

Lidia OBOJSKA

Akademia Leona Koźmińskiego w Warszawie

Łukasz KICZMA

Uniwersytet Wrocławski

ESTIMATION OF STATE'S ECONOMIC POSITION ON THE EXAMPLE OF NIGERIA

Abstract:

The scope of this manuscript is to propose a method of estimation of state's economic position. To evaluate an economic position, we apply formal analysis on Sułek's model of economic power, and analyze its factors. We evaluate whether the variables taken in a formal model are independent or not. In case they are strongly correlated, we split them or, if it is not possible, we create new factors which puts together correlated units. We apply various methods of predictions of economic power; in particular neural networks which do not require the normal distribution of errors. Finally, we estimate the state's economic position on the basis of formal analysis, predictions, and in comparison to selected economic rankings. All the results are figured out for Nigeria.

Key words: economic position, economic power, Sułek's model, formal analysis, neural networks, economic rankings, Nigeria.

Introduction

In the study below, we would like to propose a method of estimation of state's economic position, which consists of formal analysis, predictions, and evaluations on the basis of rankings. To achieve this goal, we adopt the Sułek's model of economic power. We evaluate whether the variables taken in a formal model are independent or not. In case they are strongly correlated, we split them or, if it is not possible, we create new factors which puts together correlated units. In this way, we maintain the information contained in an analyzed dataset, and eliminate noise. Among factors, we choose these components, which represent the original data in the best way, i.e., the fitting level of estimated factors to the original data is at least of the order of 90%. The factors are estimated by the use of the Exploratory Factor Analysis within the *Statistica* software. We show that the results obtained on

factorized data are better than those obtained by the use of original ones; moreover, they have better interpretations. Finally, we apply various methods of predictions; in particular we focus on neural networks which do not require the normal distribution of errors. The obtained results we discuss on the basis of economic rankings, which give an information about an analyzed state. In this way, we can estimate the state's economic position. Our case study is Nigeria, one of the strongest African countries.

Regarding the terminology used in this article, we apply the following terms: international position and regional position. International position is used to show a state's economic position within a broader context, i.e., how an investigated state is evaluated among other countries. Such an evaluation is quantified on the basis of rankings. We adopt only these rankings which give the information about economy. Instead, a regional position shows the place of a state in a region to which it belongs. These two measures strengthen or weaken an economic position of a state estimated by the use of formal methods (Blalock, 2017; Höhn, 2011; Guzzini, 2009; Gurr, 1972).

The data applied in the manuscript, i.e., GDP (according to the exchange rate), and population come from the World Bank (WB) database, and from the United Nations (UN). All the calculations of the economic power were made for the period 1961-2020. We operated on shares, e.g., a share of GDP for Nigeria is equal to the Nigeria's GDP overworld GDP. The results of the selected rankings cover the period when the data were available until 2020.

The paper is organized as follows: initial part is focused on Nigeria's economic presentation, i.e., we show Nigeria's management of natural resources, the dynamic of GDP, agriculture and general development. Since Nigeria is a very populated country, we also discuss the dynamics of Nigeria's population, and its influence on economy. The next section is dedicated to formal analysis of economic power of Nigeria on the basis of Sułek's model, i.e., we analyze the independence of used variables, estimate factors, and make predictions. All the calculations are done by the use of the *Statistica* software. In the last section 3 we show the economic position of Nigeria due to different rankings. In Conclusions we discuss the obtained results.

Nigeria: an economic overview

Nigeria is the 6th largest producer of crude oil in the world. Its economy, because of oil reserves, is the 2nd largest in Africa, and Nigeria

is considered a regional leader in the sub-region of Sub-Saharan Africa; i.e., West Africa¹. In recent years Africa has been subjected to many external shocks which have had a negative impact on the economic growth of the region. Oil exporters such as Nigeria, faced low world oil prices, and exporters of other commodities, including South Africa, were hit by a significant slowdown in China; hence, the average economic growth of African economies, which exceeded 5% annually in 2004-2014, has now dropped only to 2,20% (Kiczma, 2018).

Although the oil sector is important to Nigeria, it is in fact only part of its entire economy. The Nigerian economy is also trying to use the enormous wealth of fossil fuels to reduce poverty, which affects approximately 60% of the population. A relatively stable element of the Nigerian economy is the production of liquefied natural gas (LNG). The two currently operating production lines deliver approx. 5.6 million tons of LNG, and two more are under construction.

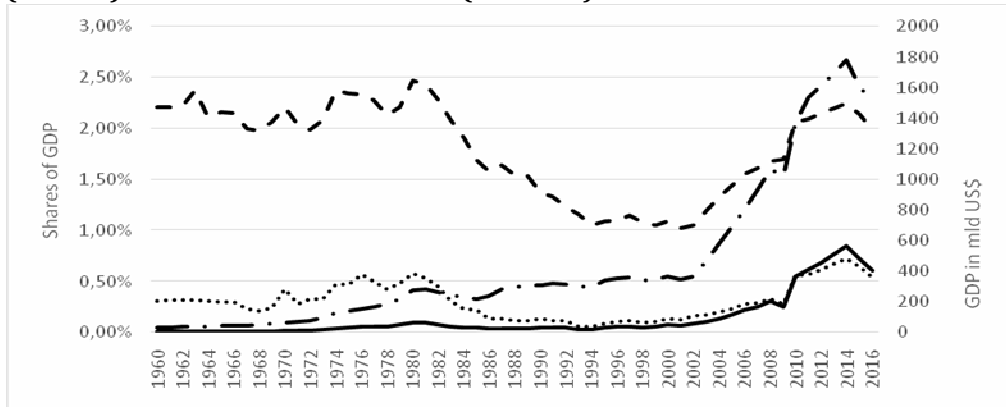
Nigeria's 2020 gross domestic product (GDP) was worth 432,29 billion US\$ (in 2019 – 448,12bln), according to official World Bank data. It consists 0,34% of the global economy. In the 4th quarter of 2019, the Nigerian economy grew by 2,55% compared to the revised growth in the previous period. It was the strongest expansion since Q3 of 2015, driven mainly by the oil sector (6,36% vs. 6,49% in Q3) with higher crude oil production (2.00 million barrels per day vs. 1.91 million in the same period of the year earlier), and more favorable prices. The non-oil services sector grew by 2,26%, supported by telecommunications and information services (10,26% vs. 12,16% in Q3), crop production (2,52% vs. 2,41%), financial services (22,33% vs 0,61%) and industrial processing (1,24% vs 1,10%). In 2019, the economy grew by 2,27%, the most growth since 2015, compared to 1,98% in 2018. The oil sector accounted for 1,50% of GDP in 2018, what can be seen in Figure 1.

In 2000, Nigeria was the 45th economy in the world in terms of GDP (current US\$), in 2010 – 31st, in 2016 - 28th, in 2020 – 26th (in comparison: in 1970 – 17th, 1980 – 22nd, 1990 – 31st). It is the largest trading partner of the United States in sub-Saharan Africa. Exports to the US account for about 10% of all US crude oil imports, making this country the 5th country from which the US imports oil. Imports are mostly machinery and equipment, chemical products, vehicles, industrial

¹ West Africa's presence in the region of Sub-Saharan Africa has a geographical rationale and reflects existing international economic institutions, namely ECOWAS (Economic Community of West Africa States), an organization created at the initiative of Nigeria in 1975 (Wilczyński, 2021, p. 660-661).

products, food and live animals. The main import partners are: China (10,70%), USA (8,40%), Netherlands (6,0%), Great Britain (5,80%), France (5,60%), Brazil (5,10%), Germany (4,50%). The trade balance is overwhelmingly favorable to Nigeria, thanks to its oil exports.

Fig. 1. Nigeria's GDP (continuous line) in comparison to Sub-Saharan African GDP (dash-dot line); GDP shares in world GDP in the period 1960-2016 for Nigeria (dot line) and for Sub-Saharan Africa (dash line)



Source: based on the World Bank data.

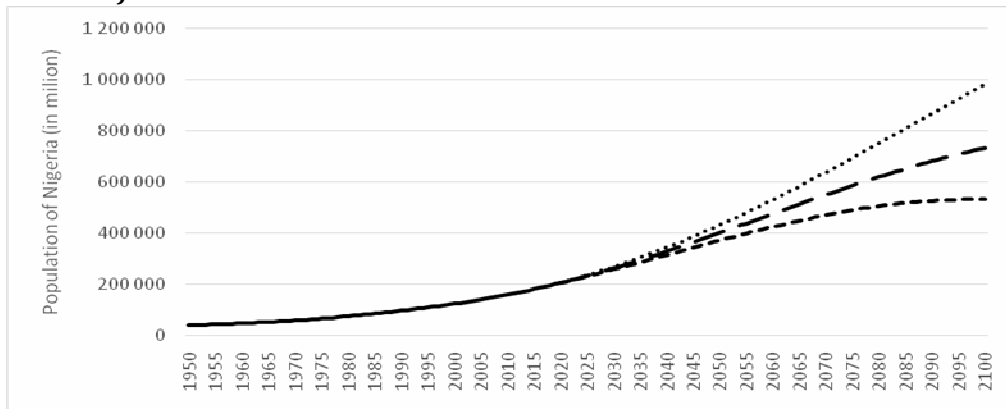
Agriculture, as the 2nd most important branch of the Nigerian economy, has had many years of mismanagement and a lack of basic infrastructure. Nevertheless, this sector accounts for approx. 20% of GDP and employs over 60% of the population. Nigeria has excellent climatic conditions that make it possible to replace agricultural imports with our own production; however, weak industrialization did not allow Nigeria to achieve a state of food self-sufficiency. The agricultural development was negatively affected by the land tenure system in Nigeria, which does not encourage long-term investments in technology and modern production methods.

Finally, Nigeria has its own space satellites and is one of the fastest growing telecommunications markets in the world. The country is also characterized by a highly developed financial services sector with a mix of local and international banks, management companies, brokerage houses, insurance and brokerage companies, and with investment banks. Manufacturing industries include the production of leather and textiles, while the automotive industry produces for the French car manufacturer: Peugeot, as well as for the English truck manufacturer: Bedford, now a subsidiary of General Motors.

Population

In 2007-2020 Nigeria was the 7th most populous country in the world after China, India, USA, Indonesia, Pakistan and Brazil. Its ranking has risen from tenth in 1990-2001 and thirteenth in 1960, despite a rising tide of emigration. For example, in 2016, emigrants from this country topped the list of illegal emigrants to Greece. In 2020, the total number of international migrants at mid-year has achieved 1.3 million (0,60% of total population); e.g., in 1990, it was 456.60 thousand (0,48% of total population).

Fig. 2. Demographic profiles in 1950-2100. Estimates of population (continuous line); high variant (dot line); medium variant (long dash line); low variant (short dash line).

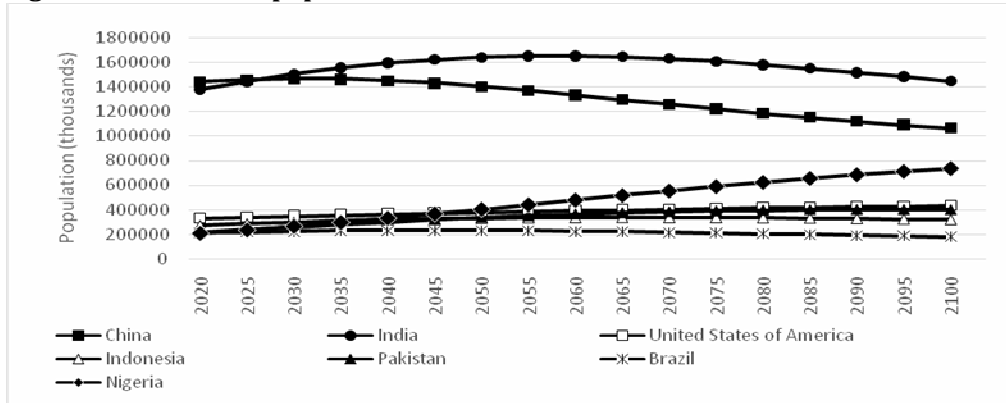


Source: <https://esa.un.org/>

The population of Nigeria increased by 5,175,984 and reached 206,140 thousand in comparison to 2020. It is estimated that in 2050 Nigeria will outclass the USA in terms of population (410,637,000 people), and become the 3rd most populous country in the world (the estimated increase by 2050 should be within 2,50% - 2,00% per year, with a downward trend). According to United Nations, the population of Nigeria is growing exponentially, and until 2100 no peak is forecast. This means that if this forecasts are met, the increase will continue (Fig. 2). In comparison, in 2025, China should reach the peak of its nation's demographic growth (Fig. 3). As we can observe, in the range of 75 years, the number of Europeans will decrease, and China will lose about 420 millions of its population. The United States should increase its population by 116 million citizens, and only Nigeria itself should increase its population by about 588 millions. Finally, the population growth of Sub-Saharan Africa in comparison to e.g. Europe will be a

challenge for everybody from the economic point of view, and will have impact on global economy, e.g., 20% of Nigerian GDP comes from agriculture, which employ 60% of population; therefore, this population growth will impact Nigerian economy.

Fig. 3. UN forecasts of population for the first seven countries in 2020



Formal analysis of the economic power

Within the group of purely formal models of economic power, apart from Sułek's model (Sułek, 2020), we can find the *Correlates of War* model (1963); Fucks' model (Fucks, 1965), and Virmani's model (Virmani, 2004).

Sułek's model of economic power (EP) is defined as follows:

$$EP = GDP^{0.652} POP^{0.217} L^{0.109} \quad (1)$$

where:

- EP–Economic Power;
- GDP–Gross Domestic Product;
- POP–Population;
- L–Land.

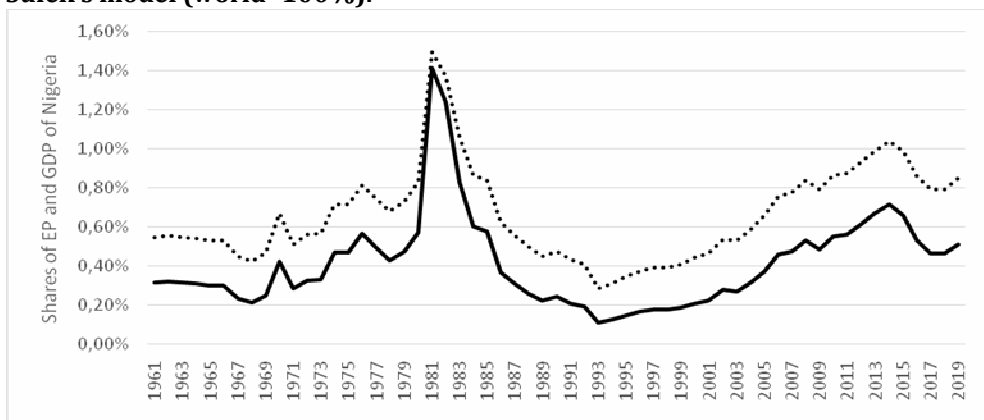
All variables denote shares in comparison to the world GDP, population and land, respectively.

We can notice that this model is a generalized Cobb–Douglas function (CDF) for more than two goods, which represents the technological relationship between the amounts of two or more inputs, in particular, physical capital and labor, and the amount of output that can be produced by those inputs (Cobb & Douglas, 1928). If we apply GDP, POP and L to CDF, this function can denote an economic power. If

we take GDP alone, we can also estimate an economic power; however, two additional variables can be seen as a formal adjustment of EP. In fact, economic power depends on the number of people and the area they live, work, and operate. The sum of coefficients is less than one to reflect the law of declining revenues. Finally, since we operate on variables shares our results belong to the interval (0,1).

In the range of the last 60 years, EP for Nigeria, estimated due to the formula (1), varies as it is shown in Fig. 4.

Fig. 4. Shares of EP (dot line) and GDP (continuous line) of Nigeria on the basis of Sułek's model (world=100%).



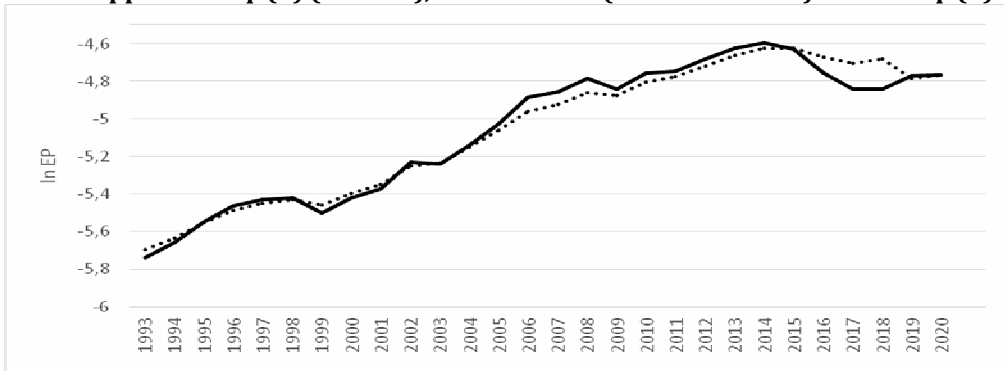
The difference between shares of EP and GDP is of the order of 0,30 percentage point, but this change do not influence the main character of EP. The dynamics of EP varies within the range 1961-2020. We can observe four local extrema: two minima, and two maxima: in 1968, 1993, and in 1980, 2014, respectively. During the period of growth (1994-2020), Nigeria increased its economic power more than 5 times: from ~ 0,20% in 1994 to ~ 1,04% in 2014. In 2020, Nigeria had a share of 0,85%. In 1961-2020 ranking of countries based on EP (out of 195 countries surveyed), the average position of Nigeria was: 28th. In 2018, Nigeria was on the 19th position, in 2020 - 18th. Even its loss of EP in the period 1980-1993 did not make Nigeria weaker in terms of EP; in fact, as Table 1 shows, Nigeria was still a local leader, i.e., its contribution was always of the order of ca. 50%. In comparison, Cameroon, which in our rankings is on the 2nd position in Nigerian neighborhood, only reached 0,098% of EP. In 2016 Nigerian EP, with its neighboring countries, was of the order of 1,08%; i.e., 1,08% of world EP (Kiczma, Sułek, 2020).

Tab. 1. Economic power of the subregions of Sub-Saharan Africa in 2016

Subregion	Position of Nigeria	Estimation of EP share (world = 1000)		EP Nigeria's share in subregion	
		without Nigeria	with Nigeria	without Nigeria	with Nigeria
Sub-Saharan Africa	1	-	-	-	-
West Africa	1	5,49	14,12	156,95%	61,08%
Central Africa	1	6,15	14,77	140,23%	58,37%
South Africa	1	6,45	15,07	133,80%	57,23%
East Africa	1	10,93	19,55	78,90%	44,10%

Analyzing EP of Nigeria, in the 1st period of time: 1961-1992 (A), we found a strong correlation between population and land: $r=0,94$; p -value $<10^{-6}$, and in the 2nd period of time: 1993-2020 (B) - a strong correlation between GDP and population: $r=0,87$; p -value $<10^{-6}$. Consequently, the data are not independent. This means that a specific data analysis should be applied. We applied an Exploratory Factor Analysis (EFA) (Jambu, 1991; Affifi, 1999) within the *Statistica* software to figure out main factors within our dataset. EFA was applied on the Bartlett test indicator ($\chi^2 = 38$, p -value $<10^{-5}$), and on logarithms of original data. In (A) we got a demographic-geographic component, and an economic factor; in (B) we got an economic-demographic component, and a geographic one. In the recent period, we can observe an influence of population to GDP, expressed in the form of one factor, what proves its economic impact. In EFA we stressed on maintaining the whole information contained in our data; hence, we tried to put together correlated factors, and maintain split those components, which are independent. For (B), in case of an economic-demographic factor, the estimated data fit is of the order of 98% for GDP, and 95% for POP (p -value $<10^{-5}$); in case of a geographic factor, the data fit is of the order of 98% (p -value $<10^{-6}$). The comparison of EP and its estimation by the use of calculated factors is presented in Figure 5. We performed analysis on factors logarithms (always in *Statistica*); fitting parameters are as follows: $R^2 = 0,97$; $F(2,25) = 495$, p -value $< 10^{-5}$.

Fig. 7. The logarithm of economic power of Nigeria calculated on the basis of factors applied to eq. (1) (dot line), and raw data (continuous line) used in eq. (1).



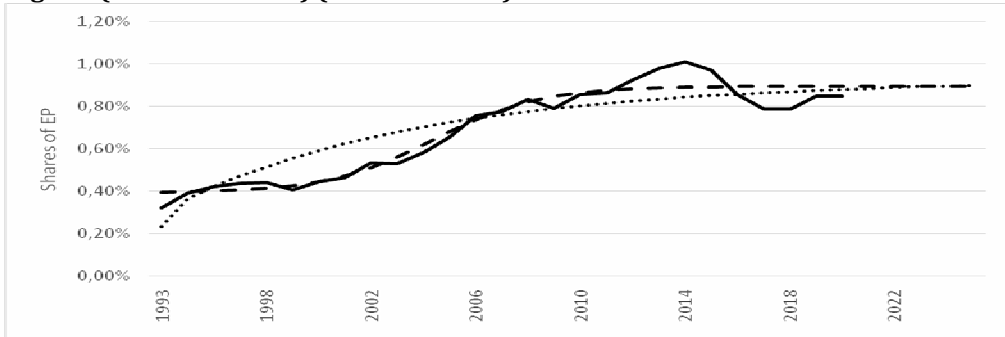
For predictions of economic power we applied different methods. First, we fit a generalized logistic function, i.e., a Richard's curve (2) to our data (Figure 6).

$$y(t) = A + \frac{B - A}{C + D e^{-K(t-t_0)}}, \quad A, B, C, D, K - \text{const.}$$

(2)

Richard's curve gives an information where the economic power of an analyzed state is in its-so called: cycle of life. This means that the economic power has periods of increasing and decreasing, but its dynamic is not a periodic function. In such a way we can estimate the behavior of EP in near future; it is not a long-term prediction. To fit a Richard's curve, we applied a nonlinear estimation based on the Gauss-Newton algorithm, and applied two kinds of loss function: (1) the squared errors; (2) the absolute values of errors. In (1) big errors become greater, in (2) all errors are treated uniformly. The estimated data fit in (1): in 97% (they explain 94% of variance-VAR); in (2): in 90% (they explain 82% of VAR), what prove a good estimation. Since in (1) the applied method is a generalization of a linear regression, the error analysis is indispensable. In our case the K-S test gave the value 0,12 (p-value $<10^{-6}$), what means that the difference with a normal distribution of errors is of the order of 12%, and this loss is significant. This means that the results can be distorted numerically, for this reason we will apply them only as an indication for further analysis.

Fig.6. Richard's curves of EP of Nigeria estimated: on the basis of least squared errors (dash line), and on the basis of absolute values of errors (dot line). EP of Nigeria (continuous line) (world = 100%).



Now, we will apply neural networks to verify whether the obtained predictions of EP by the use of Richard's curve for the year 2025 are reasonable (fig. 6), (Aggarwal, 2018). For investigations we took the whole data set (1961-2020). We applied two different methods of aggregation: linear and radial (MLP, RBF networks). We took all possible activation functions and adjusted the obtained results manually to get the best fit in terms of correlations to our data. At the end we calculated the average of the best five neural networks we estimated. Since we do not have a huge amount of data, we chose the simplest topological networks; i.e., we took into consideration the networks with maximally three neurons in the input layer, and those for which we got a linear function in the output layer. We performed predictions in two ways: (1) we predicted GDP and POP, and applied the results into Sułek's model of EP; (2) we predicted EP, directly. The following three figures (7,8,9) present the obtained results:

Fig. 7. Neural networks prediction for shares of GDP of Nigeria (dot line); GDP share (continuous line) (world = 100%).

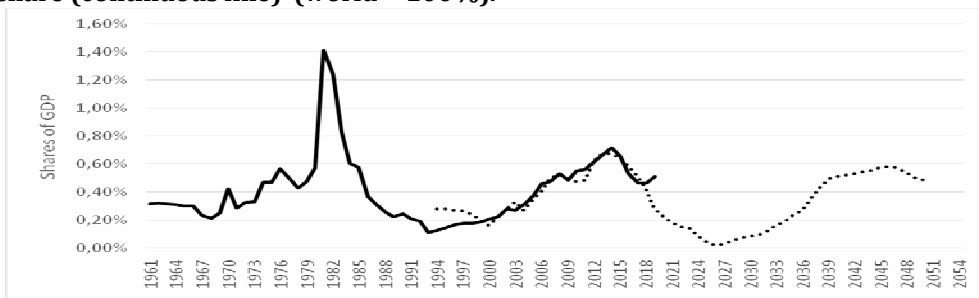


Fig. 8. Neural networks prediction for population share of Nigeria (dot line); population share (dash line) (world = 100%).

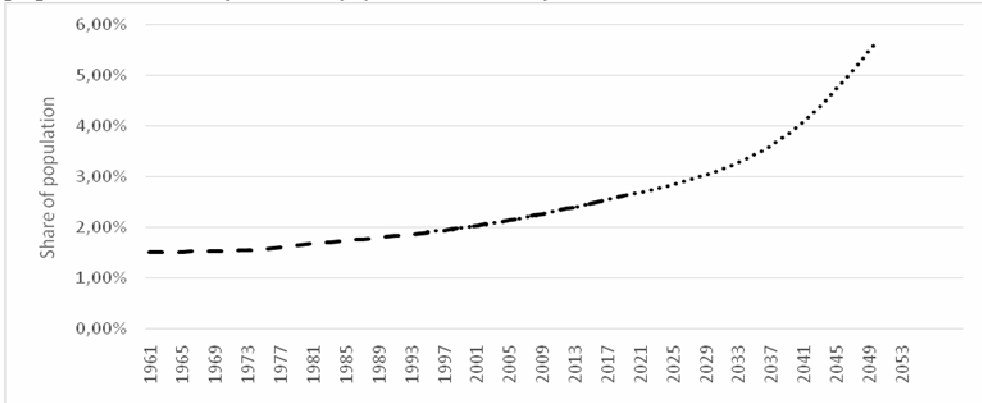
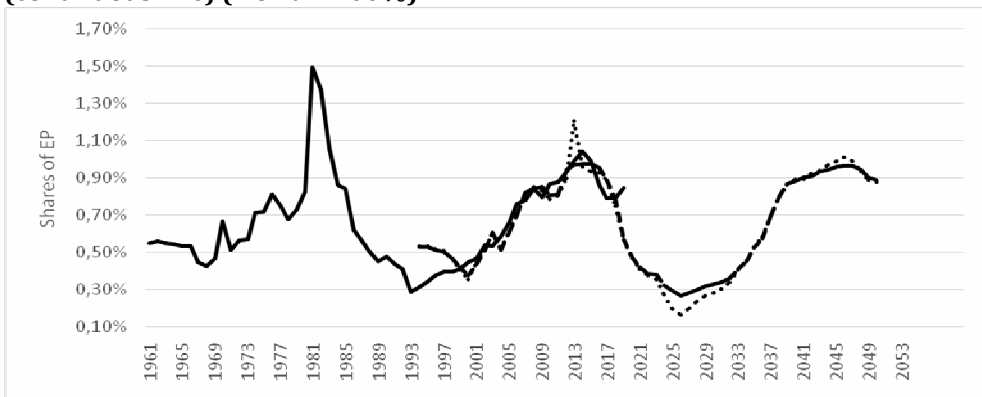


Fig. 9. Neural network predictions performed directly on EP (dot line). Estimation of EP on the basis of predicted GDP and POP (dash line); EP obtained on raw data (continuous line) (world = 100%).

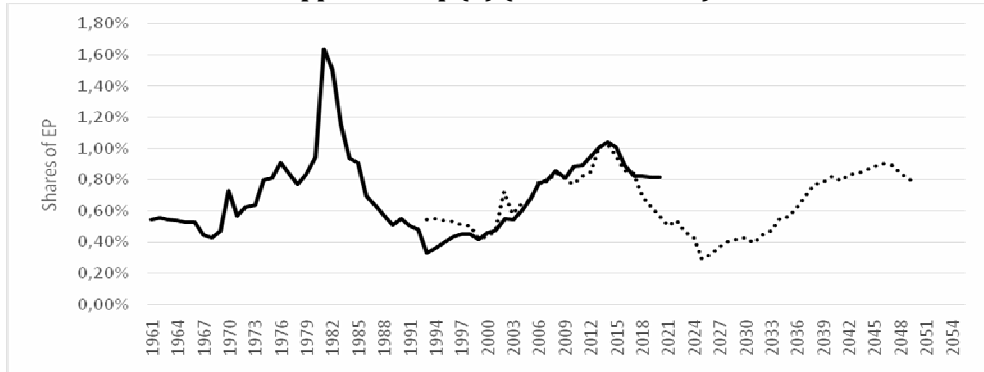


We observe differences for the year 2025 between Richard's curve (fig. 6), and EP performed by the use of neural network (fig. 9, dash line). We got EP=0,90% and EP=0,30%, respectively. In the case when we directly predict EP (fig. 9, dot line), we got EP=0,18%. The quality of the network is 94% (fig. 9, dot line), and 74% ; 58% for GDP and POP (figures 7, 8); hence, the method based on direct prediction seems more precise than predictions on the basis of single components. Regarding a Richard's curve, we observe that EP reaches a saturation level, i.e., it arrives at the end of its increasing period; hence, we can expect a decreasing tendency in EP in next future, what is confirmed by the results obtained by the use of neural networks. If we take into

consideration the predictions of population done by UN (figures 2, 3), and our prediction (fig. 8), we can observe that they are in agreement.

For the factorized data for the whole period (1961-2020), we also performed forecasts, and obtained the following results (Fig.10).

Fig. 10. Neural network predictions for EP obtained on factorized data (dot line); EP obtained on factors applied to eq. (1) (continuous line).



We can observe that the differences between original data and factors are of the order of 0,10 percentage point (fig. 9, dot line;fig.10, dot line). The quality of fitting the network is of the order of 82%. The best fit was obtained for MLP network with three hidden neurons, and three neurons in the input layer. Tanh is the function applied in a hidden layer. The network was found in 12th epoch, and the plot of learning shows a good machine learning. We see, that the obtained result is in between two outputs estimated in two methods of predictions we applied; i.e., in direct predictions of EP, and in predictions of single variables. Once again, we can stress that factor analysis should be the main approach of analyzing data. Additionally, we should have in mind, that we operate on shares; i.e., the values of the segment (0,1), that is why the differences taken into consideration of the order of 0,10 percentage points, are in fact significant.

In summary: in the near future (2025), we can expect that the economic power of Nigeria will decrease reaching its local minimum of the order of ca. 0,30% (the share in world EP, fig. 10); instead in the year 2047, we can expect the growth of EP to the share of 0,90%. These outputs seem reasonable if we compare the results with the forecast done due to eq. (1) on Pricewaterhouse Coopers data (PwC), according to which in 2050 Nigeria will shift on the 9th position (Fig. 11), and on (2) the Centre d'Etudes Prospectives et d'Informations (CEPII) data,

according to which Nigeria will shift on the 13th position (Fig. 12), what means that we can expect Nigeria's new spring (Kiczma, Sułek, 2020).

Fig. 11. The PWC ranking of EP in 2016 (dash line), 2030 (dot line) and in 2050 (continues line) (the order due to 2050)

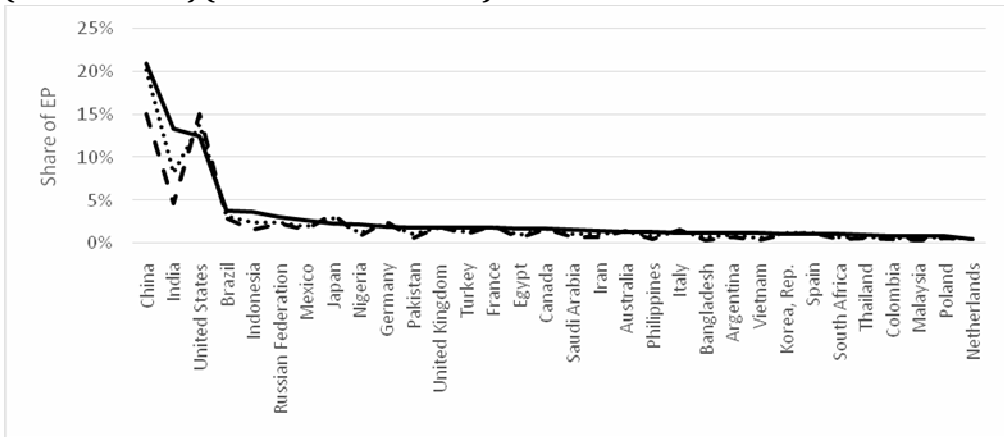
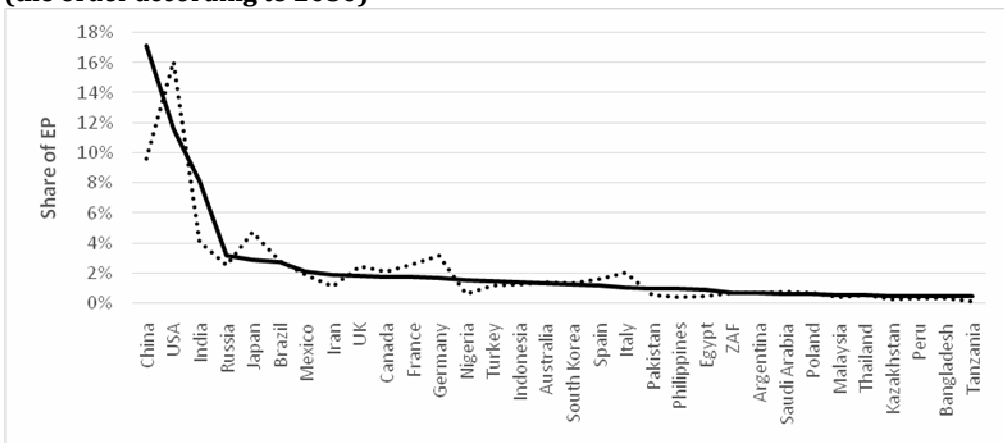


Fig. 12. The CEPII ranking of EP in 2010 (dot line), and in 2050 (continuous line), (the order according to 2050)



The economic position of Nigeria

Today, rankings are an increasingly popular research method, and their application in international relations can be used to analyze and evaluate quite complex phenomena, either theoretically or as an auxiliary method to complement the results obtained by the use of formal models (Kiczma, 2018). Table 2 presents Nigeria's international position according to selected rankings which also show Nigeria's economic position.

Tab. 2. Position of Nigeria in the world and in the region due to selected rankings

Ranking	Position of Nigeria		Last year under study
	In the world	In a region	
KOF Globalization Index	116	-	2018
KOF Globalization Index (de jure)	107	-	2018
KOF Globalization Index (de facto)	127	-	2018
Doing Business	131	17	2019
Index of Economic Freedom	105	13	2021
Economic Freedom of the World	81	-	2018
Global Competitiveness Index	116	-	2019
Global Innovation Index	117	15	2020
Freedom in the World	45 (Partly Free)	-	2021
Human Freedom Index	131	27	2018
Human Development Index	161	-	2019
Africa Regional Integration Index	-	39 (country is a low performer; it scores below the average)	2019

According to the KOF Globalization Index (KOF GI, 2020), which covers three main dimensions: the level of economic integration, the level of social integration and the level of political integration, in terms of Economic Globalization, Nigeria occupies 144th place (45.04 points), de facto - 168th place (40.02 points), de jure - 103rd place (50.06 points); in terms of social integration (Social Globalization) Nigeria takes 187th position (36.90 points), de facto - 187th (29.87 points), de jure - 182nd (43.94 points); in the area of Political Globalization Nigeria has 41st place (85.24 points), de facto - 41st (82.91 points), de jure - 44th (87.57 points). In summary, in KOF Globalization Index 2020, Nigeria was in 116th place (55.73 points), de facto - 127th (50.93 points), de jure - 107th (60.52 points).

Taking into account the results of Doing Business reports (World Bank, 2020), which also measure the level of freedom of doing business, in 2006-2018, Nigeria (in average) is on the 136th position. In 2016 and

2017, Nigeria was ranked 169th. The 2018 Doing Business edition shows a significant improvement in this ranking, which let Nigeria improve, and take 145th position; in 2020 – 131st globally and 17th regionally.

The Index of Economic Freedom (Miller, Kim, Roberts, Tyrrell, 2021) measures and compares countries in terms of the 12 quantitative and qualitative factors – from property rights to financial freedom, which are grouped in four categories of economic freedom, i.e., the Rule of Law (property rights, government integrity, judicial effectiveness); the Government Size (government spending, tax burden, fiscal health); the Regulatory Efficiency (business freedom, labor freedom, monetary freedom), and the Open Markets (trade freedom, investment freedom, financial freedom). Analyzing the results of this ranking, in 2018, Nigeria achieved an overall score of 58,50%, compared to the global average of 61,10%, and Sub-Saharan Africa – 54,40%. With this result, in 2018 Nigeria was ranked 104th in the Nigerian Economic Freedom Ranking; in 2021 – 105th globally and 13th regionally.

Economic Freedom of the World (EFW) (Sobel, 2021) is a think-tank ranking based on the principles of personal freedom, economic freedom, free market and peace-keeping. Out of 159 countries included in the ranking, Nigeria was ranked 115th with a score of 6.37 points; in 2018 – 81st.

The Global Competitiveness Report (Schwab, 2019) presents information and data that were compiled and collected by the World Economic Forum. Because the year 1979 is intended to broaden the views of policymakers, business, and the public on looking beyond the growth alone – the Report analyzes how economies should think about their revival and transformation to redesign their systems in order to enhance human development and compatibility with the environment. In 2018, Nigeria moved up two places in the ranking, reaching 125th place. In the sub-Saharan Africa region, Nigeria was ranked 23rd; and in 2019 Nigeria took 116th global position.

The Global Innovation Index (Cornell University, INSEAD, WIPO, 2020) report is based on a compilation of the capabilities and results of innovative global economies. In 2008, Nigeria was ranked 70th among world economies, and in 2017 - 119th; in 2020 – 117th globally, and 15th regionally.

The Human Freedom Index (HFI) (Vásquez, McMahon, 2020) presents the state of human freedom in the world based on a broad range of personal, civil and economic freedoms. In 2015, Nigeria took 133rd place. In terms of sub-indexes, in 2015 Nigeria was ranked 142nd

in Personal Freedom Rank, and 114th in Economic Freedom Rank; in 2018 – 131st globally and 27th regionally.

The Human Development Index (UNDP, 2020) is the most popular, complementary and refined method of analyzing GDP. The index was created to emphasize that people and their capabilities should be the final criteria for assessing a country's development. Between 2004 and 2015, Nigeria was 16th; in 2019 – 161st globally.

The 2019 Africa Regional Integration Index (Africa Regional..., 2019) indicates that the level of integration on the continent is low, with an average score of 0.327. Africa is poorly integrated either on the productive or infrastructural dimensions. They are key aspects, which form the foundations upon which other dimensions of regional integration depend. The index shows that 20 African countries are performing well, while 25 are low performing. Because of ARII's multidimensional nature, some countries' rankings for overall regional integration are higher, some are lower than expected. This is the case for Comoros, Djibouti, and Somalia, which rank highly, thanks to their top positions on the people free movements. In contrast, Nigeria's overall ranking on regional integration is low, even though it is the second-most integrated country in production and it is a strong contributor to gross domestic product. This is due to the fact that, at the time of measurement, Nigeria had signed, but not yet ratified, the African Continental Free Trade Area (AfCFTA) agreement, and only a small proportion of its imports came from within the region.

Conclusions

In the following manuscript, we proposed a methodology of estimation of state's economic position based on formal analysis, predictions and rankings. We showed that original data used for estimation of economic power should be factorized. The neural networks predictions on factorized data give better results than those performed on raw database cause factors are independent while original variables, they are not. Moreover, it is clearly seen the mutual relationship between GDP and population, what has an impact on global economy. For short period calculations of economic power, the method based on estimation of Richard's curve gives an information about a general dynamic of the analyzed phenomena, and can confirm the outcomes obtained by the use of factors.

In case of Nigeria, we showed that in the year 2025, the economic power of Nigeria will reach a local minimum. This result was confirmed

by Richard's curve since for 2020, we already got a saturation level; hence, we would have expected a decreasing dynamic of Nigerian economic position, as the consequence of its decreasing EP. In fact, in 2018, Nigeria was 19th in EP Sułek's model. Various economic rankings confirm these results. Regarding the long-term predictions obtained by the use of neural networks, in the next 30 years, we can expect an increase in Nigerian economic power; hence, Nigerian economic position should increase, but to have numerical results, global, or at least regional analysis should be figured out. The proof is the outcome that in 2047, a local maximum of EP is to be reached; however, it will be slightly lower than the one of 2014. Also here, rankings give similar insights about Nigerian economic position, e.g., in the Global Innovation Index, in 2020, we observe a slight increase, what may suggest greater future changes in economy. The same tendency we observe in the Global Competitiveness Report.

In conclusion, taking into consideration all formal results, forecasts, and rankings regarding Nigeria, we suppose that Nigeria, despite of the weak present economic position, in the next three decades will enforce its economic position to become more competitive partner to other countries; however, to have a general overview, the proposed methodology should be applied to all countries of the world.

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Ocena pozycji ekonomicznej państw na przykładzie Nigerii

Celem niniejszego artykułu jest opracowanie metodyki szacowania pozycji ekonomicznej państwa. Do oceny pozycji ekonomicznej zastosowano analizę formalną w oparciu o model siły ekonomicznej Sułka i dokonano analizy jej czynników. Oceniono stopień niezależności zmiennych uwzględnionych w modelu formalnym. W przypadku gdy są one silnie skorelowane, rozdzielono je lub, jeśli nie było to możliwe, utworzono nowe czynniki, które łączą skorelowane jednostki. Zastosowano różne metody predykcji siły ekonomicznej, w szczególności oparte na sieciach neuronowych, które nie wymagają normalnego rozkładu błędów. Na koniec oszacowano pozycję gospodarczą państwa na podstawie analizy formalnej, prognoz oraz w porównaniu z wybranymi rankingami gospodarczymi. Wszystkie wyniki opracowano dla Nigerii.

Słowa kluczowe: pozycja gospodarcza, siła gospodarcza, model Sułka, analiza formalna, sieci neuronowe, rankingi gospodarcze, Nigeria.