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ASSESSMENT OF DISTRIBUTION OF EXAMINATION POINTS AND PASSING SCORES OF EXAMS OBTAINED IN THE ADMISSION TO HIGHER EDUCATION INSTITUTIONS IN AZERBAIJAN

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ABSTRACT

Based on the official data set of the State Examination Center of the Republic of Azerbaijan, authors analysed the normality of distribution of applicants' admission exam scores with the means of Pearson's chi-squared test ($\chi 2$). It was found that admission scores do not follow the normal distribution. Based on the dynamic series, the analysis was conducted, and average score attained by applicants, deviation from the average score (σ-standard error), as well as variation coefficient was calculated and level of homogeneity of attained scores were identified.
Keywords: *examination point, chi-square, distribution, normal, statistical analysis*

1. INTRODUCTION

Development of the non-oil sector is noted as one of the main objectives in "Azerbaijan 2020: Looking to the Future" development concept ("AZERBAIJAN 2020: LOOKING TO THE FUTURE" DEVELOPMENT CONCEPT, 29 December 2012, https://president.az/files/future_en.pdf). Knowledge economy plays a big role in shaping the new economic system. Knowledge economy requires increasing the quality of science and education. Transition process from traditional economy to knowledge economy first originates in schools and for this transition it is imperative that admission to high education institutions is conducted in accordance with modern requirements. Since 1992, the State Examination Center of the Republic of Azerbaijan (formerly named State Student Admission Commission (SSAC)) (SEC) is enrolling students into higher education institutions. For example, in 2017 SEC carried out examination on 54 universities and 160 speciality. There were 43,000 planned places, of which 14,000 were in Group I, 12,500 were in Group II, 10,000 in Group III, 300 in IV Groups and 3200 in Group V. But the universities could not fullfil the plan. However, some of the private universities could fill only 11 percent of the plan.

In general, the admission plan for higher education institutions in Azerbaijan are rising year after year, but the number of applicants for admission declines sharply (https://azvision.az/news/119130/-ali-mekteblere-kecid-ballari-asagi-alinacak-ekspert.html). It should be noted that in previous years, the SEC decreased the pass score for a pre-determined competition because the applicants did not meet requirements of the contest conditions. Even though the transitional score was 250 in 2016, it was postponed to 150. (http://www.tqdk.gov.az/). Also, it is negative phenomenon that there are technical specialties among the vacant plan places. As you can see, there are certain problems in terms of the quality of teaching in secondary schools and planning abuturent admissions to higher schools. Research on these issues is scientifically relevant.

2. THE QUALITY OF EDUCATION AND ITS ROLE IN ECONOMIC GROWTH

The positive impact of increasing the quality of education on economic growth, science, social and cultural development is undeniable and there are quite a number of sources in this area. Prior to the 1990s, predominantly quantitative indicators of education were given preference for economic growth and human capital formation. From this point of view, the level of literacy of the population, the level of secondary education and, finally, the stages of education were considered. Data from this category are reflected in the statistical offices of many countries. Relevant information on Azerbaijan is provided on the official website of SSCRA (https://www.azstat.org/ [Retrieved Date 02.11.2018]), as well as in statistical journals published by the Committee (Education, Science and Culture in Azerbaijan. Statistical Yearbook. 2018, 2017, 2016, 2015). After the 1990s, quality indicators were also involved in the economic sciences. A review of quality factors affecting economic growth was given by Hanushek (2007). One of the important conclusions drawn from this review is that when a graduate of secondary school finishes high school grading, a standard deviation from the mathematics subject is higher than the national average, his annual income is 12% higher than the average. The quality factors affecting the economic growth should be specifically mentioned:

1. The median value in the admissions exams;
2. Capacity of the population to adopt new knowledge, technology and habits;
3. Computer and internet skills;
4. Foreign language skills.

It is obvious that among these factors foreign language skills play a key role in developing other factors. Another approach that can determine the quality of education in the country is to conduct international comparisons. For example, among the 15-year-olds there is a PISA competition (http: // www.oecd.org/pisa), held once every three years since 2000. Here, the knowledge, skills and habits of adolescents are checked in 3 ways: reading mastering, natural science and mathematics. Rating scopes are set up, allowing for international scores to be scored for each country in each of the three directions. This allow advanced countries in the field of education to be identified. Note that, according to the results of 2015, Singapore was the first in all three directions (http://www.oecd.org/pisa/PISA-2015-singapore.pdf). Its transformation "from third world to first" in one generation is one of Asia's great success stories. Naturally, the best practice in international education should be the model for development. Science and education have an exceptional role in the development of the country's economy. Costs incurred to develop these areas are of great importance. In economically developed countries, the share of science in GDP is fairly high. For example, for OECD countries (Bulatov, 2017, p.266) the average value of this indicator is 1.92%. For neighboring Russia this figure is 1.1%, Kazakhstan - 0.68%. The share of education expenditures in GDP is 6.1% for the OECD countries in 2011 (Bulatov, 2017, p. 268), 5.1% for Japan, 7.6% for South Korea and 7.3% for Israel.

In Russia, the corresponding expenditure is 4.6% of GDP. For Azerbaijan this indicator was 2.46%. On the other hand, the share of higher education in GDP in 2014 was 1.6% for OECD countries, 2.8% for Canada, 2.7% for USA, 2.6% for South Korea, 1.9% for Finland, 1.3% for Germany and 1.4% for Russia. For Azerbaijan this indicator is 0.85% in 2017. (Explanation on the draft law of the Republic of Azerbaijan "On the 2017 State Budget of the Republic of Azerbaijan" (2017), p.20). One of the key elements in raising the positive impact of education on economic development is to improve the quality of secondary education. Based on the experience of developed countries in this regard, we can see that the high school duration, the average score collected in the final exams or in the admission exams and its standard departure (subject to the normal distribution law), high proportion of those studying in the specialty and the share of students enrolled in higher education are one of the main factors.

3. DATA BASE OF RESEARCH, ITS PROCESSING AND STATISTICAL ANALYSIS

Table 1 represents several indicators showing the student admission to high education institutions during 1996-2017 in Azerbaijan.

Table 1: Some statistical characteristics of students' scores collected in admission to universities in Azerbaijan in 1996-2017

	Azerbaijan section			Russian section			General					
Year	Math. Expac-tation	Stan. devi-ation	Num-ber of Appli-cants	Math. Expac-tation	Stan. devi-ation	Num-ber of Appli-cants	Num-ber of Appli-cants	Math. Expacc tation	Stan. Devia-tion	Plan	Admission (in real numbers)	Diffe-rence
1996	159.21	113.50	36053	198.83	122.75	10806	46859	168.35	116.90	18941	12468	-6473
1997	152.86	113.34	38134	185.52	121,11	9972	48106	159.63	115.75	24975	15233	-9742
1998	145.39	116.66	45669	206.35	126.16	10303	55972	156.61	120.80	27586	21202	-6384
1999	170,65	120,75	53961	249.94	128.55	9719	63680	182.75	125.26	26156	20850	-5306
2000	162.74	127.71	66028	218.23	133.15	9215	75243	169.51	129.67	28254	19980	-8274
2001	208.14	145.29	72412	240.89	144.02	8786	81198	211.68	145.31	29636	22422	-7214
2002	158.37	130.56	43565	210.66	139.01	7056	50621	165.66	133.04	27577	18640	-8937
2003	169.19	138.09	65999	174.15	114.22	3452	69451	169.44	137.01	27462	24145	-3317
2004	170,59	143,25	81580	232,69	150,34	7963	89543	176.11	144.98	28475	24283	-4192
2005	181.74	146.76	89003	235.58	152.83	9185	98188	186.78	148.17	28785	27763	-1022
2006	182.01	152.16	93357	211.63	149.66	9839	103196	184.83	152.17	25629	23817	-1812
2007	183.76	148.62	93799	272.12	144.66	8620	102419	191.20	150.31	26729	25811	-918
2008	198.90	155.12	100165	255.03	149.79	10622	110787	204.28	155.50	28132	27515	-617
2009	175.38	147.29	97006	228.04	140.34	10341	107347	180.45	147.46	29030	28009	-1021
2010	181.21	150.26	98425	242.77	148.96	10104	108529	186.94	151.20	30510	28421	-2089
2011	180.75	152.69	93998	241.61	151.57	9187	103185	186.17	153.57	31365	29651	-1714
2012	172.72	151.67	87668	222.90	144.64	8803	96471	177.30	151.73	34608	32024	-2609
2013	175.27	158.30	88813	215.27	148.22	7907	96720	178.54	157.88	36537	33880	-2657
2014	175.49	160.85	84739	219.97	157.77	7904	92643	179.28	161.07	37841	33707	-4134
2015	198.14	167.07	76249	237.94	158.38	6677	82926	201.34	166.74	38914	37699	-1215
2016	211.92	168.67	72105	252.73	164.91	644[illegible]	78545	215.22	168.24	[illegible]	35572	-5[illegible]
2017	237.28	171.13	64445	258.80	164.07	6351	70796	239.21	170.62	42669	35811	-6858

Source: Information from SEC, http://www.tqdk.gov.az and calculations of authors

Figure 1 is the graphical representation of the dynamics showed in the Table 1. Figure 1 shows the number of student applicants, average score in exam for high education institutions and standard deviation from average score.

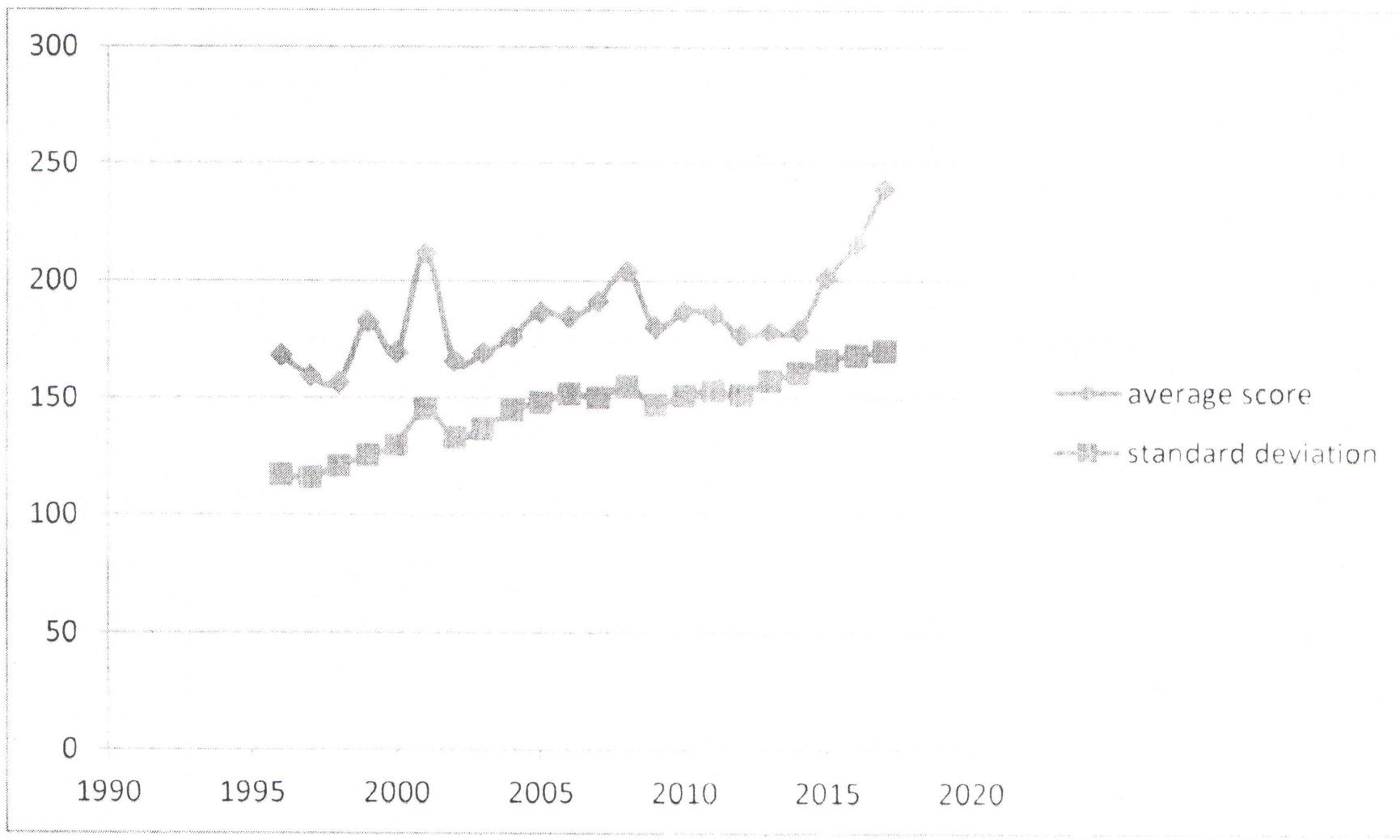

Figure 1: Graphical representation of number of student applicants, average score in exam for high education institutions and standard deviation from average score

As it is shown in Figure 1, the average admission exam score attained by applicants is higher than the standard deviation of average score, however the difference in between them is not significant. This can be considered as one of the signs of a sharp violation of the homogeneity of the level of education among applicants and secondary schools. Let's calculate the ratio of the standard deviation to the mean, that is, the coefficient of variation: (Hasanli Y, 2014, p. 69)

$$V = \frac{\sigma}{\bar{x}} * 100\% \qquad (1)$$

The lower the coefficient of variation is, the greater the homogeneity of the property value will be in the sample. At this time, the mean value becomes the typical property of the sample. The higher the coefficient of variation is, the greater the heterogeneity of the property value will be in the sample. The coefficient of variation shows change in the intensity of the property as well as the homogeneity of the sample. The higher *V* is, the higher the dispersion of the property around the mean value and the greater the heterogeneity will be in the sample. There is a scale of sample homogeneity depending on the value of the coefficient of variation.

Table 2: Levels of the coefficients of variation

V, in %	The level of sample
Up to 30 %	Homogeneous
30 %-60 %	Middle
60 % and more	Heterogeneous

Let us calculate the coefficients of variation on the basis of the data given in the Table1 (Table3).

Table 3: The dynamics of the coefficients of variation for 1996-2017 years

Years	Azerbaijan section	Russian section	General
1996	71.3	61.7	69.4
1997	74.1	65.3	72.5
1998	80.2	61.1	77.1
1999	70.8	51.4	68.5
2000	78.5	61.0	76.5
2001	69.8	59.8	68.7
2002	82.4	66.0	80.3
2003	81.6	65.6	80.9
2004	84.0	64.6	82.3
2005	80.8	64.9	79.3
2006	83.6	70.7	82.3
2007	80.9	53.2	78.6
2008	78.0	58.7	76.1
2009	84.0	61.5	81.7
2010	82.9	61.4	80.9
2011	84.5	62.7	82.5
2012	87.8	64.9	85.6
2013	90.3	68.9	88.4
2014	91.7	71.7	89.8
2015	84.3	66.6	82.8
2016	79.6	65.3	78.4
2017	72.1	63.4	71.3

The graphic image of the coefficients of variation given in the Table 3 is shown on the Figure 2. As we can see from the Figure 2, that the homogeneity of the level of education in the Azerbaijani and Russian sections of secondary schools differ sharply and is heterogeneous across the country (with the exception of the Russian section for several years).). The level of homogeneity of the coefficient of variation of education in the Russian section of secondary schools in 1999, 2001, 2007, 2008 was average. We should note that, this is due to the fact that the absolute majority of Russian schools are located in the capital of the state, Baku.

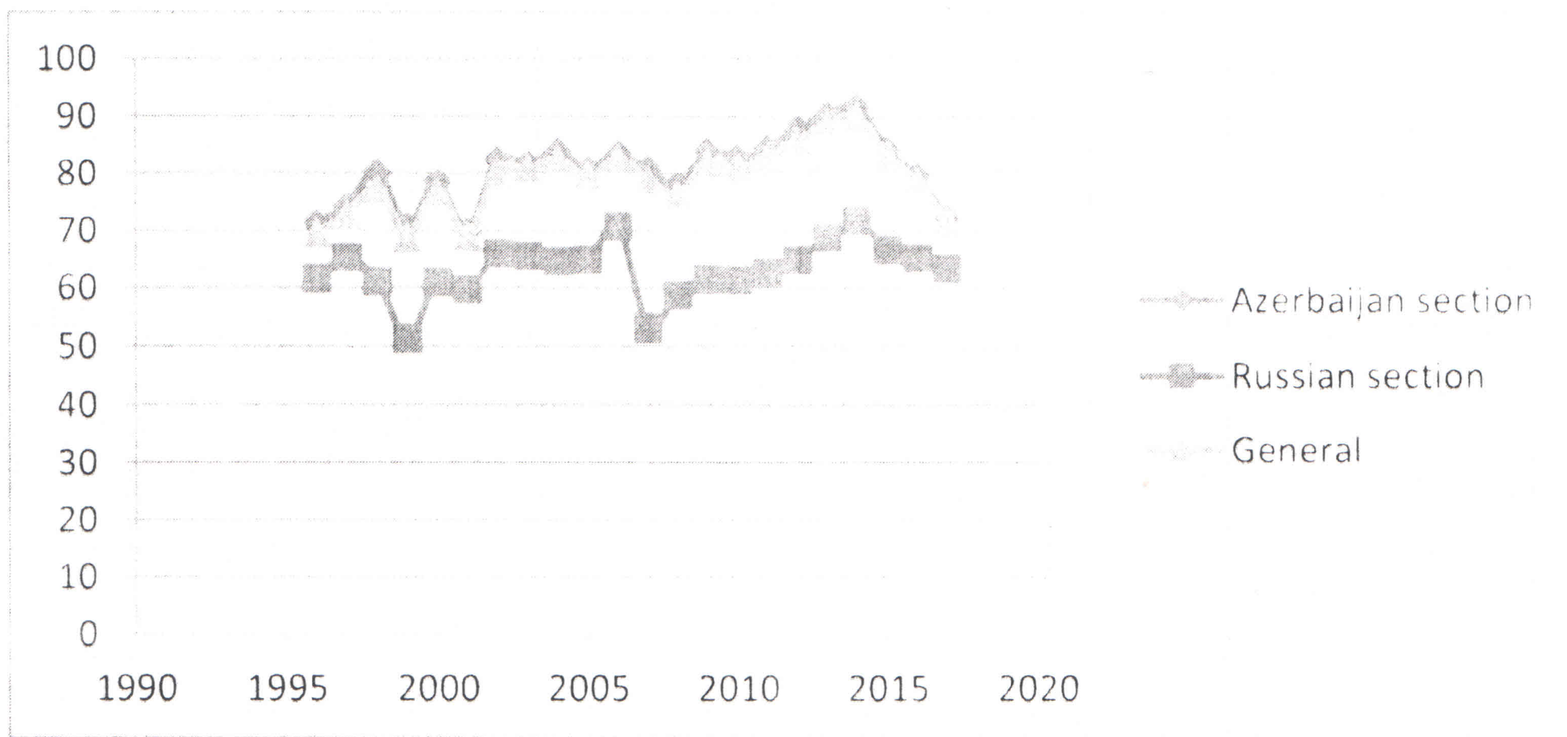

Figure 2: The graphic image of the coefficients of variation for 1996-2017 years

4. TESTING OF THE DISTRIBUTION OF ADMİSSİON SCORES TO UNIVERSITIES IN AZERBAIJAN

For example we will test the admission scores for the 2012/2013 academic year on the basis of official data of SEC, by Pearson's χ^2 criterion, to find out if the admission scores are distributed normally. For this we will make the table 4.

Table 4: Distribution of admission scores for 2012/2013 academic year

Score interval	Applicants' size	Cumu-lative sum	Empirical frequency	Theoretical frequency	EmpFre-TheorFre	(EmpFre-TheorFre)²	(EmpFre-TheorFre)² / TheorFre
0-60	27692	27692	0.286	0.001	0.285	0.081	62.486
60-120	19595	47287	0.203	0.226	-0.023	0.001	0.002
120-180	12335	59622	0.128	0.159	-0.032	0.001	0.006
180-240	9281	68903	0,096	0,079	0.017	0.000	0.004
240-300	7436	76339	0,077	0,028	0.049	0.002	0.087
300-360	5747	82086	0.059	0.007	0.053	0.003	0.400
360-420	4727	86813	0.049	0.007	0.042	0.002	0.255
420-480	3569	90382	0.037	0.028	0.009	0.000	0.003
480-540	2713	93095	0.028	0.079	-0.051	0.003	0.033
540-600	2036	95131	0.021	0.159	-0.138	0.019	0.120
600-660	1266	96397	0.013	0.226	-0.213	0.045	0.200
660-700	323	96720	0.003	0.001	0.002	0.000	0.003
			1.00000	1.00000		***16,920***	***63,600***
Conclusion: The applicants' scores have not been normal distributed.						*Chi-square* ***critical***	*Chi-square* ***evaluated***

Source: Calculations of authors based on official SEC data

Based on the Stercens formula [2], the number of intervals is 1 + log2700 = 1 + 9.45 = 10.45. We took the number of intervals 12 and calculated the intervals by 60 points, dividing 0-700 points into equal portions. Note that theoretical frequency is based on standard regular distribution tables. Then k = n-1-r, with the criterion based on the Chi-square [2] criterion, alpha = 0.05 with n = 12, r = 2 (two parameters in normal distribution: mean and standard deviation), and k=n-1-r=12-1-2=9. Therefore

$$\chi^2_{kritik}(0{,}05;9) = 16{,}92 \qquad (2)$$

$$\chi^2_{evaluated} = \sum((EmpiricalFrequency - TheoreticalFrequency) \quad TheoreticalFrequency = 63{,}60 \qquad (3)$$

and because of the calculated value is larger than the critical value, the distribution is not subject to normal law. In other words, this differs from the normal distribution law described in Figure 3.

Figure following on the next page

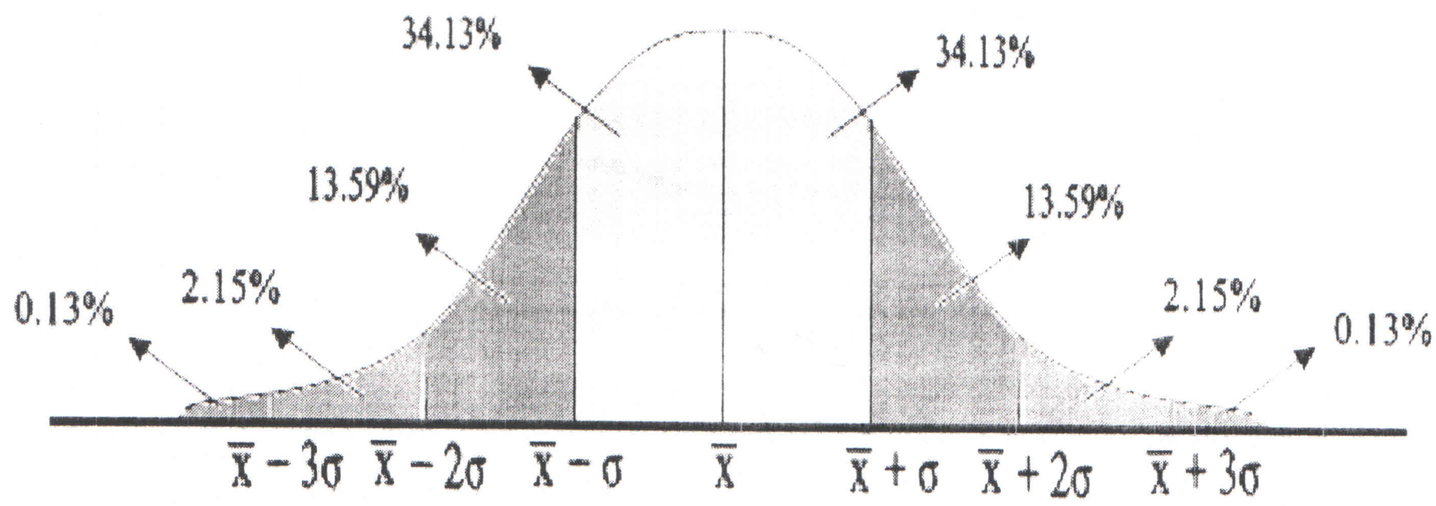

Figure 3: Curve of normal distribution. Three Sigma Rule

Empirical image of the distribution of admission scores for 2012/2013 academic year based on table 5 is given in Figure 4.

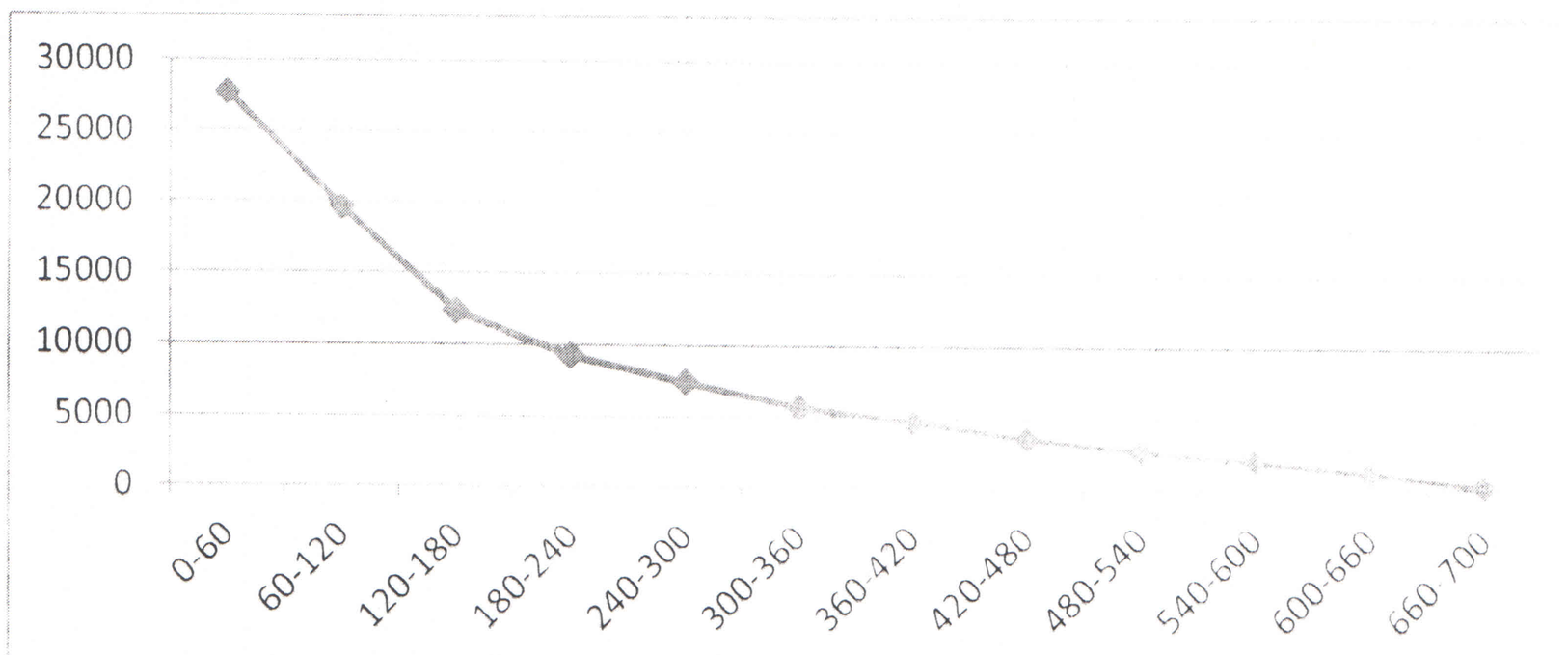

Figure 4: The distribution of the applicants by the admission scores intervals for 2012/2013 academic year. Here, on the abscissa, the intervals of admission scores and on the ordinate, the number of applicants are shown.

As we can see from the Figure 4, the empirical distribution of the admission scores to the universities, significantly differ from the normal distribution. One of the reasons of this phenomenon can be the heterogeneity of the quality of education at secondary schools.

5. RESULTS

Despite the fact that the average score gained by applicants in the entrance exams is more than the standard deviation, this difference is quite small. The value of the coefficient of variation showed that the homogeneity of the level of education in the Azerbaijani and Russian sections of secondary schools differ sharply and is heterogeneous across the country (with the exception of the Russian section for several years). The level of homogeneity of the coefficient of variation of education in the Russian section of secondary schools in 1999, 2001, 2007, 2008 was average. According to the official data of the SEC, distribution of the admission scores were tested by Pearson's χ^2 criterion and it was found out that admission scores were not distributed normally.

6. CONCLUSIONS

Heterogeneity of admission scores scored by applicant during entry exams can be explained by the fact that the quality of education differs sharply between schools or applicants.

The reason that the level of homogeneity of admission scores in the Russian section is relatively high and average in 1999, 2001, 2007 and 2008 is the fact that the absolute majority of Russian schools are located in the capital of the state, Baku. In other years, this level was heterogeneous. The reason of the fact that admission scores were not distributed normally as well as heterogeneity of admission scores can be explained by the strong difference in the level of education and knowledge of students.

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