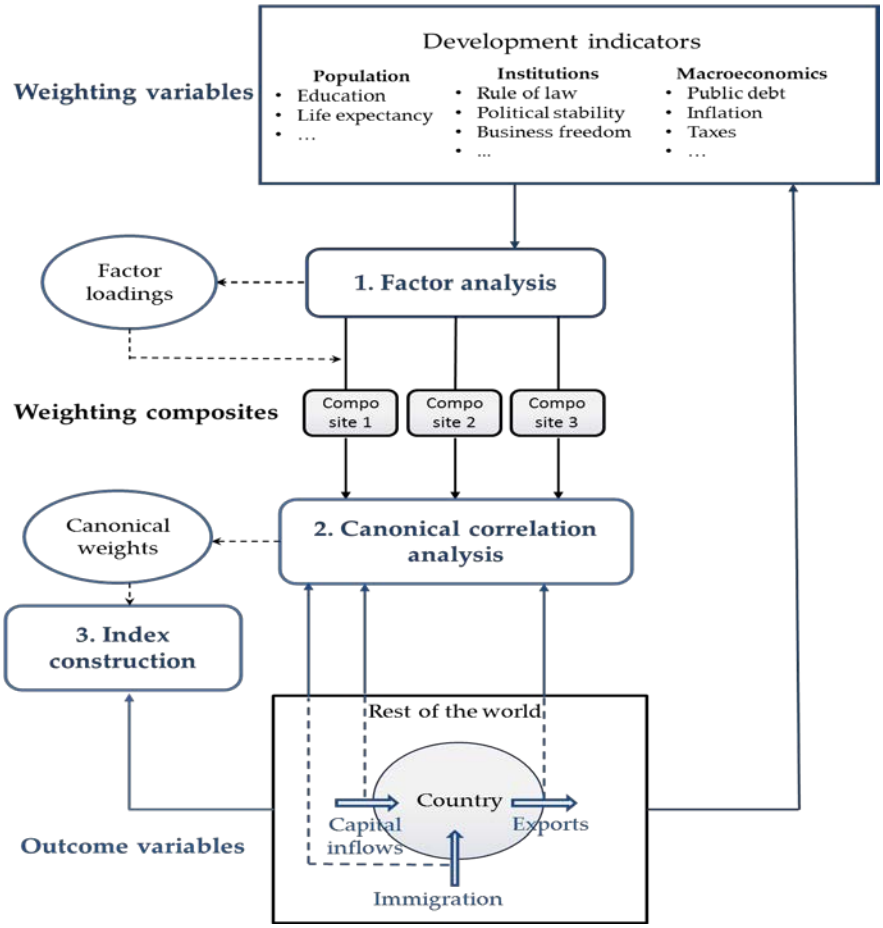
The potentially large number of available weighting variables requires an objective method of selection in order not to over-represent particular dimensions. To maintain the self-determining nature of data, a rotated factor analysis is performed in order to distil distinct composites of indicators. These composites subsequently enter the CCA as a second set. This way it is ensured that all distinct dimensions of development are

able to exert the same influence on the final index. Figure 1 summarizes our multi-step approach.

It is important to stress that this model formulation and the interpretation of its estimation results do not rest on the assumption of any kind of causal relationship between the two sets. In estimation, the two composites are completely interchangeable. The objective of the analysis is merely to provide a statistically meaningful basis for country rankings.

Figure 1

Method of index construction



Source: own representation

4 | Data and implementation

Country data for this paper has been retrieved from several international databases, including the World Bank Development Indicators, the IMF World Economic Outlook, the Heritage Foundation and the Penn World Tables. In order to capture the multidimensionality of development, the measures chosen as weighting variables span a wide range from health- and education-related measures to indicators of economic freedom and infrastructure quality. Measures of economic performance like GDP are deliberately excluded: based on our framework, they could neither be unambiguously classified as outcome variables nor as development indicators. As outcome variables, we draw upon measures that capture the three dimensions exports, capital inflows and immigration. To achieve comparability among countries of different size, these variables are all expressed in per capita terms. Exports are measured in terms of annual volumes. Capital inflows are computed as the sum of annual foreign direct investments (FDI) and portfolio investments. Immigration is measured as the annual change in the stock of foreign-born citizens, i.e. the net inflow of immigrants.

In all, the dataset spans the time period from 2006 to 2011, which both guarantees a focus on recent developments and a sufficiently large sample. A requirement for countries to be included is a population exceeding one million. Since not all variables are updated each year for each country, the panel set comprises a range of missing values. Single missing values are replaced by simple averages of preceding and subsequent values. Countries with indicators for which less than two values are reported during that time span are not included in model estimation. A closer description of the single variables and their measurement is provided in table A 1 in the Appendix.

The estimation procedure applied to generate index values consists of three steps. In a first step, a Principal Component Analysis (PCA) is carried out to extract factors from the set of weighting variables. To facilitate economic interpretation, a varimax rotation is performed.[1] The estimated factor loadings are used to group weighting variables into composites based on the approach of Nicoletti et al. (2000): each composite represents a weighted average of the variables with the highest loadings on a given factor. The weights are determined as the share of a variable's squared factor loading in the sum of squared loadings of the included variables.[2] This procedure requires choices on the number of factors to extract and on the number of variables to include in each composite. Following a common rule of thumb (Stevens, 1992), only variables whose factor loadings exceed an amount of 0.4 are considered to be sufficiently linked to the factor. As it will turn out, this threshold does further enhance interpretability of

[1] This means rotation is performed such that the variance of factor loadings is maximized.

[2] In case of negative loadings, squared loadings enter with a negative sign.

composites. To determine the number of factors considered, we apply the popular Kaiser criterion (Kaiser and Dickman, 1959) in our baseline model, according to which only factors with eigenvalues above 1.0 are considered. In a subsequent sensitivity analysis, this will be replaced by an alternative rule demanding to include enough factors to account for 90 percent of total variation in the data.

In a second step, the constructed composites enter a Canonical Correlation Analysis (CCA). They appear as one linear combination (canonical variate) in the analysis, while the three outcome variables appear as another. As a result, canonical weights for each variable maximizing the correlation between the two sets are generated. In this way, a weighting scheme for outcome variables dependent on their correlation with composites of weighting variables is attained. In addition to this aggregate version, alternative model versions are estimated where two of the three dimensions of competitiveness are further split into their subcomponents. To deepen our understanding of the nature of linkages to development, capital inflows are split into FDI and portfolio investments, total exports into merchandise and service exports as well as their subcategories.

In a last step, the canonical weights are applied to observed values of outcome variables for the single countries. To omit the influence of short-run fluctuations, each value is chosen as the simple average of annual figures from the time period 2006 to 2011. The weighted sum of these values then serves as an index score for a country. Given that the set of weights is only unique up to an arbitrary factor, rescaling is allowed. To have some anchor point, the scaling here is chosen such that the country at the top of the ranking exhibits an index score of 100.

5 | Estimation results

First, Table 1 documents the results of the PCA in the form of factor loadings and degrees of uniqueness for the single weighting variables. Factor loadings represent the correlation coefficient between the variables and a factor, while the degree of uniqueness measures the share of variance in a variable that is not accounted for by any of the considered factors. Factor loadings above the threshold of |0.4| are highlighted.

Of the four factors reported, only the first three are worth considering according to the Kaiser criterion. The first factor already captures about 50 percent of the total variation in the weighting variables. Of the 18 variables in total, 14 will be considered part of the first composite. This demonstrates that a large number of development variables are strongly correlated and appropriate weighting is thus important. One can observe particularly high loadings on measures related to the quality of infrastructure and institutions. Not included are variables like tax rate and public debt. These measures clearly represent other dimensions of development, which are not part of the latent concept expressed by factor 1. Composite 2 also includes a range of variables, where a focus on indicators of health and education is apparent. Its share of explained variance is still quite high. In contrast, composite 3 merely consists of two variables, which jointly capture the monetary dimension. The adjusted real exchange rate (adjusted for the Balassa-Samuelson effect (see Rodrik, 2008)) measures the extent of undervaluation of the domestic currency. It exhibits a strong positive correlation with the inflation rate; both variables hence enter the same composite. Further data analysis reveals a negative correlation of GDP per capita with both measures, composite 3 thus seems to indicate rather low development. Composite 4 finally includes the governmental variables taxes and public debt. Given that the nature of these measures' linkage to development is not clear from theory, it is no surprise that this factor accounts for less than five percent of total variation. Since its eigenvalue is smaller than one, it will not be included in our baseline scenario.

Table 1

Rotated factor loadings

Variable	Factor 1	Factor 2	Factor 3	Factor 4	Uniqueness
Adj. Real Exchange Rate	-0.282	0.099	**0.753**	-0.008	0.343
Business Freedom	**0.692**	**0.478**	0.078	-0.006	0.286
Control of Corruption	**0.907**	0.307	-0.171	-0.044	0.051
Inflation	**-0.468**	-0.147	**0.476**	-0.034	0.531
Internet Access	**0.708**	**0.625**	-0.172	-0.019	0.078
Investment Freedom	**0.753**	0.182	-0.071	0.026	0.394
Labour Freedom	0.361	0.143	0.256	0.015	0.783
Life Expectancy	**0.491**	**0.769**	0.139	-0.050	0.145
Number of Physicians	0.290	**0.798**	0.055	-0.013	0.275
Political Stability	**0.667**	0.255	-0.121	-0.032	0.474
Public Debt	0.051	0.123	-0.248	**0.392**	0.767
Regulatory Quality	**0.874**	0.364	-0.065	-0.077	0.093
Rule of Law	**0.920**	0.348	-0.113	-0.015	0.019
Tax Rate	-0.179	-0.009	0.050	**0.495**	0.720
Tertiary Education	**0.444**	**0.798**	-0.002	0.028	0.165
Trade Freedom	**0.584**	**0.481**	-0.002	-0.260	0.359
Transport Infrastructure	**0.720**	**0.506**	-0.165	0.152	0.175
Urbanization	**0.428**	**0.665**	-0.126	0.106	0.347
Eigenvalue	6.455	3.925	1.090	0.516	
Explained Variance (%)	0.501	0.304	0.085	0.04	
Cum. Explained Variance (%)	0.501	0.805	0.890	0.930	
Highlighted variables enter:	Composite 1	Composite 2	Composite 3	Composite 4	
N	629				

Source: own calculations.

Using these results, the constructed composites enter the CCA. Table 2 displays the estimation results in the form of canonical weights and canonical correlations obtained for the first pair of canonical variates for each of three different model versions. Model 1 is at the highest level of aggregation, while model 3 disaggregates the outcome variables as far as possible given the available data.

Table 2

Standardized canonical weights

	Model 1	Model 2	Model 3
Outcome variables			
Capital Inflows	0.005		
FDI		-0.328	-0.092
Portfolio		-0.041	0.013
Exports	1.064		
Commodities		0.418	
Food			-0.006
Fuel			-0.072
Manufactures			0.281
Metals			0.245
Raw Agriculture			0.271
Commercial services		0.750	
Communication			-0.002
Financial			0.090
Transport			0.196
Travel			0.301
Immigration	-0.129	0.040	0.128
Weighting variables			
Composite 1	0.956	0.808	0.885
Composite 2	-0.039	0.096	0.061
Composite 3	-0.131	-0.180	-0.108
Correlation Coefficient	0.694	0.755	0.834
N	581	581	533

Source: own calculations.

Throughout all model versions, composite 1 is assigned the dominant weight. Weights for composite 2 remain near zero, while weights for composite 3 are clearly negative, but are far less pronounced than those for composite 1. Hence, it is primarily indicators of institutional quality and infrastructure which are closely (even though not necessarily causally) linked to our concept of competitiveness and thus serve as main determinants of the weights assigned to outcome variables. Concerning these outcome variables, the most notable result for Model 1 is the negative sign of the weight for immigration. This indicates a negative relationship of immigrant flows with the set of development factors when controlling for exports and capital inflows. Since capital flows themselves attain a weight very close to zero, export volumes would turn out to be the dominating indicator in a competitiveness index based on Model 1. From an empirical point of view, this kind of asymmetry is rather unsatisfying: it represents a strong simplification of the heterogeneity in countries' strategies regarding global integration.

By splitting up exports and capital flows into their prime subcomponents, Model 2 shows that relevance indeed varies with investment strategy and type of good traded. When considered as single indicators, both FDI and portfolio investment appear with a negative sign, which is however much more pronounced in the case of FDI. At the same time, service exports are assigned a larger positive weight than commodity exports. Finally, Model 3 further decomposes exports into their subcategories. It highlights manufactures and agricultural goods among the commodities and travel and transport among the services as sources of the general dominance of exports.

In all three model versions, an interesting result is that factor flows prove to be much less relevant than exports. In some variants their weights are even negative. This seems to contradict the notion of highly developed countries as main attractors of mobile capital and workers. A correlation table (Table 3) reveals that partial correlations with the dominant composite 1 are indeed substantial. However, in comparison, the correlation of composite 1 with exports is much stronger. Given that both immigration and capital inflows are themselves also quite closely linked to export volumes, a large part of the variation in development variables is thus already captured by exports. Concerning investment, one explanation for its low contribution is the phenomenon of purely resource-driven FDI in developing countries. Concerning migration, preferences for regional proximity and prevailing legal restrictions on labor mobility are factors that obscure existing linkages to development.

Table 3

Correlation Coefficients for Model 1

	Comp. 1	Comp. 2	Comp. 3	Capital infl.	Exports	Immigration
Composite 1	1					
Composite 2	0.8762	1				
Composite 3	-0.5676	-0.3318	1			
Capital inflows	0.3338	0.2561	-0.2453	1		
Exports	0.7428	0.6344	-0.5024	0.5432	1	
Immigration	0.3814	0.4038	-0.2345	0.2170	0.4077	1

Source: own calculations.

For the purpose of index construction, the presence of negative weights creates some difficulties, as it complicates index interpretation. For instance, applying results of Model 2 would mean that in a comparison of two countries with identical export activities, the one with the lower level of capital inflows would actually be ranked higher. This direct application, however, would be misleading, given that the partial correlations of capital inflows with the (positively signed) weighting variables are clearly positive (as documented in Table 3). As an alternative, a restricted version of CCA featuring a non-negativity constraint on the weights of outcome variables would

therefore be desirable. Das and Sen (1994) have proposed an iterative procedure for determining canonical weights under this restriction. It is based on performing CCA on distinct subsets, each with another indicator omitted, and selecting the one which exhibits the largest correlation coefficient between the two sets. This design fits exactly our purpose: outcome measures with insufficient roots in a country's development are automatically deleted from the index.

Table 4

Standardized canonical weights based on restricted estimation

	Model 1	Model 2	Model 3
Outcome variables			
Capital Inflows	0.022		
FDI		0	0
Portfolio		0	0
Exports	0.989		
Commodities		0.489	
Food			0
Fuel			0
Manufactures			0.246
Metals			0.224
Raw Agriculture			0.282
Commercial Services		0.578	
Communication			0
Financial			0.078
Transport			0.128
Travel			0.345
Immigration	0	0.030	0.081
Weighting variables			
Composite 1	0.916	0.852	0.871
Composite 2	0.006	0.052	0.066
Composite 3	-0.134	-0.181	-0.130
Correlation Coefficient	0.691	0.739	0.832
N	581	593	534

Source: own calculations.

Table 4 reports the results of the restricted estimation for all three model versions. It is apparent that weights of the undeleted outcome measures are hardly affected by the imposed constraint. Weights attached to weighting variables are also quantitatively similar. The most significant change is that capital flows are now completely dropped from the index equation in the two more detailed model versions 2 and 3. Considering the preceding analysis, this is a rather intuitive outcome. Among our dimensions of global competitiveness, capital flows possess the weakest link to the dominant

development indicators infrastructure and institutional quality (see Table 3), their omission thus has the most beneficial impact on overall correlation between the two sets. Similar arguments could be applied to the export subcategories food, fuel and communication in version 3. Finally, we are thus endowed with a both theoretically and empirically consistent weighting scheme, which will be applied to a country ranking in the next section.

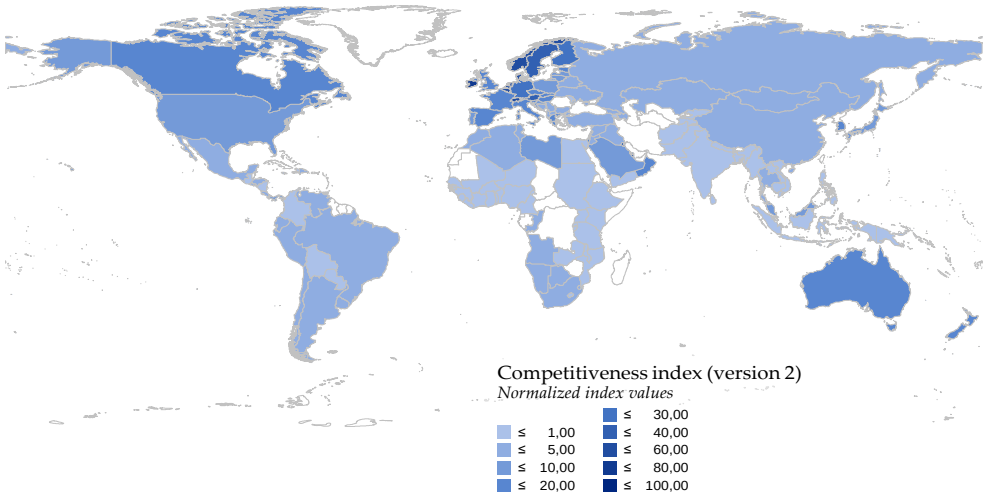
6 | Country ranking

By applying the estimated weights to observed country values for 2011, index scores are obtained and a ranking emerges. Due to missing data, some countries in Africa and West Asia had to be omitted. Apart from these, almost the complete set of countries matching our minimum threshold of one million inhabitants is covered. The total number of ranked countries is equal to 139 in model version 2 and 120 in model version 3. Figure 2 displays the global distribution of index scores for both versions. As the ranking in both cases turns out to be quite similar, we base our discussion in the following on version 2.

On a global level, the ranking is clearly dominated by developed countries from the western hemisphere. However, among the top-ranked countries also non-traditional high-income economies with sound institutions like Singapore, Hong Kong and Qatar can be found (see Table A1 in the Appendix). In general, top places are occupied by comparatively small countries. This is in line with our concept of competitiveness as a measure of participation in international goods and factor trade. Due to their smallness, these economies are less self-sufficient by nature and thus face higher pressure to integrate. In contrast, the large emerging economies Russia (Rank 56), Brazil (84), China (85) and India (108) are all ranked much lower.

Figure 2

Index scores of countries worldwide (model versions 2 and 3)



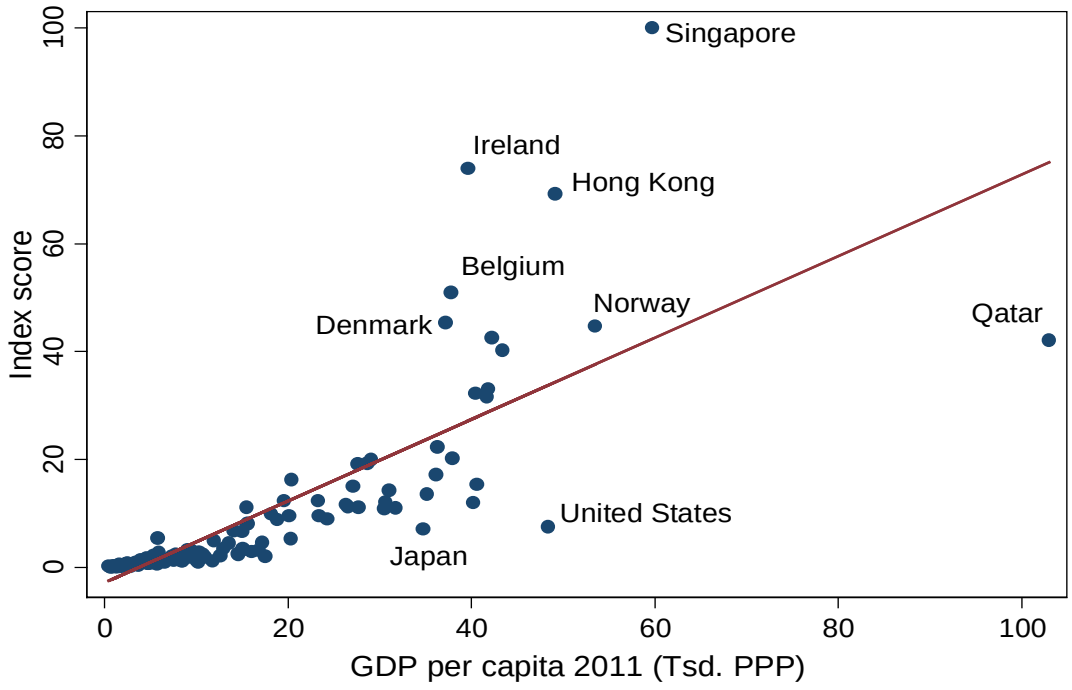
Blanks indicate missing countries

Source: own calculations.

Within the developed world, the rather low ranks of the United States (41) and Japan (42) are noteworthy. Figure 3 identifies them as outliers in a comparison of index scores with GDP per capita in 2011. Another outlier in this direction is Qatar, despite a high overall export performance. The reason in this case is the high share of less development-based oil exports, which impairs the performance of Qatar under our weighting scheme. At the other extreme, Singapore, Ireland and Hong Kong as countries with highly integrated service sectors exhibit considerably higher scores than what is predicted by national income. Apart from these exceptions, the relationship of index scores to per capita income is quite close.

Figure 3

Comparison of index scores with country's income levels



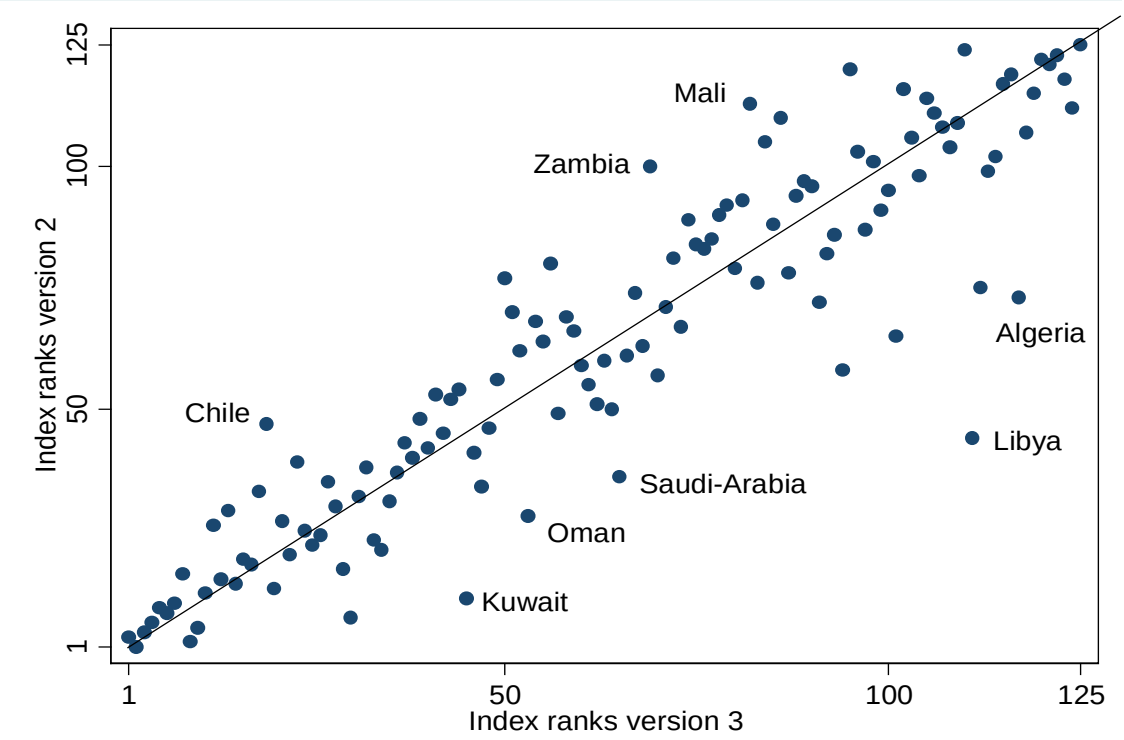
Source: own calculations

7 | Sensitivity analysis

While our method of index generation is rooted in well-established statistical techniques, the eventual ranking is undoubtedly sensitive to the selection of indicators. This concerns both the choice of outcome and of weighting variables. Comparing estimation results for model versions 2 and 3, the weighting of exports compared to factor flows is broadly similar, the overall distribution of index scores worldwide is thus as well. Nevertheless, as version 3 introduces additional refinement in the weighting of export subcategories, a few economies with highly specialized export patterns do experience a serious shift in their position. In line with our aim of emphasizing development-related performance, these are primarily oil-exporting countries from the Arab region. Since weights of fuel exports are driven down to zero in our constraint-based estimation, these countries are downgraded by several ranks compared to model version 2 (see Figure 4). Interestingly, the same does not apply to resource exports in the form of metals and ores. For this reason, economies with significant trade in precious metals like Chile and Mali are able to rise significantly in the ranking. This demonstrates that correlation patterns between trade performance and the distinct dimensions of development are complex enough to deserve a disaggregated analysis. However, as always in empirical research, the benefits gained from a more refined picture have to be weighed against the costs of a smaller range of observations (i.e. a lower number of countries ranked) and lower degrees of freedom in estimation.

Figure 4

Comparison of model versions 2 and 3



Source: own calculations

Regarding the choice of weighting composites, rules other than the Kaiser criterion could be implemented. For instance, an alternative rule of choosing factors such that 90 percent of total variation in weighting variables is covered would demand to include the relevant indicators behind factor 4 as well (see Table 1). These are the level of public debt and the total tax rate. Corresponding estimation results are documented in Table A 2 in the Appendix. The weights assigned by CCA to the additional composite 4 are marginal. As a consequence, weights of outcome variables are also hardly affected. Our public finance indicators hence do not only possess weak linkages to indicators of infrastructure and institutions, they are apparently also poorly related to a country's performance on the world market when controlling for other country characteristics.

8 | Conclusion

Our achievement in this paper was to develop and implement a new approach of ranking countries according to their level of competitiveness. Competitiveness was conceptualized as the degree of participation in global integration, measured by the levels of exports, capital inflows and immigration. Based on a wide range of development indicators, composite indicators were constructed by means of a Principal Component Analysis. In turn, these composites entered a Canonical Correlation Analysis as one set of variables and the index variables as another. Estimated canonical weights were used as weights in the calculation of index scores. In this way, an index was constructed where weights are assigned based on an element's roots in the stage of development as opposed to pure first-nature advantage. In comparison with prevailing macroeconomic indices, our method of index construction is superior in at least two respects. First, direct measures of a country's performance are methodologically separated from mere performance drivers, contributing to higher clarity concerning the concept to be measured. Second, weights of performance drivers are not determined arbitrarily or based on subjective judgment, but emerge from a transparent and well-established statistical procedure.

The application of our procedure to recent worldwide country data has provided interesting insights. Among our development indicators, measures of institutional and infrastructure quality have proven to be most closely connected to a country's ability to export and to attract foreign factors of production. Indicators of currency evaluation and public finance, on the contrary, do not contribute much to explaining the variation of our competitiveness measures. Concerning the weighting of outcome variables, the imposition of a non-negativity constraint implies that capital flows are dropped from the index. Within the data at hand, inflows of foreign capital have turned out to correlate much less with our weighting composites than export volumes. A further disaggregation has shown that in the field of exports some product categories are much closer linked to development indicators than others, thus should receive larger weights. This strong asymmetry in index weights can be seen as a justification of our estimation-based approach, as any a priori weighting would most probably misfit the underlying correlation structure.

Regarding prospects for future research, a broad range of further applications of our approach in the macro area is conceivable, including measures of a country's quality of schooling, the quality of its health care system or of its governmental institutions. We hope our contribution will serve as an inspiration in this regard.

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Appendix

Table A 1

Data sources

Variable	Description	Measurement	Source
Outcome variables			
FDI	Annual inflows of foreign direct investment per capita	US-Dollars PPP	UNCTAD
Portfolio	Annual inflows of portfolio investment per capita	US-Dollars PPP	IMF
Exports (including subcategories)	Annual export volumes of commodities and services per capita	US-Dollars PPP	WTO
Immigration	Average annual net increase in the number of reported foreign-born citizens between 2006 and 2011 relative to total population size	Number of people	World Bank
Weighting variables			
Adj. Real Exchange Rate	The average real exchange rate of the national currency to US-Dollar in a year corrected for differences in real GDP per capita (Balassa-Samuelson effect; methodology adopted from Rodrick 2008)	Dimensionless	Penn World Tables; Own estimations
Business Freedom	Index measuring the ability to start, operate, and close a business	Interval scale between 0 (worst) and 100 (best)	Heritage Foundation
Control of Corruption	Index measuring perceptions of the extent to which public power is exercised for private gain	Interval scale between -2.5 (worst) /+2.5 (best)	World Bank
Inflation	Annual percent change in the level of consumer prices	Percentage	Penn World Tables
Internet Access	Number of citizens per 1000 people with regular access to the internet	Number of people	World Bank
Investment Freedom	Index measuring the absence of constraints on the flow of investment capital	Interval scale between 0 (worst) and 100 (best)	Heritage Foundation
Labour Freedom	Index measuring the quality of the legal and regulatory framework of a country's labor market.	Interval scale between 0 (worst) and 100 (best)	Heritage Foundation
Life Expectancy	Average life expectancy of citizens in years	Number of years	World Bank
Number of Physicians	Number of physicians per 1000 people	Number of people	World Bank
Political Stability	Index measuring the likelihood that the government will be destabilized or overthrown by unconstitutional means	Interval scale between -2.5 (worst) /+2.5 (best)	World Bank
Public Debt	Ratio of government debt to GDP	Percentage	IMF
Taxes	Ratio of the sum of total taxes and contributions payable by businesses to commercial profits	Percentage	World Bank
Tertiary Education	Ratio of total enrollment in tertiary schooling to the size of the relevant age group	Percentage	World Bank
Trade Freedom	Index measuring the absence of tariff and non-tariff barriers	Interval scale between 0 (worst) and 100 (best)	Heritage Foundation
Transport Infrastructure	Logistics performance index measuring the quality of transport infrastructure	Interval scale between 1 (worst) and 5 (best)	World Bank
Urbanization	Ratio of number of persons living in urban areas to total population size	Percentage	World Bank

Table A 2

Standardized canonical weights

	Model 1	Model 2	Model 3
Outcome variables			
Capital Inflows	0.018		
FDI		0	0
Portfolio		0	0
Exports	0.991		
Commodities		0.491	
Food			0
Fuel			0
Manufactures			0.241
Metals			0.226
Raw Agriculture			0.285
Commercial Services		0.575	
Communication			0
Financial			0.081
Transport			0.128
Travel			0.343
Immigration	0	0.032	0.083
Weighting variables			
Composite 1	0.877	0.841	0.866
Composite 2	0.035	0.061	0.07
Composite 3	-0.143	-0.184	-0.132
Composite 4	-0.086	-0.024	-0.0165
Correlation Coefficient	0.693	0.739	0.832
N	581	593	545

Source: own calculations.

Table A 3

Complete country ranking (model version 2)

Index			Rank Indicators (2011)		
Rank	Country	Score	Exports p.c.	Capital inflows p.c.	Immigration p.c.
1	Singapore	100	1	4	4
2	Ireland	73.92	4	1	14
3	Hong Kong	69.34	3	2	6
4	Belgium	51.04	7	3	40
5	Denmark	45.45	10	23	41
6	Norway	44.68	6	6	38
7	Netherlands	42.61	8	20	34
8	Qatar	42.14	2	131	1
9	Switzerland	40.28	5	5	10
10	Austria	33.1	11	12	19
11	Sweden	32.24	12	11	22
12	Kuwait	31.63	9	38	2
13	Finland	22.36	13	15	56
14	Germany	20.23	14	37	26
15	Cyprus	20.04	31	18	21
16	Slovenia	19.26	16	40	45
17	Bahrain	19.21	15	14	8
18	United Kingdom	17.18	21	8	36
19	Estonia	16.31	22	17	25
20	Canada	15.3	17	13	13
21	Czech Republic	15.01	20	36	55
22	Israel	14.26	28	16	5
23	France	13.57	23	21	37
24	Hungary	12.31	25	10	65
25	Slovak Republic	12.28	19	35	80
26	Spain	12.12	33	22	23
27	Australia	11.93	26	7	12
28	Greece	11.65	39	44	39
29	Oman	11.22	18	28	7
30	New Zealand	11.2	32	31	11
31	Lebanon	11.15	45	24	16
32	Korea, Rep.	11	29	130	106
33	Italy	10.87	30	53	47
34	Croatia	9.91	41	29	18
35	Trinidad and Tobago	9.56	24	134	77
36	Portugal	9.55	36	27	42
37	Saudi Arabia	8.89	27	137	9
38	Lithuania	8.78	35	45	60
39	Malaysia	8.16	34	73	44

Index			Rank Indicators (2011)		
Rank	Country	Score	Exports p.c.	Capital inflows p.c.	Immigration p.c.
40	Latvia	8.12	42	34	20
41	United States	7.57	40	19	24
42	Japan	7.07	38	61	95
43	Panama	6.78	43	32	68
44	Mauritius	6.63	48	9	69
45	Libya	5.45	37	47	32
46	Poland	5.28	44	39	85
47	Costa Rica	4.97	60	48	33
48	Chile	4.67	46	26	91
49	Bulgaria	4.55	49	25	100
50	Kazakhstan	3.46	47	30	15
51	Belarus	3.44	50	65	28
52	Romania	3.28	59	49	117
53	Thailand	3.25	52	71	96
54	Jamaica	3.23	71	59	104
55	Uruguay	3.19	56	41	82
56	Russian Federation	3.08	51	52	43
57	Botswana	2.83	58	51	52
58	Jordan	2.82	64	43	3
59	Macedonia	2.76	70	58	50
60	Azerbaijan	2.73	53	42	72
61	Turkey	2.48	61	57	89
62	Tunisia	2.46	62	69	127
63	Serbia	2.37	67	50	48
64	Albania	2.37	83	46	73
65	Mexico	2.37	57	66	116
66	Bosnia and Herzegovina	2.35	77	74	111
67	Venezuela	2.23	55	116	67
68	Angola	2.21	54	129	123
69	Swaziland	2.14	68	79	61
70	Argentina	2.02	65	68	66
71	Namibia	2.01	69	55	51
72	Dominican Republic	1.92	79	63	54
73	South Africa	1.91	63	67	62
74	Ukraine	1.86	74	70	30
75	Congo, Rep.	1.74	73	139	64
76	Algeria	1.63	66	87	113
77	Morocco	1.63	86	86	135
78	Iraq	1.42	72	95	132
79	Honduras	1.33	93	76	126

Index			Rank Indicators (2011)		
Rank	Country	Score	Exports p.c.	Capital inflows p.c.	Immigration p.c.
80	Mongolia	1.27	80	33	121
81	El Salvador	1.21	90	80	115
82	Ecuador	1.15	76	103	74
83	Peru	1.15	78	60	136
84	Brazil	1.13	81	54	124
85	China	1.13	82	72	139
86	Syrian Arab Republic	1.07	85	85	31
87	Georgia	1.05	87	56	63
88	Egypt, Arab Rep.	0.95	95	83	129
89	Moldova	0.92	98	77	29
90	Paraguay	0.9	75	98	78
91	Colombia	0.87	84	64	133
92	Armenia	0.84	97	62	35
93	Guatemala	0.8	91	89	120
94	Philippines	0.79	99	102	118
95	Vietnam	0.79	88	78	137
96	Papua New Guinea	0.73	89	138	122
97	Bolivia	0.67	92	93	99
98	Indonesia	0.63	94	97	138
99	Kyrgyz Republic	0.61	104	88	58
100	Sri Lanka	0.6	101	123	97
101	Cambodia	0.58	106	92	81
102	Cote d'Ivoire	0.54	96	109	27
103	Nicaragua	0.48	100	82	112
104	Nigeria	0.43	102	91	110
105	Zambia	0.41	103	81	93
106	Ghana	0.39	108	75	46
107	Yemen	0.38	107	107	84
108	India	0.36	113	100	119
109	Lesotho	0.36	105	96	130
110	Senegal	0.36	112	104	94
111	Cameroon	0.34	109	113	107
112	Lao PDR	0.34	111	94	128
113	Kenya	0.27	115	118	86
114	Sudan	0.25	110	84	83
115	Tajikistan	0.24	114	108	57
116	Togo	0.22	116	114	71
117	Gambia, The	0.22	119	101	17
118	Benin	0.2	118	121	75
119	Tanzania	0.18	126	110	98

Index			Rank Indicators (2011)		
Rank	Country	Score	Exports p.c.	Capital inflows p.c.	Immigration p.c.
120	Afghanistan	0.18	131	133	131
121	Liberia	0.17	117	90	76
122	Mali	0.17	120	126	105
123	Mozambique	0.15	124	99	88
124	Myanmar	0.14	123	132	134
125	Pakistan	0.13	121	106	79
126	Guinea-Bissau	0.13	127	122	102
127	Guinea	0.12	122	127	59
128	Uganda	0.11	128	105	87
129	Haiti	0.11	129	115	125
130	Bangladesh	0.11	125	120	109
131	Timor-Leste	0.08	134	135	103
132	Rwanda	0.08	137	119	53
133	Sierra Leone	0.07	133	111	92
134	Burkina Faso	0.07	132	125	49
135	Nepal	0.07	136	136	70
136	Ethiopia	0.07	138	124	114
137	Malawi	0.07	130	117	90
138	Niger	0.07	135	112	101
139	Burundi	0.01	139	128	108

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