ATLANTIS PRESS
Advances in Economics, Business and Management Research, volume 83
2nd International Scientific Conference on 'Competitive, Sustainable and Safe Development of the Regional Economy' (CSSDRE 2019)

Structural Analysis of Egyptian Economy: Trends in Service and Digitalization

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***Abstract* — In 2019, Egypt celebrates the 150th anniversary of the opening of the Suez Canal, which brought new impulses and challenges to the economy and political development of this state. Egypt and Russia have long-term history of successful economic cooperation. This paper presents results of structural analysis of Egyptian economy, describes actual trends of its development, evaluates the effectiveness of managing the evolution process and takes into account both global and national trends of digitalization of the economy. The authors used comparative analysis of developmental indices of the national economic system over the period of 1998-2016 which allowed to make a series of proposals to adjust the public Egyptian economic structural policy in order to increase the level of digitization of the national economy.**

Keywords — Gross Value Added, Intersectoral Proportions, Level of Service Economy Development, Digitalization Trend

I. INTRODUCTION

Historical events, which effected trajectory and developmental potential of national economic systems, can have long-term effect. For instance, the history of the Suez Canal opening and operation reflects the trend of Egyptian economy, national political objectives and military threats as well as its developmental potential and reality.

In order to conduct structural assessment of Egyptian economy the authors have taken into account various external factors such as threats to sovereignty during the colonial period of the global history, income loss during wars and political conflicts, consequences and instability of revolutions and the rule of the Muslim Brotherhood in Egypt in 2011. Such milestones in the history of Egypt and its economy allowed substantiating the relevance of structural rank analysis (SRA) of national economy and applying expert interpretations of the obtained calculations.

SRA method was approved by previously published papers [1], [2], [3], and by the authors` works deposited in the Russian National copyright Registry [4]. The suggested method differs from both traditional structural and rank analysis. Classical structural analysis is applied at the initial stage and compares intersectoral proportions in terms of gross value added (GVA) structure over time. In order to demonstrate structural analysis results, evolutionary graph is constructed. It is based on calculations, reflecting structural changes and their vector. Whereas, rank analysis reflects the results of the structural analysis and consists in calculating the "effective" rank. It measures and takes into account degree of inequality between adjacent units of the aggregate to be ranked. This method is protected by the copyright certificate of state registration of a computer program [5]. For calculations, we used the UN statistics data on the industry structure of the GVA for the period 1998-2016. [6], as well as international ratings of countries` level of digitalization (UN and other international organizations` indices) [7], [8], [9].

II. MATERIALS AND METHODS (MODEL)

The research employed the following methods: structural analysis based on the calculation of coordinate indexes; graphic analysis of measuring intersectoral proportions in the dynamics; empiric approach to identification of types of economic systems according to their level of development, including development of digitalization; critical approach to the evaluation of the international digital economy and digital government indexes.

The method of structural analysis developed by the authors enables to evaluate industrialization and servitization of the countries, investigate digital transformation trend at the level of national economy and receive original results.

The effective rank method developed and patented in 2017 occupies a special place in the research methods. Applying it to the results of structural analysis is a new result of testing this method.

III. Results and Discussion

STRUCTURAL ASSESSMENT OF EGYPTIAN ECONOMY BY THE ALGORITHM OF SRA

A. Cross-country comparison of inter-sectoral proportional changes of the Egyptian economy GVA structure over1998-2016

The authors' approach to the study of dynamics of the national economy`s intersectoral structure is based on the following conditions and is conducted in the particular order:

1) we used traditional for macro-statistics and national accounting classification of sectoral structure of gross value added (GVA). It divides GVA into Agriculture, Hunting, Forestry, Fishing (ISIC AB), Mining, Manufacturing, Utilities (ISIC CE), Construction (ISIC F) and Service sector. The latter comprises Wholesale, Retail, Hospitality (ISIC GH), Transport, Storage and Logistics (ISIC I) and Other Activities (ISIC JP) (according to the UN data);

- Aggregation of the elements presented in the GVA is carried out according to the following scheme:

1) Agricultural sector (DA) includes ISIC A-B;

2) Industrial sector (DI) includes ISIC C-E;

3) Service sector (DS) consists of ISIC G-H, ISIC I and ISIC J-P.

It is to be clarified that Section F "Construction" is not included in any of the above sectors, but participates in the formation of $D_{G.}$ This is an additional indicator of the analysis, which accumulates all goods produced by national or regional economies.

2) Calculation of t_α and t_β coefficients representing ratio between $D_{S,}$ D_I , D_S sectors over at least 10 year period:

$$t_\alpha = D_I / D_A \quad (1)$$

$$t_\beta = D_S / D_I \quad (2)$$

where t_α shows the degree of industrialization and demonstrates how many dollars produced by industry account for 1 dollar produced by the agricultural sector.

t_β shows degree of service development and reveals how many dollars produced by service sector account for 1 dollar produced by industry.

3) Graphical analysis of t_α and t_β evaluates economic system evolution, identifies evolution vector over a period and compares expert assessment of the quality of structural changes and trends of a national economy or a group of economies.

In the course of the study, it was determined that the more basic t_α and t_β values exceed 1, the more economically developed the country will be according to its structural changes over the period. Such economy can be referred to as industrially and service developed one

The authors obtained the following results of structural changes assessment of Egyptian economy by using formulas (1) and (2), according to the UN, (Fig. 1):

1) in 1998, the following values of : t_α and t_β were obtained for the Egyptian economy. t_α, equaled 1,9 which means that we had one dollar ninety cents produced by the Egyptian Industry for one dollar produced by Agriculture. tβ equaled 1.85, therefore one dollar eighty five cents produced by the Egyptian Service sector accounted for one dollar produced by Industry. The services sector exceeded the industrial sector by 85%;

2) during the analyzed period, the following "zones" of structural fluctuations can be observed, which can also be interpreted as a transitional period in the evolution of the system. After 1999 and up to 2004, the growth of the industrial sector was higher and more noticeable against the background of decrease in the service sector compared to the industrial sector. Over 2004-2011. strong structural fluctuations were observed, arguably, caused by economic consequences of political instability in Egypt. Only over 2014-2016. one can observe a clear vector of growth in the services sector, which, on the one hand, threatens the industry and its competitiveness in the external market (against the background of the reduction of the share of the agricultural sector in Egypt's GVA from 14.9% in 1998 to 11.9% in 2016 and The decline in the share of the industrial sector from 28.3% in 1998 to 27.5% in 2016), on the other hand, testifies to the rate of improving the quality of life and increasing the services sector, including government, ensuring an increase in public satisfaction in the consumption of and sought-after benefits;

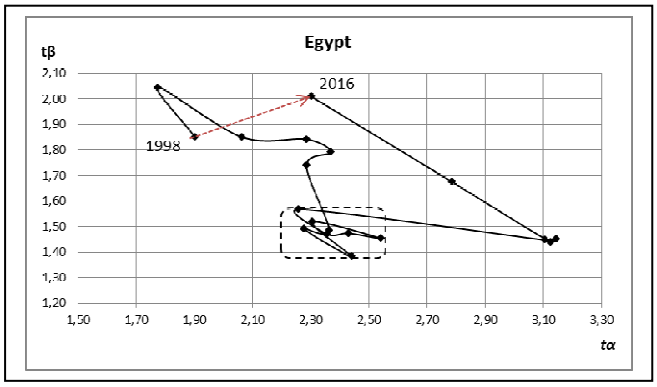

Fig.1. Distribution of t_α and t_β coefficients for Egypt over 1998-2016.

Assessment of the final vector of evolution of Egyptian l economy over 1998-2016. (red arrow in Figure 1) reveals a harmonious growth of both t_α from 1.9 in 1998 to 2.3 in 2016, and t_β from 1.85 in 1998 to 2.01 in 2016. However, the question arises about the feasibility of all fluctuations in terms of the resources spent by the state and the results obtained in the development of the national economy and its progress along the evolutionary graphic field in accordance with the public economic policy.

The USA, Japan, Germany as economically developed countries, and Russia, India and Egypt as economically developing countries were selected in a sample of countries for the purposes of comparative analysis and identification of economic development patterns.

Although coefficients t_α and t_β tα are close to those of Russia and India, a detailed cross-country analysis shows different vectors of development of national economic systems (see Fig. 1 and Fig. 2).

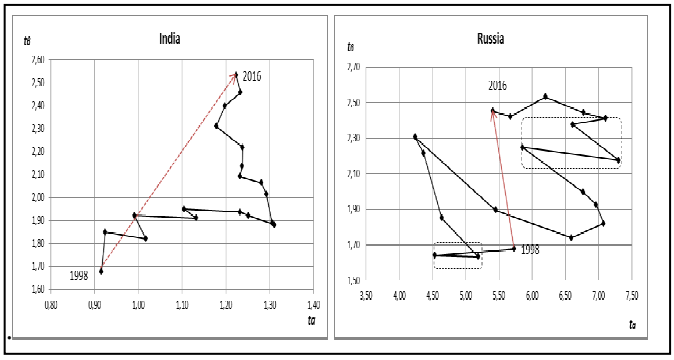

Fig.2. Distribution of t_α and t_β coefficients for India and over 1998-2016.

Both for India and Egypt, the increment of service and industrialization development is important for national economies. As for Russia, frequent zones of "structural fluctuations" were typical, which may indicate, firstly, a high elasticity in reaction to external and internal factors of economic development. Secondly, by the policies of owners of large businesses and changing supply and demand for the key branches of the Russian economy in the structure of GVA. Nevertheless, the general vector of Russian economic development is in the direction of the growth of service sector. Nevertheless, there are problems in the growth of high-tech production and automation of the agricultural sector.

The results obtained for the economically developing countries vary considerably from those of the USA, Japan and Germany (see Fig.3 and Fig.4).

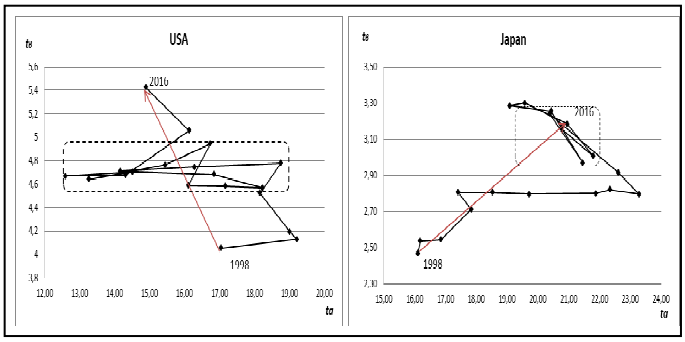

Fig.3. Distribution of t_α and t_β coefficients for the USA and Japan over 1998-2016

In 2016, the United States has the following t_α and t_β coefficients values: t_α = 14,9; t_β =5,4 (see figure 3). For the entire analyzed period in the USA there was a trend of reducing the level of industrialization (as evidenced by the policy of transferring industrial production to countries with cheap labor and loyal environmental legislation). Besides, there is an increasing level of service development, which is confirmed by export structure, dominated by financial services. According to the international digitalization index, the rate of digitalization is high; the dotted line indicates the area of structural fluctuations, showing weak controllability of the development of the US economy and the instability of economic relations in the conditions of their high politicization and focus on the import of consumer goods.

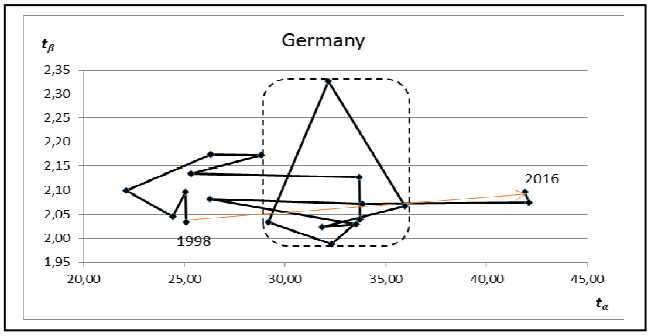

Fig.4. Distribution of t_α and t_β coefficients for Germany over 1998-2016

For Japan, over the analyzed period, a uniform increase in of these indicators were all indicators, both t_α ,and t_β, was typical. In 2016, the values as follows: t_α , = 20.76; t_β = 3.2 (Fig. 3). Presence of structural fluctuations in the Japanese economy can be explained by the influences of both external factors (global economic crisis, sanctions regimes and trade wars), and the dynamics of domestic demand and supply for different groups of goods and services, different rates of these changes over various periods.

Germany had the highest t_α coefficient throughout the entire analyzed period, which confirms the status of the German economy as the largest and most industrially developed global economies. In 2016, the values of t_α and t_β were as follows: t_α = 41,9; t_β =2,1 (fig.4). For comparison, in 2016, in Egypt t_α = 2,3; t_β =2,01; in Russia, t_α = 5,4; t_β =2,45, in India, t_α = 1,22; t_β =2,53.

A. *Position of the Egyptian economy in the evolutionary cross-country graph.*

We applied the method of Intersectoral Structural Changes by Clark-Fisher ([10], [11]), assessed the evolution of t_α and t_β coefficients and analyzed corresponding structural changes in the Egyptian and other countries` economies over 1998-2016 on the evolutionary graph (Fig. 5).

According to the three-sector Clark-Fisher model, the most evolutionary developed economies of these three countries are the those of Germany and Japan, since their sectoral structure not only satisfies the condition: $D_A<D_I<D_S$, but also in comparison with other countries (first of all, Russia), the values of t_α and t_β coefficients are significantly higher, This indicates a high level of development and automation of the agrarian and industrial sectors of the national economies of these countries.

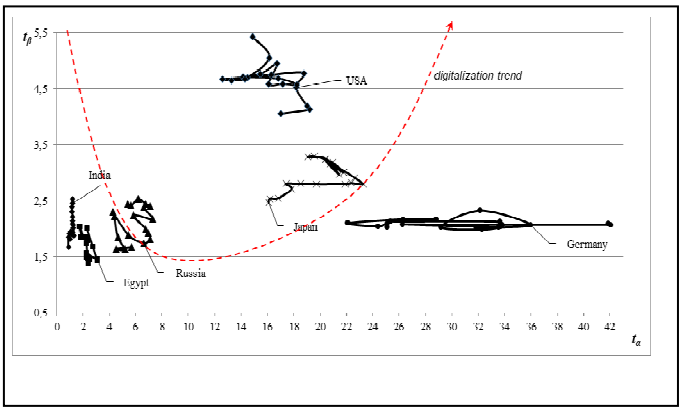

Fig.5. Distribution of t_α and t_β coefficients for 6 countries over 1998-2016

On the graph, Egypt is placed between India and Russia. The graph shows a kind of rating of countries regarding the quality of structural changes in the economy.

For the chosen countries, the rating is as follows:

- the US economy is on the first place e with the highest level of service sector development (even in comparison with Japan and Germany). This trend corresponds to digitalization increase of national and global economies, for which the growth of the services sector is higher than industry or agriculture;

- Japan takes the 2nd place in the ranking, as compared to Germany, the service sector is also a priority in its development;

- Germany occupies the 3rd place from the selected countries, its priority of the economic structure is the industrial sector;

- developing economies are presented in the ranking starting from the 4th places. These countries are characterized by lower values of t_α coefficients t_β. The 4th position is occupied by Russia, with largest number of structural changes, sharp changes in the developmental vector throughout the analyzed period;

- the 5th place among the selected economies for cross-country comparison is taken by Egypt, which has a pronounced vector of increasing the level of industrialization and the level of service at the same time;

- 6th place in the ranking goes to India, which has the most stable evolutionary trajectory over the period. The trend can be interpreted as a development with a high level of controllability.

RANKING OF EGYPTIAN AND THE 6 COUNTRIES` ECONOMIES ACCORDING TO THE RESULTS OF THE STRUCTURAL ANALYSIS AND LEVEL OF DIGITALIZATION

Let us present the ranking result of the selected economies taking into account the degree of difference between adjacent objects. In order to do so we take into account the degree of difference in the achieved developmental level and use the effective rank method (see [2], [3]). The ranked indicators are t_α (see table 1) and t_β (see table 2) coefficients.

TABLE 1. Distribution of t_α coefficient by ordinal and effective ranks for 6 countries over 1998-2016

Country	t_α in 1998	Ordinal Rank	Effective Rank	Country	t_α in 2016	Ordinal Rank	Effective Rank
Germany	25,08	1	1	Germany	41,89	1	1
USA	17,05	2	2	Japan	20,76	2	4
Japan	16,11	3	2	USA	14,9	3	4
Russia	5,73	4	4	Russia	5,41	4	6
Egypt	1,9	5	4	Egypt	2,3	5	6
India	0,92	6	4	India	1,22	6	6

Source: compiled by the authors

Table 1 shows that for the selected countries, the distribution of industrialization of national economies did not change over the period 1998-2016, but the result of calculating the effective rank suggests that these countries can be systematized into 3 groups. The first group possesses a high level of industrial development(for instance Germany) and the gap between them and the rest developed economies belonging to the second group (Japan and the USA) is twice as much. The third group includes emerging economies (Russia, Egypt, India), the gap from the leader increased even more considerably.

TABLE 2 Distribution of t_β coefficient by ordinal and effective ranks for 6 countries over 1998-2016.

Country	t_β in 1998	Ordinal Rank	Effective Rank	Country	t_β in 2016	Ordinal Rank	Effective Rank
USA	4,05	1	1	USA	5,42	1	1
Japan	2,47	2	6	Japan	3,16	2	12
Germany	2,03	3	8	India	2,53	3	16
Egypt	1,85	4	8	Russia	2,45	4	16
Russia	1,68	5	9	Germany	2,1	5	18
India	1,68	6	9	Egypt	2,01	6	18

Source: compiled by the authors

Table 2 reveals strong elasticity of the effective rank in terms of t_β coefficient value, which is evidenced first of all by higher maximum value of the effective rank as compared to the ordinal one. Secondly, by a larger number of groups into which the analyzed sample of countries can be distributed according to the degree of service:

- In 1998 the gap between the United States as the leader (included in the first group) and the other countries was at its peak and was nine times higher for the fourth group countries such as Russia and India. Egypt occupied the 4th place and was included in 3 groups by the value of the effective rank. In 2016, the situation changed significantly: the USA remained the leader, but the maximum value of the effective rank increased by 2 times and reached 18, and Egypt changes its position with Russia and India. The latter countries increased their t_β coefficient values and went to the 3 groups, while Egypt increased its t_β and was included into the 4 group of countries according to the degree of the development of service sector;

- regarding Egypt, for the analyzed period, it can be concluded that there is a steady increase in the industrial sector, the rates of which are typical for economically developing countries. Nevertheless, there is a need to ensure a greater increase in service sector, since this is an important factor in the growth of competitiveness of the entire economy. Besides, it will ensure the increase of the quality of life of Egyptian population. At the same time, the growth of the degree of service is relevant both in the business environment and in the system of government, the implementation of public services to the population.

In addition to the conducted ranking of the countries regarding their t_α and t_β coefficient values we present the result of each countries` position in the international digitalization ranking. Their digitalization indices analysis prove the hypothesis of a high level of correlation between the trend of service sector development and the digitization of national economic systems.

Our attention was focused on three digitalization indexes, two of which are calculated in the UN structures (e-Government Development Index, EGDI and ICT Development Index), the third was The Networked Readiness Index, calculated on the basis of the World Economic Forum.

Table 3 summarizes the characteristics of these indices across the 6 countries. For each index, its value and the position of each state in the world rankings are presented.

1) The e-Government Development Index (EGDI) since 2001 is a composite indicator that measures the readiness and ability of the government to use information and communication technologies to provide services to the public; Table 3 shows that from the six countries analyses in the paper, Egypt had the lowest value of this index. Therefore, the priority task of the Egyptian Government should be the formation of a full-fledged national e-government system. According to Russia's experience for national security purposes, such a system must be developed on its own, since the diffusion of such information through digital technologies has strong risks and threats to the cybersecurity of the entire government system and budget process;

2) Information and Communication Technology Development Index (ICT Development Index) is submitted since 2007 by the International Telecommunication Union (ITU) which a specialized UN unit in the field of information and communication technologies [8]. According to Table 3, it can be argued that, in general, Egyptian economy has digitalization tendencies which correspond to the evolutionary trend towards a steady increase in the industrial and services sectors. Besides, the value of the ICT Development Index itself for Egypt is intermediate between Russia and India, as well as in the evolutionary a graphic field where countries are distributed about the level of economic values (Fig. 5);

TABLE 3. Distribution of the six countries by a the UN digitalization indexes and the World Economic Forum

Страны	EGDI 2018		ICT Development Index 2016		Networked Readiness Index 2016	
	Global ranking position	Index value	Global ranking position	Index value	Global ranking position	Index value
USA	11	0,8796	15	8,13	5	5,8
Japan	10	0,8783	11	8,32	10	5,6
Germany	12	0,8765	13	8,2	15	5,6
Russia	32	0,7969	43	6,91	41	4,5
Egypt	114	0,4880	104	4,44	96	3,7
India	96	0,5669	138	2,65	91	3,8

Source: compiled by the authors on the materials [7], [8] and [9]

3) The International Networked Readiness Index of the World Economic Forum and the International Business School INSEAD has been calculated since 2002. It takes into account 53 parameters combined into three main groups: the availability of conditions for the development of ICT, the willingness of citizens, business and government agencies to use ICT and the use of ICT in the public, commercial and public sectors [7]. The maximum value of the index was 6 (for Singapore and Finland), the minimum was 2.2 (for Chad). Such a small range of values of the index allows to group the sample of countries (Table 3) into 3 groups. The first one includes such leading countries as the USA, Japan and Germany. Russia is placed separately with the index value of 4.5, attributing it to the countries with fairly advanced IT technologies and a good level of network readiness. Egypt and India are included in group 3, they have very similar index values of 3.7 and 3.8 respectively. The development of ICT in these countries is at the medium level. For them, the development of national networks is of high relevance. In Russia the monopolization and centralization of the digital economy markets are typical. Besides, one can observe concentration of the majority of newly created or rapidly growing companies in several large megalopolises.

IV. Conclusion

The main results of the structural-rank analysis of the Egyptian economy conducted by the authors were obtained when taking into account the global growth trends in the services sector and the digital development of national economies, and include the following conclusions and suggestions:

- the conducted structural analysis allowed to determine the place and features of the evolution of the national system of Egypt in the world economy among economically developed and developing countries, the trend of increasing both the industrial sector and the service sector for the period 1998-2016; However, the identified changes include structural fluctuations and indicate the need to adjust the public economic structural policy of Egypt to the development of the public digital services sector (using the example of e-government, a single state portal of services for the population and business) and to support its own innovations, information technologies, digital trends provided a high level of protection against cyber threats;

- the results of the calculation of the effective rank of t_α and t_β values (Table 1 and Table 2) revealed insufficient growth rates in the services sector, which in the medium and long term may lead to lagging behind countries with similar levels and potential for economic development; it is important to ensure the preservation of the achieved gains in the industrial sector, bringing it to a high level through automation and digitalization; this trend leads to the release of labor resources, traditionally employed in agriculture and industrial production; the task of the state is to reorient the education system, retraining, stimulating business to create new jobs in the services sector and digital services for society; this is a factor not only of competitiveness in the external market, but also a condition for the growth of the quality of the population;

- Comparison of the place that Egypt occupies among the sample of countries regarding the three key factors such as digitalization indexes (EGDI, ICT Development Index and Networked Readiness Index) with the results of the structural-ranking analysis conducted in this paper allows us to conclude that Egypt's position in the world rankings is highly dependent on digitalization and government will to support and finance ICT at the national level. This will ensure a systematic approach and contribute to overcoming the digital inequality of urban and rural residents in professional and social life. The experience of Russia with its progressive public system and the policy of digitalization includes protection against cyber threats. According to the rating of global economies conducted by the UN according to the Global Cybersecurity Index, Russia ranks 10th, second only to the USA with 2nd place, while all the rest the countries from our sample are lagging behind these two leaders: Japan is the 11th, Egypt is the 14th, India is the 23rd and Germany is the 24th.

Acknowledgment

We thank the Volgograd Institute of Management (branch of the Russian Academy of National Economy and Public Administration) for support which enabled to prepare the presented paper (Project 02-2018 VIU "Implementation of a multidisciplinary approach to research on social and economic systems for long-term sustainable development of territories".

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