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The Principal Components Approach to Quota Formulation at the IMF: 2011 Economic Size and Quota Formula Update

Thierry Nguéma-Affane¹

Abstract

This paper updates economic size rankings and quota formulas derived from the principal components approach to quota formulation at the IMF developed by Nguéma-Affane (2008). Using available annual sets of quota data up to 2011, the paper shows that the top 10 countries remained broadly stable in 2009-2011, with one notable development: China is now the largest economy since 2009 followed by the United States, Japan and Germany. Quota shares mirror this development, notably the downward trend of the quota shares of advanced economies. China is incontestably experiencing the highest gain in quota shares consistent with its continuous economic dynamism. The paper also explores the impact of removing openness and/or variability from the dataset used for the purpose of the PCAp. It shows that the variables openness and variability play the same role as they reinforce the size dimension through their strong correlation with GDP. However they contribute very little to the significance of the economic size indicator.

¹ Advisor to the Executive Director, International Monetary Fund (IMF). The views expressed in this paper are my own and should not be attributed to the IMF, its Executive Directors and the countries they represent, or its Management. I thank my colleagues in the Executive Director Office for their comments on earlier versions. I am solely responsible for any errors and omissions. Comments are welcome.

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Abbreviations

AE	Advanced Economy
Corr	Correlation
Cov	Covariance
G7	Group of Seven
GDP	Gross Domestic Product
EMDC	Emerging Market and Developing Country
IMF	International Monetary Fund
NATESI	Indicator of Economic Size
OPEN	Openness
PC	Principal Component
PC1	First Principal Component
PCA	Principal Components Analysis
PCAp	Principal Components Approach to Quota Formulation at the IMF
PCDR	Post Catastrophe Debt Relief
PRGT	Poverty Reduction and Growth Trust
RES	Reserves
VAR	Variability

I. Introduction

In a paper published in 2008, Nguéma-Affane developed an original approach to quota formulation at the International Monetary Fund (IMF): the principal components approach (PCAp). The originality of this approach, which is based on the principal components analysis (PCA), is three-fold. First, no judgment is made about the weights of the variables, which are generated by the PCA. Second, it enables the establishment of an indicator of economic size (NATESI) of IMF members using the variables in the institution's quota formula. This indicator is then used to rank countries by economic size. Third, it enables the determination of quota formulas based on the variables' weights generated by the PCA. Since then, the quota formula framework has evolved with notably the adoption of a new quota formula (see Annex I) and an expansion of the membership.

The purpose of this paper is to update rankings and review quota formulas under the PCAp using most recent available quota data. The paper is organized as follows. Section II will present the protocol used to undertake this update. A data analysis will be conducted in Section III. The update of NATESI will be done in Section IV. The review of quota formulas will be undertaken in Section V. The removal of one or more variables is considered in Section VI. Section VII concludes.

II. Update protocol

The update protocol will broadly follow the methodology used in the original paper over successive years. In particular, it will be done in three steps:

1. Assessment of the prerequisites for a PCAp
2. Update of NATESI rankings
3. Review of the PCA quota formulas

Assessment of the prerequisites for a PCAp

A data analysis is conducted to ascertain that the conditions for updating the NATESI Indicator and reviewing the PCA quota formulas are met. This analysis will determine whether the PCA will be running on the correlation or covariance matrix. In this regard, a special attention will be given to the difference between the variances of the variables. Then once the PCA is performed, the first principal component (PC1) will be examined. Firstly, the correlations between the original variables and the first principal component will be evaluated to assess the importance of their contributions to its formation. Secondly, the share of the total variance in different datasets explained by the first principal component will determine whether it could be considered as an indicator of economic size.

Update of NATESI rankings

Assuming the data analysis is conclusive, NATESI rankings will be derived from the scores of countries on the first principal component. An analysis of rankings will then be made, notably to determine whether changes in top rankings are consistent with observed economic developments of the countries concerned. The stability of top rankings will be established by using two temporal perspectives: a forward-looking temporal perspective and a backward-looking temporal perspective. The forward-looking temporal perspective is applying variables' weights derived from a PCA on less recent datasets (datasets of years $n-1$, $n-2$, ...) to the most recent dataset (dataset of year n). The backward-looking temporal perspective is applying variables' weights derived from a PCA on the latest dataset (dataset of year n) to those of previous years (datasets of years $n-1$, $n-2$,...). A set of top ranking countries will be considered as stable when these countries hold the same set of rankings using both perspectives. Changes within these top groupings will be examined to determine whether they are of structural or temporary nature. In particular, like in the original paper, temporal paths will be drawn to show the most important developments.

Review of PCA quota formulas

PCA-generated weights of variables will be analyzed and used to derive annual PCA quota formulas and calculate quota shares. An examination of the weights will be undertaken and an analysis of quota shares of individual countries and country groupings will be made, with notably a comparison to actual quota shares.

III. Data analysis

Datasets

Annual data from the Fund for the years 2005 and 2007 to 2011 will be used for the purpose of this paper.²

Data analysis

Table 1 presents the descriptive statistics of the four variables in shares of the IMF quota formula: Income (GDP), Openness (OPEN), Variability (VAR) and Reserves (RES). Since the variables, which are shares of grand totals, are in the same range and measured on the same scale and there are no significant differences between the variances of the four variables in all six years of interest, we can perform the PCA on the covariance matrix.

A look at the correlation matrix in Table 2 shows that GDP, OPEN and VAR are highly correlated to each other in 2011 with a correlation coefficient higher than 0.90. RES is clearly less correlated to these three variables. This feature is the same in all years of interest.

² See IMF (2009, 2012a, 2012b, 2012c and 2013). No data from 2006 is available in IMF documents.

Table 1 – Descriptive statistics of variables, 2005 and 2007-2011

	2005	2007	2008	2009	2010	2011
Number of countries	186	186	187	187	188	188
GDP						
Mean	0.538	0.538	0.535	0.535	0.532	0.532
Standard deviation	2.225	2.102	2.047	2.012	1.978	1.967
Maximum	26.471	24.723	23.899	23.000	22.189	21.573
Minimum	0.000	0.000	0.000	0.000	0.000	0.000
OPEN						
Mean	0.538	0.538	0.535	0.535	0.532	0.532
Standard deviation	1.581	1.543	1.505	1.485	1.468	1.463
Maximum	15.046	14.141	13.635	13.349	13.072	12.989
Minimum	0.000	0.000	0.000	0.000	0.000	0.000
VAR						
Mean	0.538	0.538	0.535	0.535	0.532	0.532
Standard deviation	1.742	1.705	1.566	1.366	1.451	1.452
Maximum	20.724	19.936	17.57	14.051	15.491	15.803
Minimum	0.001	0.001	0.001	0.001	0.001	0.000
RES						
Mean	0.538	0.538	0.535	0.535	0.532	0.532
Standard deviation	2.240	2.265	2.276	2.451	2.475	2.567
Maximum	22.277	24.381	25.832	29.336	30.483	32.198
Minimum	0.000	0.000	0.000	0.000	0.000	0.000

Table 2 – Matrices of covariances and correlations, 2011

Cov	GDP	OPEN	VAR	RES	Corr	GDP	OPEN	VAR	RES
GDP	3.848				GDP	1.000			
OPEN	2.635	2.129			OPEN	0.915	1.000		
VAR	2.698	2.014	2.096		VAR	0.951	0.960	1.000	
RES	2.73	1.948	1.586	6.553	RES	0.515	0.496	0.429	1.000

Results of the PCA

Table 3 shows that the correlations between each variable and the first principal component (PC1) are high, consistent with the correlation matrix. Therefore the four variables can be retained for the purpose of the analysis. In addition, we can see, by squaring the correlations, that the first principal component explains a large share of the variances of each variable (more than 65 percent in the last two years).

Table 3 – Correlations between the variables and PC1, 2005 and 2007-2011

	2005	2007	2008	2009	2010	2011
GDP	0.963	0.953	0.936	0.905	0.911	0.906
OPEN	0.929	0.925	0.911	0.886	0.891	0.884
VAR	0.942	0.934	0.928	0.870	0.871	0.846
RES	0.655	0.668	0.708	0.789	0.808	0.836

The first principal component explains a large share, at least 72 percent, of the total variance in the dataset in all years of interest. The second principal component accounts for at least 22 percent. Both components therefore account for a minimum of 97 percent of the total variance in the five years of interest. We can conclude that differences between countries *as per* the four original variables are accurately captured by these two components, which are linear combinations of the original variables.

Table 4 – Variances of principal components, 2005 and 2007-2011

PC	2005		2007		2008		2009		2010		2011	
	Value	Share	Value	Share	Value	Share	Value	Share	Value	Share	Value	Share
1	11.538	0.748	10.819	0.733	10.202	0.728	10.154	0.723	10.496	0.738	10.904	0.746
2	3.507	0.227	3.591	0.243	3.445	0.246	3.562	0.253	3.425	0.241	3.436	0.235
3	0.278	0.018	0.278	0.019	0.264	0.019	0.267	0.019	0.247	0.017	0.224	0.015
4	0.100	0.006	0.073	0.005	0.103	0.007	0.070	0.005	0.055	0.004	0.062	0.004
Total	15.424	1.000	14.761	1.000	14.013	1.000	14.054	1.000	14.222	1.000	14.626	1.000

Since the first principal component explains more than 72 percent of the total variance and is highly correlated with the four original variables, it clearly displays an overall size dimension. Therefore, like in the original paper, this component could be interpreted as reflecting economic size in the global economy. The second component which is highly correlated with RES displays a contrast between the biggest economies with respect to that variable. In particular, it opposes economic powers with large reserves such as China, Japan and Russia, to other powers with low reserves, such as United States, Germany, France and United Kingdom. We conclude that the first component continues to serve as the indicator of economic size (NATESI).

IV. Update of NATESI rankings

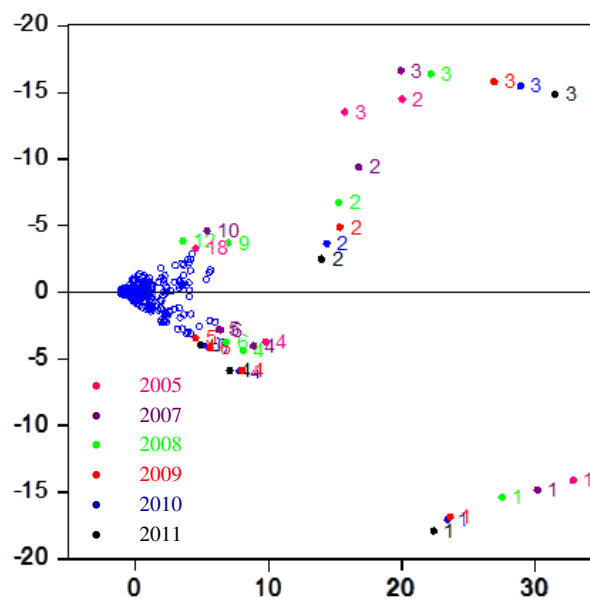
Scores on the first PC are used to rank countries. Table 5 shows the top 10 countries in all years of interest. Interestingly, the top 10 countries are from the same set of 13 countries (2011 top 10 countries plus Canada, Italy and Korea) and the top 20 countries are drawn from a group of 23 countries (2011 top 20 countries plus Belgium, Ireland and Turkey). Also noteworthy is that the top 4 countries (China, Germany, Japan, and the United States) are the same in all years.

Table 5 – NATESI - Top 10 rankings, 2005 and 2007-2011

	2011	2010	2009	2008	2007	2005
1	China	China	China	United States	United States	United States
2	United States	United States	United States	China	China	Japan
3	Japan	Japan	Japan	Japan	Japan	China
4	Germany	Germany	Germany	Germany	Germany	Germany
5	Russia	Russia	Russia	Russia	United Kingdom	United Kingdom
6	United Kingdom	United Kingdom	United Kingdom	United Kingdom	France	France
7	India	France	France	France	Russia	Korea
8	Saudi Arabia	India	Saudi Arabia	India	Korea	Italy
9	France	Saudi Arabia	India	Korea	Italy	Russia
10	Brazil	Italy	Italy	Saudi Arabia	India	Canada

More striking is the fact that China is taking over from the United States as the largest economy since 2009. This can be seen by looking at their temporal paths in Graph 1. The United States (1) and Japan (2) are moving leftward indicating a decline in relative economic size. China (3) is moving in the opposite direction as its relative economic size grows.

Graph 1 – Temporal paths, 2005 and 2007-2011



These findings suggest a relative stability in the top rankings over years, which could be further explored by using the forward-looking and backward-looking temporal perspectives. Table 6 shows that both perspectives yield the same top 12 countries in 2009-2011 although with some differences in terms of rankings³. It also shows stable subsets of different size within that set of 12 countries, regardless of the temporal perspective employed. One subset is comprised of Brazil, Italy, and Korea on the last three places. Only Brazil seems to exhibit a stable ranking at the 10th place under the forward-looking perspective. A second stable subset encompasses India, France and Saudi Arabia with India, standing consistently at the 7th place under the forward-looking perspective. Both perspectives definitely put United Kingdom, Russian Federation, Germany and Japan at the 6th, 5th, 4th and 3rd places respectively. Likewise, China's claim for the top spot is evident under both approaches and hence relegating the United States at the second top spot.

Interestingly, the top 12 countries are the same when using the temporal perspectives in 2008-2010 (see Annex II). A notable difference between the two ranking stability analyses is the confirmation of the relative positions of China, United States, Russia and United Kingdom. Also noteworthy is the exit of Italy from the top 10 in favor of Brazil.

Table 6 – Stability of top rankings, 2009-2011 1/

Forward-looking temporal perspective				Backward-looking temporal perspective			
2011			Countries	Countries	2011 weights		
2009 weights	2010 weights	2011 weights			2011	2010	2009
1	1	1	China	China	1	1	1
2	2	2	United States	United States	2	2	2
3	3	3	Japan	Japan	3	3	3
4	4	4	Germany	Germany	4	4	4
5	5	5	Russia	Russia	5	5	5
6	6	6	United Kingdom	United Kingdom	6	6	6
7	7	7	India	India	7	7	9
9	9	8	Saudi Arabia	Saudi Arabia	8	8	7
8	8	9	France	France	9	9	8
10	10	10	Brazil	Brazil	10	10	12
12	12	11	Korea	Korea	11	12	11
11	11	12	Italy	Italy	12	11	10

1/ Countries between two double-lines constitute a stable set of countries using both perspectives.

³ The choice of the years 2009, 2010 and 2011 for ranking stability purposes stems from the application of the forward-looking temporal perspective with the 2005, 2007 and 2008 PCA weights. The top 12 rankings are only the same in all three years 2009, 2010 and 2011.

There is less stability in the depths of NATESI rankings because quota shares are smaller and close. Top gains and losses are mainly recorded by emerging markets and developing countries (EMDCs) (Table 7). The large swings in rankings is explained by either strong dynamism or economic contraction due to, among others, instability and conflict.

Table 7 – NATESI rankings – Top 10 gains and losses, 2011

Country	Ranking	Gain	Country	Ranking	Loss
1 Turkmenistan	73	43	1 Zimbabwe	139	-69
2 Equatorial Guinea	98	39	2 Zambia	115	-52
3 Congo	101	34	3 Somalia	185	-51
4 Iceland	68	33	4 Sierra Leone	160	-39
5 Mongolia	126	32	5 Guyana	159	-32
6 Mauritius	113	28	6 Liberia	142	-32
7 Botswana	96	27	7 Côte d'Ivoire	103	-29
8 Bolivia	90	25	8 Guinea	145	-26
9 Albania	122	22	9 Ghana	91	-24
10 Algeria	27	19	10 Burundi	162	-23

Table 8 – IMF and NATESI rankings, 2011

Ranking	IMF	NATESI	Gain/Loss(-) under NATESI
1	United States	China	2
2	Japan	United States	-1
3	China	Japan	-1
4	Germany	Germany	0
5	France	Russia	4
6	United Kingdom	United Kingdom	-1
7	Italy	India	1
8	India	Saudi Arabia	4
9	Russia	France	-4
10	Brazil	Brazil	0
11	Canada	Korea	5
12	Saudi Arabia	Italy	-5
13	Spain	Singapore	12
14	Mexico	Canada	-3
15	Netherlands	Switzerland	4
16	Korea	Netherlands	-1
17	Australia	Spain	-4
18	Belgium	Mexico	-4
19	Switzerland	Thailand	13
20	Turkey	Australia	-3

Comparison with actual rankings

As already noted, a notable difference between NATESI rankings and actual IMF rankings is that China occupies the top spot before the United States (2nd), Japan (3rd) and Germany (4th) in NATESI rankings, whereas it only occupies the third place in actual rankings (Table 8). These four countries form the only stable set of countries in the top rankings. Eighteen countries in the IMF top 20 countries are in NATESI top 20 countries in 2011. Belgium and Turkey would exit the top 20 in favor of Singapore and Thailand, the two countries with the highest jumps in that top group (+13 and +12 respectively). Other remarkable gains in rankings are Korea (+5), Russia (+4), Saudi Arabia (+4) and Switzerland (+4). The biggest losses are Italy (-5), France, Mexico and Spain (-4 each).

It is worth recalling that in the original paper, the NATESI ranked China at the 3rd place using 2004 data of the old variables in the IMF quota formula. Using the 2005 dataset with updated variables, NATESI still ranks China third, whereas it was at the 6th place in the IMF rankings. China finally moved to the third spot after the 2010 quota reform using the 2008 data. NATESI would rank that country second with the same data set. China's relative position has improved in the following years not only under NATESI, but also when using the IMF quota formula which ranks it second. There is therefore a broad consistency between the two approaches with respect to China's economic size. Future quota reviews should reflect this development.

V. Review of the PCA quota formulas

The weights of the original variables in the PC1 are presented in Table 9. There is a clear opposite evolution of the weights of GDP, OPEN and VAR on the one hand and that of RES on the other hand. The weights of GDP, OPEN and RES have been declining steadily in successive years of interest, while that of RES has been increasing. GDP had the highest weight in the 2005, 2007 and 2008 datasets. RES has the highest weight since 2009. This is consistent with the fact that RES has the highest variance in those years whereas this was the case for GDP in previous years. The growing contribution of RES to the first principal component also explains the differences between the IMF and NATESI rankings.

Table 9 – Weights of variables in the first principal component, 2005 and 2007-2011

	2005	2007	2008	2009	2010	2011
GDP	0.319	0.306	0.302	0.291	0.283	0.276
OPEN	0.218	0.218	0.216	0.210	0.205	0.201
VAR	0.244	0.244	0.229	0.190	0.198	0.190
RES	0.218	0.232	0.254	0.309	0.314	0.333

Individual quota shares

A look at Table 10 shows that 8 of the top 10 gains in quota shares concern countries in the top 20 rankings. Four of the top gains are from Asian EMDCs, with China registering the highest increase in quota shares. While Japan is the only G7 country to register higher quota share, the other G7 countries in the top 10 countries have all lost quota shares.

Table 10 – PCA quota shares - Top 10 gains and losses, 2011.

Country	PCA quotas	Gain	Country	PCA quotas	Loss
China	16.762	10.372	United States	12.077	-5.321
Japan	7.740	1.279	France	2.535	-1.690
Singapore	1.771	0.955	Germany	4.197	-1.386
Russia	3.298	0.593	United Kingdom	3.064	-1.161
Saudi Arabia	2.642	0.547	Italy	2.186	-0.973
Thailand	1.207	0.534	Canada	1.738	-0.573
Algeria	0.848	0.437	Spain	1.549	-0.450
Korea	2.232	0.433	Venezuela	0.361	-0.419
Switzerland	1.640	0.430	Belgium	0.988	-0.356
Luxembourg	0.481	0.204	Mexico	1.532	-0.336

Most importantly, the temporal trend of PCA quota shares of top countries is similar to that of their IMF formula quota shares. However annual changes in PCA shares are on average higher than those in IMF formula shares. For example, the United States experiences a continuous decline in its quota share from 2005 to 2011. Under the PCAp, the US quota share would be below 15 percent in 2011 whereas the IMF quota formula continues to yield a quota share above that benchmark. China has an inverse, faster trend under the PCAp and its quota share is above the 15 percent benchmark in 2011.

Country groupings and constituencies

The changes in the quota shares of top ranking countries explain those in quota shares of country groupings and constituencies (Table 11). In particular, quota shares of advanced economies (AEs) register a downward trend with IMF formula shares consistently higher than PCA shares which stand below 50 percent in 2009-2011. The same downward trend is observed when AEs are combined with European EMDCs. The upward trend in EMDCs quota shares is driven by that of Asian EMDCs.

A notable outcome is that the quota shares of PRGT and PCDR groupings in both formulas are always lower than their post-2010 reform quota shares. A related outcome is that the post-2010 quota shares of the two African constituencies (occupied currently by The Gambia and Togo) that include many low-income countries are significantly higher than quota shares calculated with both the Fund and PCA formulas.

Table 11- Quota shares of country groupings and constituencies, 2005 and 2007-2010

	Post-2010 Reform	2010		2009		2008		2007		2005	
		Fund formula	PCA formula	Fund formula	PCA formula	Fund formula	PCA formula	Fund formula	PCA formula	Fund formula	PCA formula
<i>Weights of variables</i>											
GDP		0.500	0.283	0.500	0.291	0.500	0.302	0.500	0.306	0.500	0.319
OPEN		0.300	0.205	0.300	0.210	0.300	0.216	0.300	0.218	0.300	0.218
VAR		0.150	0.198	0.150	0.190	0.150	0.229	0.150	0.244	0.150	0.244
RES		0.050	0.314	0.050	0.309	0.050	0.254	0.050	0.232	0.050	0.218
Compression factor		0.950	0.950	0.950	0.950	0.950	0.950	0.950	0.950	0.950	0.950
<i>Quota shares, in percent</i>											
Advanced Economies (AEs)	57.637	56.050	47.371	57.496	48.379	58.224	50.065	60.431	53.788	63.767	58.317
EMDCs	42.357	43.950	52.629	42.504	51.621	41.776	49.935	39.569	46.212	36.233	41.683
EMDC Africa	4.438	3.279	3.698	3.231	3.798	3.146	3.730	3.075	3.640	2.796	3.189
EMDC Asia	16.046	19.599	25.323	18.327	23.977	17.732	21.994	17.244	21.216	15.847	19.212
EMDC Europe	7.225	7.712	8.687	7.770	8.758	7.687	9.057	7.003	8.268	6.189	6.964
EMDC Middle East	6.742	6.214	7.840	6.228	8.157	6.160	7.996	5.371	6.068	4.772	5.426
EMDC Western Hemisphere	7.907	7.146	7.082	6.947	6.931	7.051	7.157	6.875	7.021	6.629	6.893
AEs and EMDC Europe	64.862	63.762	56.057	65.266	57.137	65.911	59.122	67.434	62.056	69.955	65.281
Other EMDCs	35.132	36.238	43.943	34.734	42.863	34.089	40.878	32.566	37.944	30.045	34.719
PRGT	3.995	2.650	2.626	2.599	2.690	2.581	2.806	2.525	2.806	2.214	2.364
PCDR	3.063	1.837	1.750	1.794	1.771	1.762	1.820	1.722	1.825	1.565	1.604
Argentina	1.496	1.478	1.561	1.413	1.526	1.411	1.536	1.373	1.505	1.331	1.488
Australia	3.649	3.779	3.867	3.785	3.879	3.901	4.044	3.889	4.309	3.952	4.486
Austria	3.158	3.555	3.322	3.579	3.355	3.466	3.330	3.461	3.447	3.317	3.468
Brazil	2.902	2.661	2.775	2.565	2.691	2.613	2.788	2.440	2.563	2.179	2.188
Canada	3.197	3.229	2.660	3.320	2.738	3.486	3.071	3.636	3.335	3.862	3.640
China	6.390	9.413	13.998	8.628	13.086	7.917	10.886	7.475	9.905	6.389	8.048
Denmark	3.223	3.417	3.435	3.493	3.453	3.366	3.278	3.377	3.420	3.463	3.645
Egypt	2.891	2.932	3.439	2.961	3.616	2.988	3.722	2.690	3.322	2.323	2.816
France	4.225	3.603	2.673	3.787	2.833	3.789	2.958	4.212	3.662	4.015	3.355
Gambia	2.556	1.873	1.855	1.818	1.867	1.835	2.001	1.766	1.941	1.554	1.662
Germany	5.583	5.677	4.420	5.782	4.480	5.678	4.495	5.888	4.868	6.226	5.329
India	3.098	2.907	2.862	2.718	2.809	2.666	2.859	2.449	2.561	2.266	2.342
Iran	2.109	1.916	2.329	1.879	2.409	1.800	2.220	1.788	2.182	1.715	2.019
Italy	4.174	4.105	3.200	4.364	3.459	4.089	3.177	4.223	3.393	4.555	3.777
Japan	6.461	6.153	7.455	6.259	7.889	6.493	7.786	6.987	8.490	8.030	10.003
Mexico	5.355	5.152	4.347	5.206	4.391	5.171	4.448	5.204	4.600	5.314	4.971
Netherlands	5.264	5.876	5.482	6.022	5.587	5.449	4.953	5.459	5.124	5.687	5.557
Russia	2.705	2.645	3.332	2.663	3.369	2.938	3.984	2.435	3.242	2.053	2.401
Saudi Arabia	2.095	1.423	2.563	1.470	2.702	1.337	2.362	0.850	0.779	0.835	0.819
Singapore	4.182	4.898	5.809	4.589	5.447	4.602	5.455	4.693	5.649	4.503	5.519
Switzerland	2.654	2.857	3.277	2.785	2.874	2.817	2.939	2.763	2.961	2.513	2.683
Togo	1.005	0.548	0.545	0.556	0.571	0.540	0.571	0.541	0.591	0.504	0.527
United Kingdom	4.225	4.071	3.238	4.297	3.348	4.662	3.902	4.584	3.714	4.429	3.554
United States	17.398	15.831	11.556	16.061	11.620	16.987	13.238	17.816	14.438	18.988	15.703

VI. Additional consideration

The IMF report on the outcome of the quota review formula indicates that there is a considerable support for dropping variability from the formula (IMF, 2013a). This is based on the difficulties of identifying a superior variability measure and the little empirical evidence of a relationship between variability and actual demand for Fund resources⁴.

⁴ Seeking a relationship between variability and actual demand for Fund resources is arguable since variability is intended to reflect potential demand for Fund resources.

In order to assess the impact of removing one or more variables, we apply the PCAP to remaining variable sets. Table 12 shows that dropping variability or openness or both variables does not change the conclusion that the first principal component could serve as an indicator of economic size. In particular, the proportion of variances explained by the first PC is even higher when dropping either VAR or OPEN or both. This outcome indicates that the inclusion of either variable is not adding information on the first component. However, it increases the correlation of the first component with GDP.

Table 12 – Impact of dropping variables from the quota formula, 2011

	Actual	Fund formula	PCA formula			
			No variable dropped	OPEN dropped	VAR dropped	OPEN and VAR dropped
<i>Proportion of variance explained by PC</i>						
PC1			0.746	0.748	0.761	0.793
PC2			0.235	0.243	0.222	0.207
<i>Weights of variables</i>						
GDP		0.500	0.276	0.331	0.322	0.383
OPEN		0.300	0.201		0.232	
VAR		0.150	0.190	0.221		
RES		0.050	0.333	0.448	0.446	0.617
<i>Quota shares, in percent</i>						
AEs	57.637	54.717	45.706	41.304	42.290	35.938
EMDC Africa	4.438	3.382	3.781	3.974	3.657	3.882
EMDC Asia	16.046	20.643	26.880	29.760	30.429	34.853
EMDC Europe	7.225	7.632	8.496	8.724	8.242	8.509
EMDC Middle East	6.742	6.370	7.934	8.580	8.024	8.885
EMDC Western Hemisphere	7.907	7.257	7.202	7.658	7.359	7.933
PRGT	3.995	2.775	2.699	2.707	2.506	2.476
PCDR	3.063	1.949	1.839	1.840	1.692	1.660

NATESI rankings would change in the top 20 countries, as shown in Table 13. EMDCs will have better rankings and represent half of the top 10 countries. Distributions of quota shares would reflect these developments. In particular, the quota shares of advanced countries would decline.

Table 13 – NATESI Rankings with and without OPEN and VAR, 2011

	No variable dropped	OPEN dropped	VAR dropped	OPEN and VAR dropped
China	1	1	1	1
United States	2	2	2	3
Japan	3	3	3	2
Germany	4	6	4	9
Russia	5	4	5	4
United Kingdom	6	9	9	11
India	7	8	6	7
Saudi Arabia	8	5	8	5
France	9	11	10	12
Brazil	10	7	7	6
Korea	11	10	11	8
Italy	12	12	12	15
Singapore	13	13	14	13
Canada	14	16	15	17
Switzerland	15	14	13	10
Netherlands	16	19	19	29
Spain	17	18	17	22
Mexico	18	15	16	14
Thailand	19	17	18	16
Australia	20	22	21	25

VII. Conclusion

The paper updated the indicator of economic size and reviewed the PCA quota formulas under the principal components approach to quota formulation at the Fund. Using the most available datasets related to the IMF quota formula, the paper concludes that advanced economies are steadily losing relative economic size in favor of emerging markets and developing countries between 2005 and 2011. China is taking over from the United States as the largest economy and is the country experiencing the biggest gain in quota shares. These findings are consistent with recent economic developments of the major economic powers. The removal of one or more variables from the quota formula was also explored. The application of the PCAp shows that this would favor EMDCs in terms of ranking and quota shares.

In light of the robust results of the application of the PCAp, and given that no hypothesis has been formulated in the paper, we continue to believe that this approach is objective in determining relative economic sizes and guiding quota share realignment at the IMF.

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Annex I - The IMF Quota Formula⁵

The current quota formula was agreed in 2008. It includes four variables (GDP, openness, variability, and reserves), expressed in shares of global totals, with the variables assigned weights totaling to 1.0. The formula also includes a compression factor that reduces dispersion in calculated quota shares. The formula is:

$$\text{CQS} = (0.5 * \text{GDP} + 0.3 * \text{OPEN} + 0.15 * \text{VAR} + 0.05 * \text{RES})^{\text{K}}$$

where:

CQS = calculated quota share;

GDP = a blend of GDP converted at market rates and PPP exchange rates averaged over a three-year period. The weights of market-based and PPP GDP are 0.60 and 0.40, respectively;

OPEN = the annual average of the sum of current payments and current receipts (goods, services, income, and transfers) for a five year period;

VAR = variability of current receipts and net capital flows (measured as the standard deviation from a centered three-year trend over a thirteen year period);

RES = twelve month average over one year of official reserves (foreign exchange, SDR holdings, reserve position in the Fund, and monetary gold);

and K = a compression factor of 0.95. The compression factor is applied to the uncompressed calculated quota shares which are then rescaled to sum to 100.

⁵ Adapted from Box 1 in IMF (2011)

Annex II – Stability of top rankings in 2008-2010

Table A shows that both perspectives yield the same top 17 countries in 2008-2010 although with some differences in terms of rankings⁶. It also shows stable subsets of different size within that set of 17 countries, regardless of the temporal perspective employed. One subset is comprised of Mexico, Netherlands, Singapore and Spain on the 14th to the 17th place. Only Mexico seems to exhibit a stable ranking at the 17th place under the forward-looking perspective. Canada firmly holds the 13th place under both perspectives. A third stable subset encompasses Brazil, India, Italy, Korea and Saudi Arabia with India, Korea and Brazil standing consistently at the 8th, 11th and 12th respectively under the forward-looking perspective. France is consistently holding the 7th place over 2008-2010. A fifth subset comprises Russia and United Kingdom for the 5th and 6th places with both perspectives yielding quasi-opposite rankings. Both perspectives definitely put Germany and Japan at the 4th and 3rd places respectively. The last subset comprises China and the United States for the two top spots. China's the top position is evident under the forward-looking approach and strong under the backward approach.

Table A – Stability of top rankings, 2008-2010 1/

Forward-looking temporal perspective				Backward-looking temporal perspective			
2010			Countries	Countries	2010 weights		
2008 weights	2009 weights	2010 weights			2010	2009	2008
1	1	1	China	China	1	1	2
2	2	2	United States	United States	2	2	1
3	3	3	Japan	Japan	3	3	3
4	4	4	Germany	Germany	4	4	4
6	5	5	Russia	Russia	5	5	5
5	6	6	United Kingdom	United Kingdom	6	6	6
7	7	7	France	France	7	7	7
8	8	8	India	India	8	9	8
10	9	9	Saudi Arabia	Saudi Arabia	9	8	9
9	10	10	Italy	Italy	10	10	12
11	11	11	Brazil	Brazil	11	12	11
12	12	12	Korea	Korea	12	11	10
13	13	13	Canada	Canada	13	13	13
16	14	14	Singapore	Singapore	14	16	14
14	15	15	Spain	Spain	15	14	16
15	16	16	Netherlands	Netherlands	16	15	17
17	17	17	Mexico	Mexico	17	17	15

1/ Countries between two double-lines constitute a stable set of countries using both perspectives.

Countries between a thick line and a double-line or another thick line constitute a stable group of countries of countries under the related perspective.

⁶ Here, the top 17 rankings are the same in all three years.

