A MULTIDISCIPLINARY APPROACH, IN TERMS OF ECONOMETRICS, STATISTICS AND MECHANICS, TO PREFERENCES FOR DATA SAMPLES

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Abstract. This article tries to find econometric viable, timely and sufficiently grounded solutions, in the selection of samples or tests and experiments in relation to a standard experiment. The example selected is a real one, and was generated by mechanical experiments concerning pressure and its successive measurements, the identification of a prompt and accurate choice between two samples of experimental data in relation to a standard one, for abnormally spread, unimodal or antimodal, data distributions, requiring, in the end, the simple quality of statistical thinking against a multidisciplinary, both econometric and mechanical, analysis. A brief introduction concerning the delimitation of the problem presented, is followed by a section describing a number of data samples and their analysis, covering different situations, while the final part emphasizes the importance of a multidisciplinary approach within the framework of experimental research.

Keywords: experiment, sample, multidisciplinary thinking and analysis, experiment and sample selection

1.INTRODUCTION

One of the difficult practical issues in experimental research lies in identifying rapid solutions to select samples from several samples and tests, in relation with an experiment considered as a standard. The most difficult questions usually yield unexpected answers, but the analytical efforts fail to consider precisely the simple solutions, as the researcher is always looking for complex and fully justified alternatives, armed with an arsenal of tests and complex validations that have to justify certain choices. Obvious deadlock situations also occur, however, where empirical data sets, and experimental data appear not to be relevant, and selecting a sample or experiment is at least difficult if not impossible. The multidisciplinary approach and seeking solutions as simple as possible seem to be the researcher's best solutions when in a tight spot.

2. STATISTIC ANALYSIS AND SPECIFIC MOTIVATION OF SELECTING A SERIES OF DATA IN CONJUNCTION WITH A STANDARD EXPERIMENT

The results of an experimental investigation, which are described below, have brought about the dilemma of selecting between several samples, which, for methodological purposes, were distinctly named: a) SER01= Experiment data A; b) SER02= Pressure chamber A data variant 1; c)SER03 = Pressure chamber A data variant 2; d) SER04= Experiment data B; e) SER05= Pressure chamber B data variant 1; SER06 = Pressure chamber B data variant 2.

Descriptive statistics of the first set of series of the pressure in the cylinder

Table no. 1

	Experiment data A	Pressure chamber A data variant 1	Pressure chamber A data variant 2
Code	SER01	SER02	SER03
Mean	1.531551	1.392482	1.491696
Median	0.993200	0.700347	0.701360
Maximum	**9.410600**	**8.939087**	**9.813486**
Minimum	0.359600	0.389500	0.390894
Std. Dev.	1.969562	1.898032	2.093992
Skewness	**2.695708**	**2.695446**	**2.694673**
Kurtosis	**9.476500**	**9.379527**	**9.373798**
Jarque-Bera	21300.77	4185.605	4180.221
Probability	0.000000	0.000000	0.000000
Sum	11025.64	2005.174	2148.042
Sum Sq. Dev.	27922.30	5184.033	6309.730
Observations	7199	1440	1440

Software used: EViews

The EViews software package turns to best account the Jarque-Bera test, which denies the normality of the series generated by the experimental data at any test associated probability (often, 0.01 or 0.05). According to the $\chi 2$ distribution, the Jarque-Bera test critical value for a statistical significance threshold of 0.05 is 5.99, and for 0.01 it is 9.21.The Jarque-Bera statistics, calculated for the series of values of variable SER01 is 21,300.77, far greater than 5.99 or 9.21, and the null hypothesis is rejected with a confidence level of 95 or 99 cases out of 100 (or a probability of 0.95 or 0.99). The data series is not normally distributed in the experiment for the 7199 values. Analogously, the SER 02 and 03 series are abnormally distributed according to the values of the JB test. In conclusion, all three series are abnormally distributed, heterogeneous, highly asymmetric and excessively arched. There are no significant differences between the means and variances of the two series, according to the tests further applied (in keeping with the average, median or dispersion).

Table no. 2

Test for Equality of Means Between Series			
Sample: 1 1440			
Method	df	Value	Probability
t-test	2878	1.332149	0.1829
Anova F-statistic	(1, 2878)	1.774621	0.1829
Test for Equality of Medians Between Series			
Sample: 1 1440			
Method	df	Value	Probability
Wilcoxon/Mann-Whitney		2.561753	0.0104

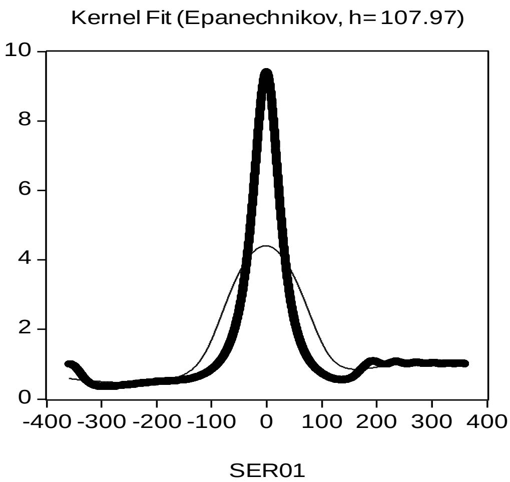
Method	df	Value	Probability
Wilcoxon/Mann-Whitney (tie-adj.)		2.561753	0.0104
Med. Chi-square	1	5.512503	0.0189
Adj. Med. Chi-square	1	5.338891	0.0209
Kruskal-Wallis	1	6.562695	0.0104
Kruskal-Wallis (tie-adj.)	1	6.562696	0.0104
van der Waerden	1	8.784998	0.0030
Test for Equality of Variances Between Series			
Sample: 1 1440			
Method	df	Value	Probability
F-test	(1439, 1439)	1.217147	0.0002
Siegel-Tukey		1.575943	0.1150
Bartlett	1	13.86501	0.0002
Levene	(1, 2878)	4.806099	0.0284
Brown-Forsythe	(1, 2878)	1.309178	0.2526

Software used: EViews

The Kernel type graphs of the probability distributions are similar in the three cases, only the arching is different, as can be seen from the maximum values.

SER01 = Data of A experiment

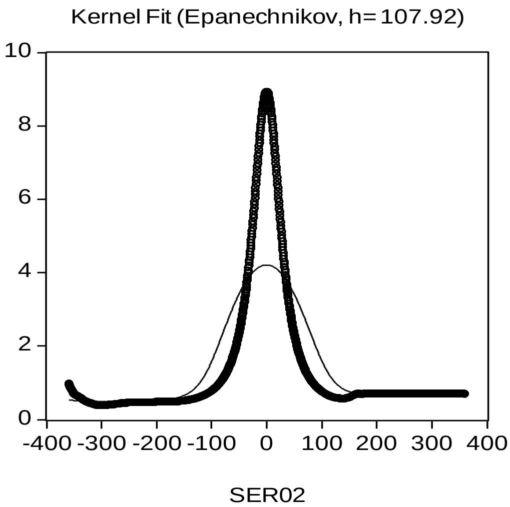
Graph no. 1.



Software used: EViews

SER02=Data of pressure chamber A variant 1

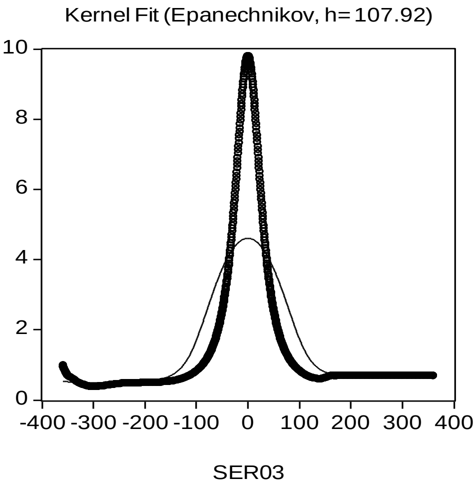
Graph no. 2.



Software used: EViews

SER03=Data of pressure chamber A variant 2

Graph no. 3.



Software used: EViews

In the statistical analysis conducted to identify the criteria for selecting one of the two series were valued the samples in their graphic peaks of distribution curves for the data series, and the range [-16.5, 16.5] was considered representative, where, simultaneously, all the three sets of data show a normal distribution, at the maximum permissible limit of the Jarque-Bera, for a significance threshold of 0.05 (according to the $\chi 2$ distribution, the criticial value of Jarque-Bera for a statistical significance threshold of 0.05 is 5.99). For the experiment only the values corresponding to the series compared were kept.

Taking the three samples of pressure inside the A chamber

Table no. 3.

The pressure's evolution inside the A chamber			
Interval	Experiment data A	Pressure chamber A data variant 1	Pressure chamber A data variant 2
-16.5	7.497	6.982994	7.659019
-16	7.5947	7.076958	7.763063
-15.5	7.6899	7.170318	7.866379
-15	7.7852	7.26295	7.968813
-14.5	7.8796	7.354702	8.070212
-14	7.9718	7.445426	8.170412
-13.5	8.0624	7.53497	8.269252
-13	8.1518	7.623183	8.366561
-12.5	8.2419	7.709903	8.462169
-12	8.3282	7.794968	8.555875
-11.5	8.4128	7.878213	8.64753
-11	8.493	7.959477	8.736955
-10.5	8.5731	8.038593	8.823974
-10	8.6495	8.115394	8.908405
-9.5	8.7228	8.189713	8.990075
-9	8.7971	8.26139	9.068806
-8.5	8.8622	8.330231	9.144426
-8	8.9254	8.396095	9.216762
-7.5	8.9881	8.458815	9.285651
-7	9.044	8.518244	9.350929
-6.5	9.0981	8.57424	9.412441
-6	9.1464	8.626665	9.470038

-5.5	9.1922	8.675389	9.52358
-5	9.2334	8.720294	9.57293
-4.5	9.2707	8.761266	9.617968
-4	9.3047	8.798201	9.65855
-3.5	9.3361	8.831003	9.694601
-3	9.3596	8.859591	9.726026
-2.5	9.3757	8.88389	9.752747
-2	9.3899	8.903822	9.774667
-1.5	9.4029	8.919339	9.791732
-1	9.4076	8.930413	9.803908
-0.5	9.4095	8.937002	9.81116
0	9.4034	8.939087	9.813486
0.5	9.3966	8.937007	9.811172
1	9.3833	8.930415	9.803898
1.5	9.3637	8.919324	9.791688
2	9.3423	8.90377	9.774595
2.5	9.3125	8.883817	9.752657
3	9.2798	8.859487	9.725933
3.5	9.2418	8.830879	9.694477
4	9.2024	8.798049	9.658404
4.5	9.1548	8.761082	9.617808
5	9.107	8.720089	9.572764
5.5	9.0546	8.675153	9.523412
6	8.9935	8.626407	9.469878
6.5	8.9328	8.573976	9.412297
7	8.8679	8.517985	9.35081
7.5	8.8016	8.45857	9.28557
8	8.7257	8.395873	9.216704
8.5	8.6507	8.330043	9.144399
9	8.5722	8.261229	9.06882
9.5	8.4876	8.189585	8.990137
10	8.4061	8.115276	8.908525
10.5	8.3173	8.038452	8.82418
11	8.2265	7.959277	8.737254
11.5	8.1371	7.877913	8.647927
12	8.0457	7.794521	8.556376
12.5	7.9514	7.709266	8.462778
13	7.8518	7.622305	8.367314
13.5	7.7526	7.533809	8.270148
14	7.6536	7.44392	8.171458
14.5	7.5505	7.352792	8.071408
15	7.4524	7.260572	7.970165
15.5	7.3489	7.167411	7.867889
16	7.2482	7.073446	7.764734
16.5	7.1457	6.97883	7.660853

The test of significance between the experimental sample and the data sample SER02 = Data for pressure in chamber a variant 1 identifies significant differences according to the statistics of the test (*t* - test is equal to 3.284419, and greater than 1.667 *t*-table, the series are significantly different as mean level, or mean - type parameter).

Table no. 4.

Test for Equality of Means Between Series			
Sample: 1 67			
Method	df	Value	Probability
t-test	132	3.284419	0.0013
Anova F-statistic	(1, 132)	10.78741	0.0013
Analysis of Variance			
Source of Variation	df	Sum of Sq.	Mean Sq.
Between	1	4.942938	4.942938
Within	132	60.48421	0.458214
Total	133	65.42715	0.491933

Software used: EViews

Analogously, the tests of significance between the experimental sample and sample SER03 = Data for pressure in chamber A variant 2 identifies significant differences according to statistics of test *t* (*t*-test is equal to 3.740852, and greater than the tabled *t* 1667, and the series are significantly different).

Table no. 5

Test for Equality of Means Between Series			
Sample: 1 67			
Method	df	Value	Probability
t-test	132	3.740852	0.0003
Anova F-statistic	(1, 132)	13.99397	0.0003
Analysis of Variance			
Source of Variation	df	Sum of Sq.	Mean Sq.
Between	1	5.849088	5.849088
Within	132	55.17230	0.417972
Total	133	61.02139	0.458807

Software used: EViews

Tested together, the series of data samples SER02 = Data for pressure in chamber a variant 1, and SER03 = Data for pressure in chamber A varaint 2, are even more clearely defined after the value of test *t* (*t* - test is 7.1101, and greater than 1,667 *t* - tabled).

Table no. 6

Test for Equality of Means Between Series			
Sample: 1 77			
Method	df	Value	Probability
t-test	132	7.110098	0.0000
Anova F-statistic	(1, 132)	50.55349	0.0000
Analysis of Variance			
Source of variation	df	Sum of Sq.	Mean Sq.
Between	1	21.54594	21.54594
Within	132	56.25852	0.426201
Total	133	77.80446	0.584996

Software used: EViews

All this information justifies sampling from the peak of the curves of the data distributions, and increase confidence in the analysis of their descriptive statistic. The criteria for the selection of one of the two series, by comparison with the experiment data series, remain those of homogeneity and normality of the series described by the data samples SER02 = Data for pressure in chamber A variant 1, and SER03 = Data for pressure in chamber A variant 2, and the analysis of the descriptive statistic, of the Jarque-Bera test and the coefficient of homogeneity or uniformity conduce to the following results:

The descriptive statistic of the three samples from the peak of the curves of unimodal distributions

Table no. 7

Sample: 1 67			
	Experiment data A	Pressure chamber A data variant 1	Pressure chamber A data variant 2
Mean	8.626258	8.208407	9.010381
Median	8.797100	8.330231	9.144426
Maximum	9.409500	8.939087	9.813486
Minimum	7.145700	6.978830	7.659019

Std. Dev.	0.670809	0.621256	0.682966
Skewness	-0.535415	-0.489012	-0.490193
Kurtosis	2.039230	1.923168	1.925154
Jarque-Bera	5.778070	5.907442	5.908423
Probability	0.055630	0.052145	0.052120
Sum	577.9593	549.9633	603.6955
Sum Sq. Dev.	29.69900	25.47330	30.78521
Observations	67	67	67

Software used: EViews

The homogeneity of the data SER02 = Data for pressure in chamber A variant 1 is found to be slightly further from the experiment, according to the signals derived from the absolute and relative amplitude, from the value of the standard deviation, and above all, the value of coefficient of homogeneity, and SER03 = Data for pressure in chamber A variant 2 is more similar, as far as the level of all indicators and trend are concerned, to the data series in the experiment.

Table no. 8.

	Experiment data A	Pressure chamber A data variant 1	Pressure chamber A data variant 2
Range	2.2638	0.598856	0.669060
Relative range	0.262431	0.072956	0.074254
Coefficient of homogeneity -%	7.776361	7.568533	7.579768

Software used: EViews

Analogously, the data in series SER02 = Data for pressure in chamber A variant 1 can be seen to have both a slightly smaller asymmetry (Skewness) and arching (kurtosis), while the the series SER03 = Data for pressure chamber A variant 2 and SER01 = Data experiment A have more extensive similar trends (tendential similarity in indicators, too, represents a a large enough set of arguments on account of which SER03 = Data pressure in chamber A variant 2 is preferred, as determined by analysing the samples taken from the peak of the curves of distributions).

The case of the analysis of the data series on pressure inside the B chamber, generating antimodal distributions reveals other quantitative aspects and results leading towards the same decisional deadlock in choosing the sample with a greater similarity in relation to the standard experiment.

Descriptive statistics of the first set of series of pressure inside B chamber

Table no. 9.

The pressure's evolution inside the B chamber			
	Experiment data B	Pressure chamber B data variant 1	Pressure chamber B data variant 2
Code	SER04	SER05	SER06
Mean	*0.613536*	*0.563182*	*0.577859*
Median	0.605130	0.530464	0.545044
Maximum	0.704660	0.699983	0.699983
Minimum	0.540860	0.487248	0.511179
Std. Dev.	*0.060959*	*0.076945*	*0.067545*
Skewness	*0.204802*	*0.562395*	*0.603365*
Kurtosis	*1.458467*	*1.722522*	*1.764616*
Jarque-Bera	*189.3235*	*43.21512*	*44.48703*
Probability	0.000000	0.000000	0.000000
Sum	1095.775	201.6191	206.8735
Sum Sq. Dev.	6.633078	2.113629	1.628763
Observations	1786	358	358

Software used: EViews

The Jarque-Bera statistic, calculated for the series of values of variable SER04, is 189.3235, therefore much higher than 5.99 or 9.21, and the null hypothesis is rejected, with a confidence level of 95 or 99 cases out of 100 (or a probability of 0.95 or 0.99). the series of experimental data is not normally distributed for the 1786 values. Analogously, series SER 05 and 06, too, are abnormally distributed in view of the values of the JB test. The three series are abnormally distributed but homogeneous, slightly asymmetric or at the limit of slight positive asymmetry, and of medium arching. No significant differences exist between the means and variances of the two series, in keeping with the tests further applied (in view of dispersion).

Table no. 10

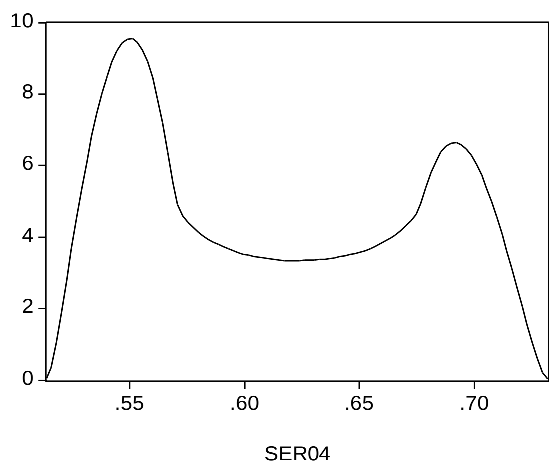
Test for Equality of Variances Between Series			
Date: 01/12/12 Time: 11:54			
Sample: 1 358			
Method	df	Value	Probability
F-test	(357, 357)	1.297690	0.0140
Siegel-Tukey		9.187565	0.0000
Bartlett	1	6.034981	0.0140
Levene	(1, 714)	12.85911	0.0004
Brown-Forsythe	(1, 714)	5.567339	0.0186

The Kernel type of graphs for probability density distributions are similar in the three cases, only differing in the first portion of the arching, and the subsequent antimodal evolution is done on different minimum levels, as can be seen from the values, which are maximum, at first, and minimum, in the central portion of the graphs.

SER04 = data of experiment B

Graph no. 4.

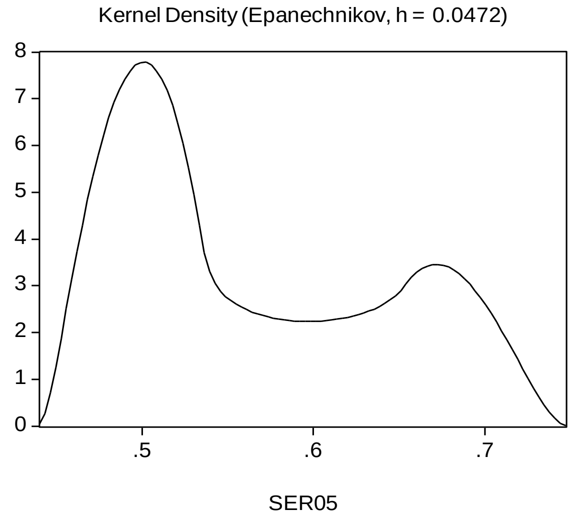
Kernel Density (Epanechnikov, h = 0.0272)



Software used: EViews

SER05 = Data for pressure chamber B variant 1

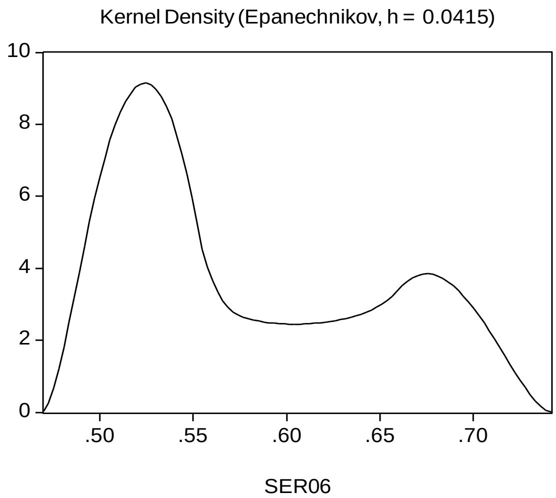
Graph no.5



Software used: EViews

SER06 = Data for pressure chamber B variant 2

Graph no. 6.



Software used: EViews

In the statistical analysis conducted to identify the criteria for selecting one of the two series, the samples in the central or antimodal area of the three curves were turned to used, centered on value of - 272, and the range [-285; -261] was considered representative, where, simultaneously, all the three data series show a normal distribution at the maximum permissible limit of the Jarque-Bera test, for a significance level of 0.05 (according to $\chi 2$ distribution, the Jarque-Bera critical test for statistical significance level of 0.05 is 5.99). (Note: for the experiment only the values corresponding to the series compared with a 0.5 to 0.5 leap were kept). Sampling normally distributed population samples observed the criterion of the intersection of the three graphs in the antimodal area, which is virtually the larger portion of the antimodal curve of distributions.

Taking the three samples of pressure in chamber B

Table no. 11

The pressure's evolution inside the B chamber			
Interval	Experiment data B	Pressure chamber B data variant 1	Pressure chamber B data variant 2
-285	0.67245	0.630362736	0.63620366
-284.5	0.67174	0.629157593	0.63511052
-284	0.67058	0.627946016	0.63401078
-283.5	0.67035	0.626728583	0.63290493
-283	0.66935	0.625507279	0.63179507
-282.5	0.66861	0.624283636	0.63068297
-282	0.66827	0.623057798	0.62956907
-281.5	0.66731	0.621829503	0.62845313
-281	0.66669	0.62059879	0.62733506
-280.5	0.66618	0.619364459	0.62621355
-280	0.6651	0.61812863	0.62509098
-279.5	0.66473	0.616892494	0.62396911
-279	0.66398	0.615652542	0.62284448
-278.5	0.66347	0.614404324	0.62171205
-278	0.66283	0.613146095	0.62056942
-277.5	0.66203	0.611880869	0.61941934
-277	0.66131	0.610614177	0.61826762
-276.5	0.66014	0.60935008	0.61711874
-276	0.65967	0.608089438	0.61597392
-275.5	0.65896	0.606824568	0.6148255
-275	0.65786	0.605542714	0.61366051
-274.5	0.65728	0.604239211	0.61247422
-274	0.65635	0.60292043	0.61127316
-273.5	0.65508	0.601596487	0.61006749
-273	0.65491	0.60027431	0.60886393
-272.5	0.65375	0.598957351	0.60766559
-272	0.6532	0.597646593	0.60647321
-271.5	0.65261	0.596340998	0.60528559
-271	0.65133	0.595038299	0.60410029
-270.5	0.6507	0.59373616	0.60291478
-270	0.64964	0.59243304	0.60172741
-269.5	0.64896	0.591126718	0.60053602
-269	0.64839	0.589814653	0.59933823
-268.5	0.64774	0.588495751	0.59813311
-268	0.64677	0.587171012	0.5969217
-267.5	0.64581	0.585844389	0.59570793
-267	0.64505	0.58452103	0.59449694
-266.5	0.64467	0.583204349	0.59329223
-266	0.64369	0.581894843	0.59209467
-265.5	0.64319	0.580591139	0.5909034
-265	0.64206	0.579291509	0.58971747
-264.5	0.64123	0.577994875	0.58853652
-264	0.64073	0.576701127	0.58735958
-263.5	0.63916	0.575410833	0.58618533
-263	0.63866	0.574124624	0.5850122
-262.5	0.6378	0.572852675	0.58385061
-262	0.63657	0.571606463	0.58271365
-261.5	0.63605	0.570385593	0.58160249
-261	0.63481	0.569179412	0.58050633

The tests of significance between the experimental sample and the sample of pressure data inside B, variant 1, identify significant differences according to t test statistics (t-test is equal to 17.73026, and greater than 1.676, and t-table series are significantly different as medium level, or medium type parameter).

Table no.12.

Test for Equality of Means Between Series			
Sample: 1 49			
Method	df	Value	Probability

t-test	96	17.73026	0.0000
Anova F-statistic	(1, 96)	314.3622	0.0000
Analysis of Variance			
Source of Variation	df	Sum of Sq.	Mean Sq.
Between	1	0.072474	0.072474
Within	96	0.022132	0.000231
Total	97	0.094606	0.000975

Software used: EViews

Analogously, the test of significance between the experimental sample and the sample of pressure data inside B, variant 2, identifies significant differences according to t test statistics (t-test is equal to 15.96466, and greater than t tabled 1676, the series are significantly different).

Table no. 13.

Test for Equality of Means Between Series			
Sample: 1 49			
Method	df	Value	Probability
t-test	96	15.96466	0.0000
Anova F-statistic	(1, 96)	254.8704	0.0000
Analysis of Variance			
Source of Variation	df	Sum of Sq.	Mean Sq.
Between	1	0.051397	0.051397
Within	96	0.019359	0.000202
Total	97	0.070757	0.000729

Software used: EViews

Tested together, pressure data series of samples for data inside B, variant 1 and variant 2, are also different according to *t* test value (*t* - test is 7.1101, and greater than *t* tabled 1676), but, in point of limit, they can be compared with the differences between each single data sample, and the data in the experimental sample.

Table no. 14.

Test for Equality of Means Between Series			
Sample: 1 49			
Method	df	Value	Probability
t-test	96	2.418029	0.0175
Anova F-statistic	(1, 96)	5.846865	0.0175
Analysis of Variance			
Source of variation	df	Sum of Sq.	Mean Sq.
Between	1	0.001806	0.001806
Within	96	0.029657	0.000309
Total	97	0.031463	0.000324

Software used: EViews

All this information warrants sampling in the antimodal area of the data distributions curves, and increase confidence in their descriptive statistical analysis. The criteria for selecting one of the two series by comparison with the experiment data series, are the same, i.e. homogeneity and normality of the series described by the samples of data for pressure inside chamber B, variant 1, and variant 2, and the analysis of the descriptive statistic, of the test Jarque-Bera and the coefficient of homogeneity or uniformity leads to the following results:

Descriptive statistics of the three samples from the peak of the distributions curve

Table no. 15.

Sample: 1 49			
	Experiment data B	Pressure chamber B data variant 1	Pressure chamber B data variant 2
Mean	0.654445	0.600056	0.608643
Median	0.654910	0.600274	0.608864
Maximum	0.672450	0.630363	0.636204
Minimum	0.634810	0.569179	0.580506
Std. Dev.	0.01030	0.018380	0.016735
Skewness	-0.084226	-0.027377	-0.030311
Kurtosis	1.793653	1.780113	1.780161
Jarque-Bera	3.029119	3.044376	3.045520
Probability	0.219905	0.218234	0.218109
Sum	2.06780	29.40276	29.82348
Sum Sq. Dev.	0.005917	0.016215	0.013442
bservations	49	49	49

Software used: EViews

It was found that the coefficient of homogeneity for the data series of pressure data inside chamber B variant 1 is slightly larger, analogously the signals derived from the absolute and relative amplitude, from the value of standard deviation, but above all, of the value of the homogeneity or uniformity coefficient, describing a relatively small distance of that series from the experiment, while the data series for pressure inside B variant 2 is more like, in point of the level of indicators and trend, the data series of experiment.

Table no. 16.

	Experiment data B	Pressure chamber B data variant 1	Pressure chamber B data variant 2
Range	0,0376401	0,061185	0,055698
Relative range	0,0575145	0,101965	0,0915118
Coefficient of homogeneity -%	1,696552	3,0630474	2,7495593

Software used: EViews

Analogously, it can be noticed that the data series SER05 on the pressure inside a B, variant 1, also have a slightly lower vaulting (kurtosis), while the data series on the pressure inside chamber B, variant 2, and the data in experiment B have similar but more extended trends (the trend and indicator similarity is a set of arguments consistent enough, for which the data series SER06 = data for pressure inside B variant 2 is preferred, as determined by the analyses of the samples taken from the common or value intersected area, i.e. the antimodal area of the distributions curves) .

3. A FINAL REMARK

Following the approaches of a multidisciplinary type, one can select appropriate samples from the data series of experimental character that simplify and motivate the reasons o scientific research itself. An approch that is simultaneously statistical through testing, econometric through modelling, and mechanical through selective and experimental impact may result in simple solutions with quick and efficient effect.

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