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Ways to Recover from Economic Crises

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Abstract: *This article offers the options which can be used to recover from economic crises constantly happening in the modern society and affecting virtually all world countries to a certain extent. On the grounds of calculations, the author plotted 2D and 3D graphs providing a more precise demonstration of the impact that various variables exert onto a country's GDP. The calculations made it possible to build three tables and identify options of recovery from an economical crisis.*

Key words: *2D and 3D graphics, calculation, total tables, GDP*

INTRODUCTION

The author's earlier articles demonstrated that in order to describe the processes taking place within a country's economy this economy can be viewed as the volume of the economic shell. This article considers a country's GDP as the surface area of the economic shell (Pil, 2015).

GDP can be calculated by estimating the surface area S_{su}, which is affected by external forces P. To perform the calculation, we used four variables, i.e. S_{su} (GDP_{su}) = f(X1, X2, X3, X4). Here we have X1, X2, X3 and X4, the variables that influence the country's GDP.

In this case, the reduction of the X3 variable increases the GDP value, whereas the X4 variable may only asymptotically approach one. It should immediately be noted that during calculation and plotting of construction drawings, the parameters of X1, X2, X3 and X4 could be constant values, increase or decrease by 10 times. On the basis of the calculations made, 81 graphics were built, which can be divided into the four following groups:

- variable values X1, X2, X3 and X4 increase and are constant;
- variable values X1, X2, X3 and X4 decrease and are constant;
- variable values X1, X2, X3 and X4 decrease and increase;
- variable values X1, X2, X3 and X4 are constant, they decrease and increase.

Figure 1 represents a two-dimensional graph of the dependence S_{su} (GDP_{su}), where X1 = X2 = X3 = 1 and X4 = 0,1…0.99, which shows that the initial values of S_{su} increase gradually from 14.58 to 23.77 in point 9, and then increase considerably to 102,86, i.e. more than three times 3.22. Figure 2 shows one 3D graph, which allows us to see the changes of S_{su} more clearly. In this case, it makes sense for us to have the values of the rightmost points, as at these values the value of S_{su} (GDP_{su}), i.e. GDP, will be at its maximum. Figure 2 is plotted with the use of variables X3 and X4, i.e. S_{su} (GDP_{su}) = f(X3, X4).

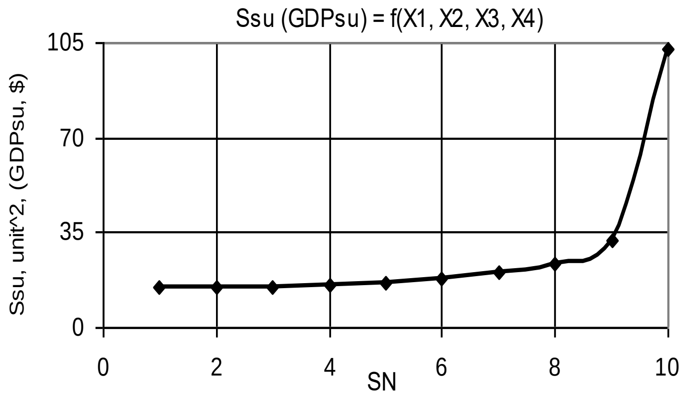


Figure 1: S_{su} (GDP_{su}) = f(X1, X2, X3, X4)
when X1 = X2 = X3 = 1, X4 = 0.1…0.99

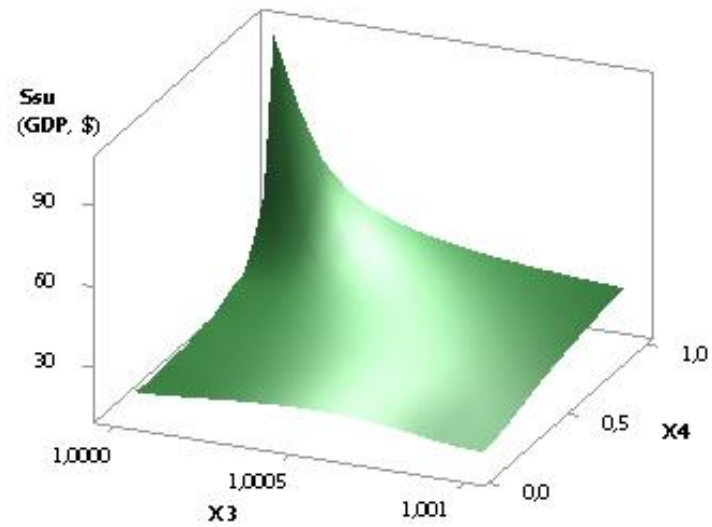


Figure 2: 3D graphic: S_{su} (GDP_{su}) = f(X3, X4)
when X1 = X2 = X3 = 1, X4 = 0.1…0.99

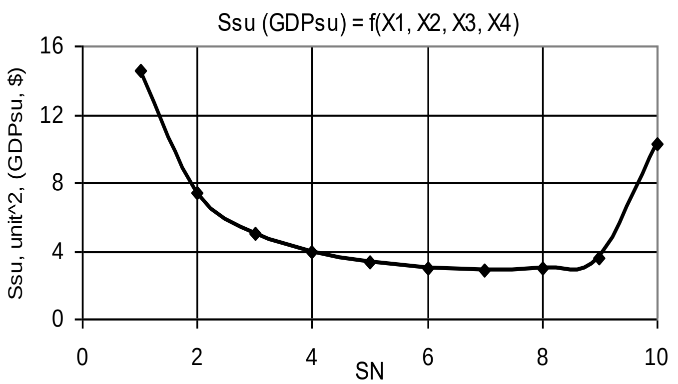


Figure 3: S_{su} (GDP_{su}) = f(X1, X2, X3, X4)
when X1 = X2 = 1, X3 = 1…10, X4 = 0.1…0.99

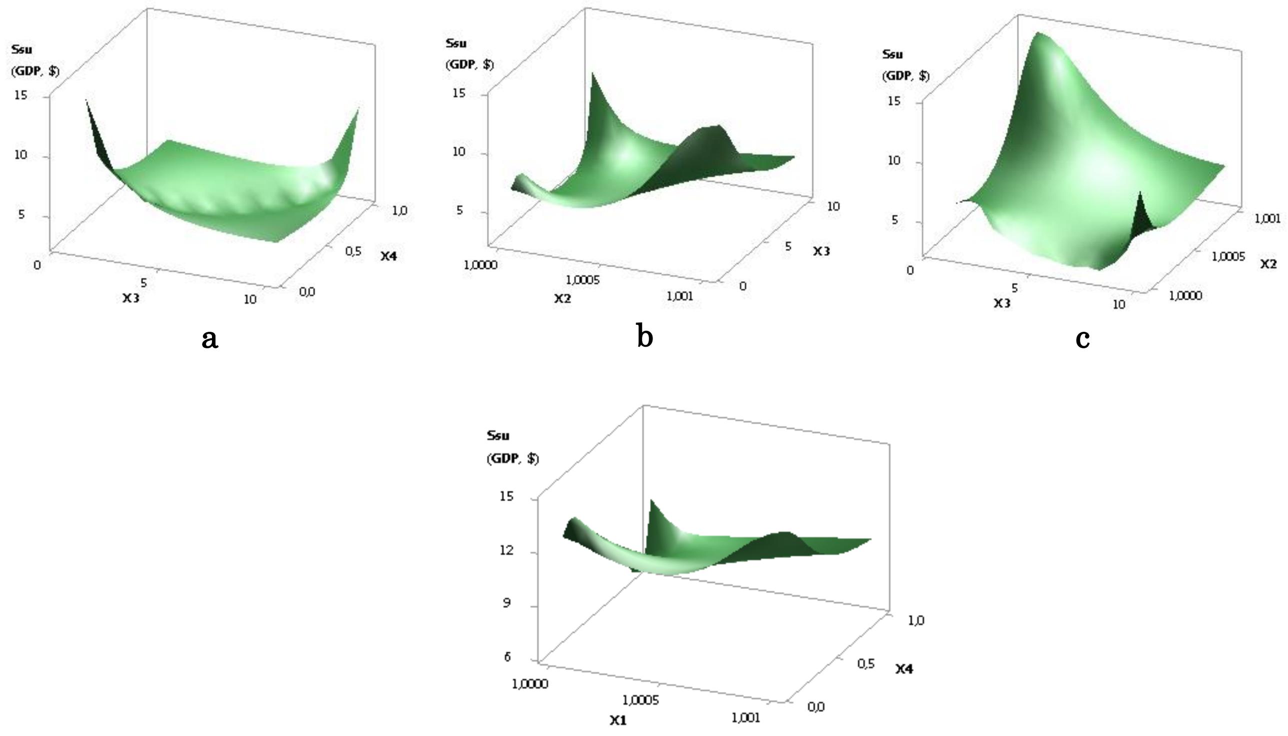


Figure 4: 3D graphics: *a* – S_{su} (GDP_{su}) = f(X3, X4); *b* – S_{su} (GDP_{su}) = f(X2, X3);
c – S_{su} (GDP_{su}) = f(X3, X2); *b* – S_{su} (GDP_{su}) = f(X1, X4)
when X1 = X2 = 1, X3 = 1…10, X4 = 0.1

The following Fig. 3 shows that first, at X1 = X2 = 1, X3 = 1…10, X4 = 0.1 …0.99, the plotted curve S_{su} decreases fivefold from 14.58 to the minimum of $S_{su\,min}$ = 2.88 in point 7, and then it drastically increases 3,4 times to 10,29. Figure 4 demonstrates four forms of this dependence as three-dimensional graphs. Here we must note that the form of the 3D graph depends on the choice of the applied axes sequence. For example, in Fig. 4*b* and 4*c* we can see 3D graphs with the same variables X2 and X3, but with different axes sequences. As we can see, these two graphs' appearances differ significantly. Based on Fig. 3, it makes sense for us to have the values of the extreme points, as at these values the value of S_{su} (GDP_{su}) will be at its maximum.

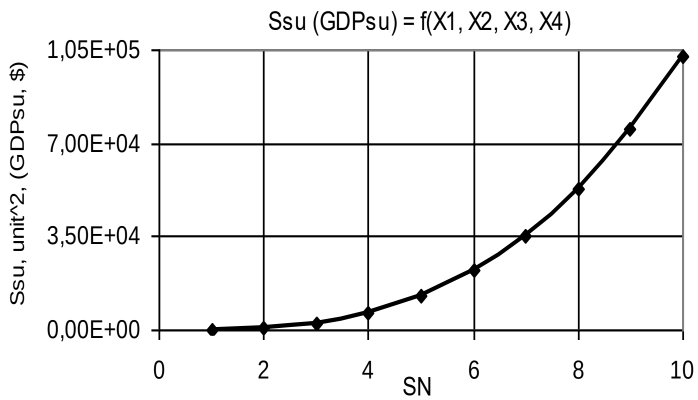


Figure 5: S_{su} (GDP_{su}) = f(X1, X2, X3, X4)
when X1 = X2 = 1…10, X3 = 1, X4 = 0.99

The plotted curve in Fig. 5 demonstrates that here the values of S_{su} (GDP_{su}) at X1 = X2 = 1…10, X3 = 1 and X4 = 0.99 are rather high, from 102.86 to 102861.38, i.e. they have increased more than 1000 times. Figure 6 shows the plotted 3D graph.

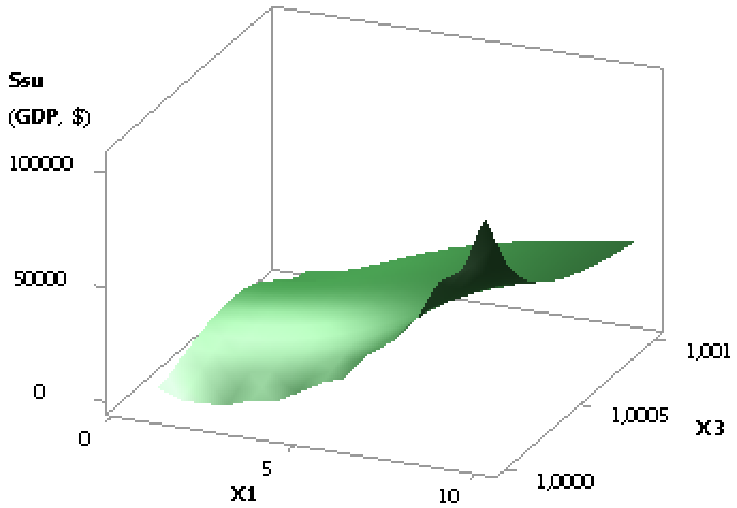


Figure 6: 3D graphic: S_{su} (GDP_{su}) = f(X1, X3);
when X1 = X2 = 1…10, X3 = 1, X4 = 0.99

Figure 7 demonstrates the dependence of S_{su} (GDP_{su}) at X1 = 1, X2 = X3 = 1…0.1 and X4 = 0.1…0.99. As we see from the Figure, at first the values of S_{su} (GDP_{su}) decrease according to the linear dependence from 14.58 to their minimum of 6.39 at point 9. Then they increase in steps up to 10.29. Figure 8 shows two 3D graphs S_{su} (GDP_{su}) = f(X2, X1) and S_{su} (GDP_{su}) = f(X1, X4) respectively. At the given values of the variables, it also makes sense to choose the extreme point values in Fig. 7, which allows us to have the maximum values of S_{su} (GDP_{su}).

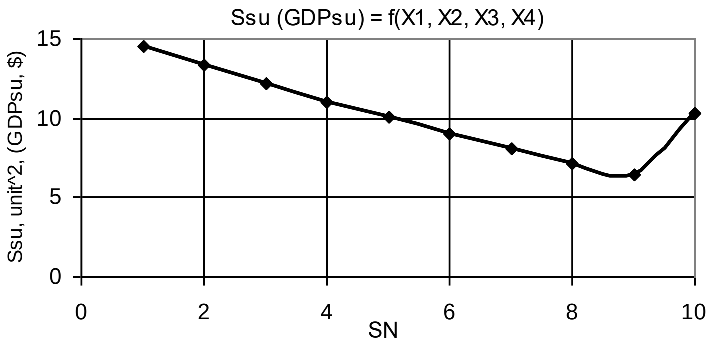


Figure 7: S_{su} (GDP_{su}) = f(X1, X2, X3, X4)
when X1 = 1, X2 = X3 = 1…0.1, X4 = 0.1…0.99

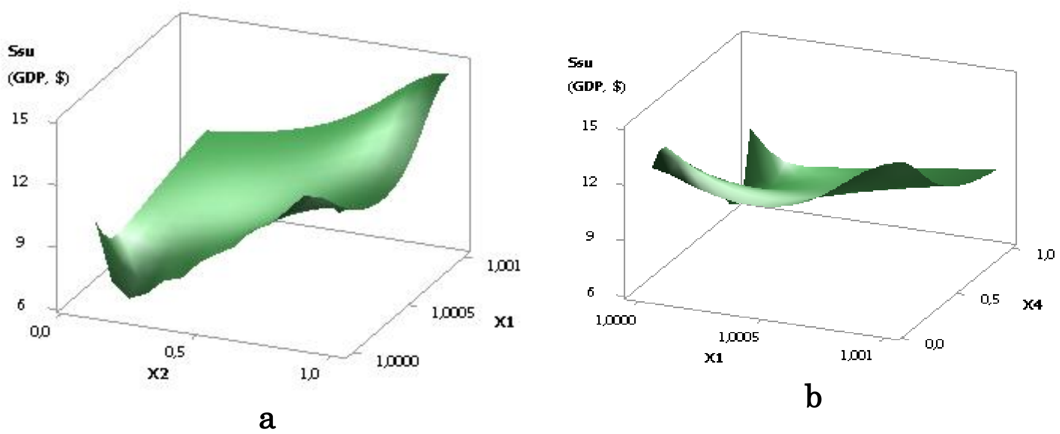


Figure 8: 3D graphics: *a* – S_{su} (GDP_{su}) = f(X2, X1); *b* – S_{su} (GDP_{su}) = f(X1, X4)
when X1 = 1, X2 = X3 = 1…0.1, X4 = 0.1…0.99

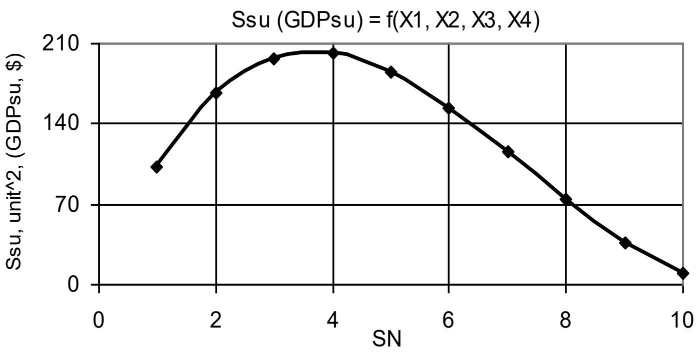


Figure 9: S_{su} (GDP_{su}) = f(X1, X2, X3, X4)
when X1 = 1…10, X2 = 1…0.1, X3 = 1, X4 = 0.99

The following Fig. 9 shows that first the values of S_{su} (GDP_{su}) here increase from 102.86 to their maximum of 201.64 in point 4, and then they gradually decrease to the value of 10.29, i.e. go down nineteenfold. Figure 10 represents three 3D graphs for S_{su} (GDP_{su}) = f(X2, X1), S_{su} (GDP_{su}) = f(X3, X1) and S_{su} (GDP_{su}) = f(X3, X2) respectively.

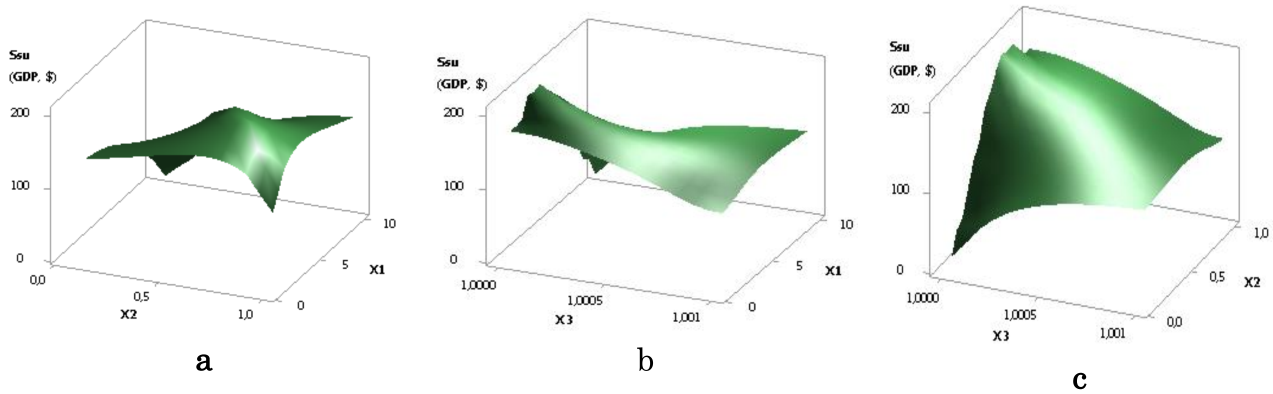


Figure 10: 3D graphics: *a* – S_{su} (GDP_{su}) = f(X2, X1); *b* – S_{su} (GDP_{su}) = f(X3, X1);
c – S_{su} (GDP_{su}) = f(X3, X2)
when X1 = 1…10, X2 = 1…0.1, X3 = 1, X4 = 0.99

In Fig. 11 we can see that the plotted curve S_{su} (GDP_{su}) increases gradually from the value of 102.86 to its maximum of $S_{su\,max}$ = 309.72 in point 7, and then it decreases 2.12 times to the value of 145.82. This Figure was plotted at the following values of the variables: X1 = 1…0.1, X2 = 1…10, X3 = 1, X4 = 0.99…0.1.

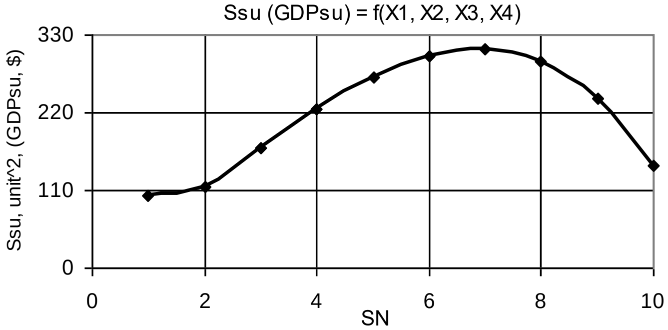


Figure 11: S_{su} (GDP_{su}) = f(X1, X2, X3, X4)
when X1 = 1…0.1, X2 = 1…10, X3 = 1, X4 = 0.99…0.1

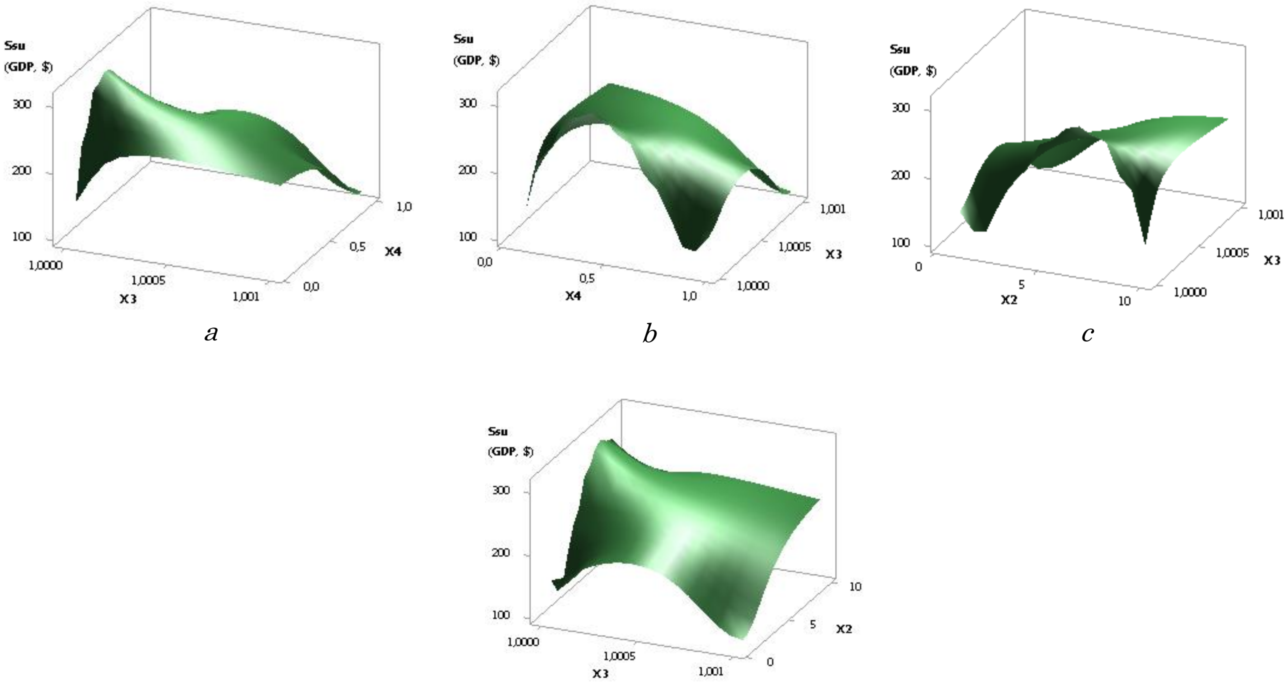


Figure 12: 3D graphics: *a* – S_{su} (GDP_{su}) = f(X3, X4); *b* – S_{su} (GDP_{su}) = f(X4, X3);
c – S_{su} (GDP_{su}) = f(X2, X3); *b* – S_{su} (GDP_{su}) = f(X3, X2)
when X1 = 1…0.1, X2 = 1…10, X3 = 1, X4 = 0.99…0.1

For Fig. 9 and 11, it makes sense to choose the values of the variables that are close to their maximum points.

The next Fig. 12 represents four 3D graphs of S_{su} (GDP_{su}), and here Figures 12*a* and 12*b*, as well as 12*c* and 12*d* are plotted with the axes modified.

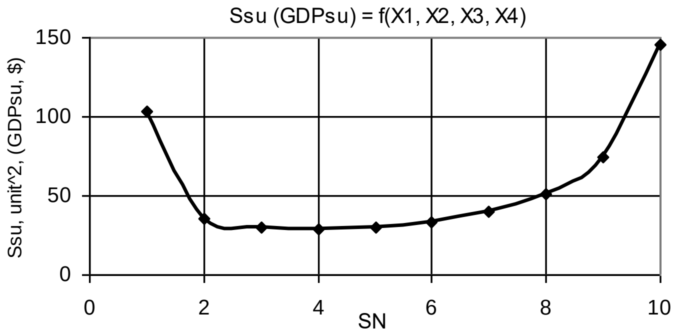
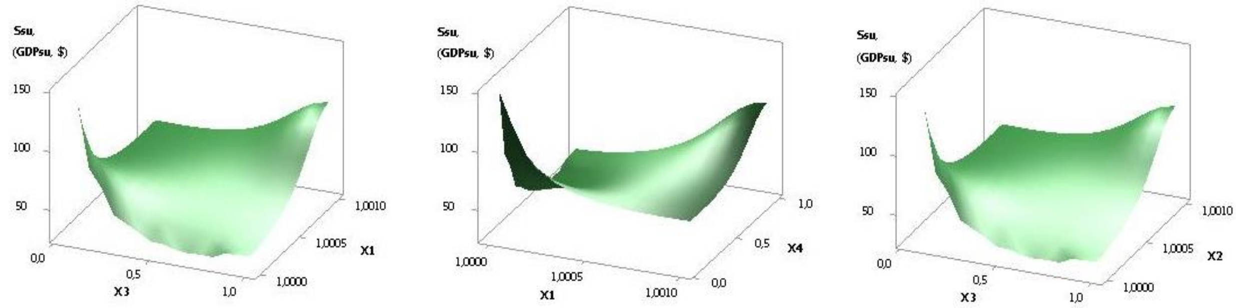


Figure 13: S_{su} (GDP_{su}) = f(X1, X2, X3, X4)
when X1 = X2 = 1, X3 = 1…0.1, X4 = 0.99…0.1

Figure 13 shows the 2D curve S_{su} (GDP_{su}), which first decreases by a factor of 3.58 from 102.86 in point 1 to its minimum $S_{su\,min}$ = 28.75 in point 4, then increases by a factor of 5.07 to its maximum value 145.82 ($S_{su\,max}$ = 145.82) in point 10. This Figure 13 shows that it is reasonable to have here the values of end points, because S_{su} (GDP_{su}) will then have its maximum magnitude. This curve was plotted under the following values of variables X1 = X2 = 1, X3 = 1…0.1, X4 = 0.99…0.1. The 3D graph represented in Figure 14 clearly demonstrates the impact that the two variables have on the calculated values of S_{su} (GDP_{su}).



a *b* *c*

Figure 14: 3D graphics: *a* – S_{su} (GDP_{su}) = f(X3, X1); *b* – S_{su} (GDP_{su}) = f(X1, X4); *c* – S_{su} (GDP_{su}) = f(X3, X2) when X1 = X2 = 1, X3 = 1…0.1, X4 = 0.99…0.1

The next Figure 15 demonstrates the curve S_{su} (GDP_{su}), with the values of the variables being X1 = 1…0.1, X2 = X3 =1…10, X4 = 0.99….0.1. As we see from this Figure, the values of S_{su} (GDP_{su}) gradually increase from 14.58 in point 1 to 57.04 in point 8, i.e. by a factor of 3.91. The values of S_{su} (GDP_{su}) between points 8 and 9 remain almost unchanged and equal 57.04 and 57.53 respectively. Then the plotted curve increases significantly by a factor of 1.79 between points 9 and 10 and reaches its maximum value of 102.86.

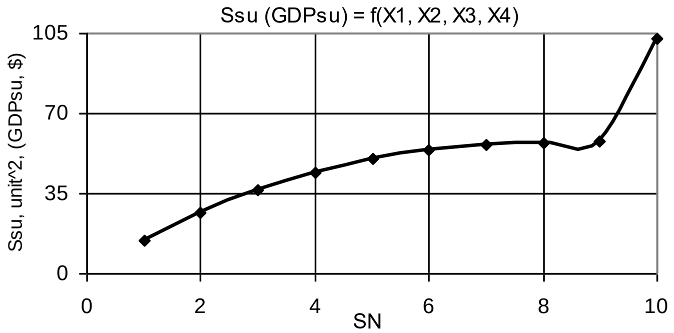
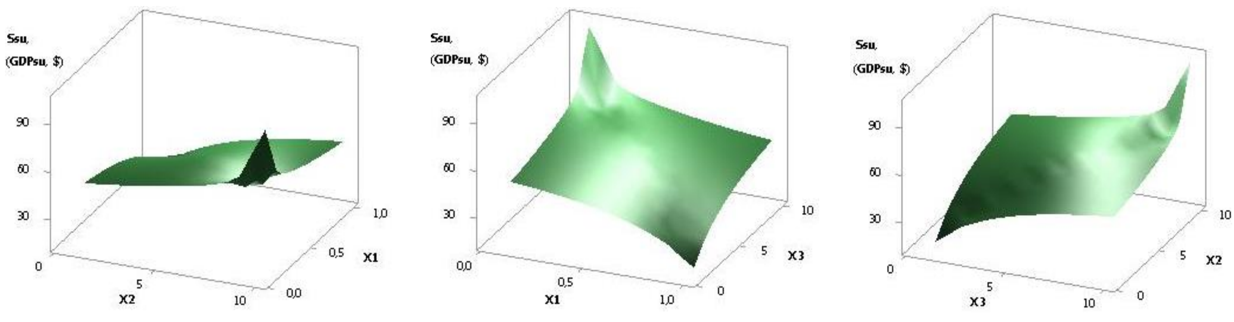


Figure 15: S_{su} (GDP_{su}) = f(X1, X2, X3, X4) when X1 = 1…0.1, X2 = X3 =1…10, X4 = 0.99….0.1



a *b* *c*

Figure 16: 3D graphics: *a* – S_{su} (GDP_{su}) = f(X2, X1); *b* – S_{su} (GDP_{su}) = f(X1, X3); *c* – S_{su} (GDP_{su}) = f(X3, X2) when X1 = X2 = 1, X3 = 1…0.1, X4 = 0.99…0.1

Figure 16 shows three options of 3D graphs S_{su} (GDP_{su}), giving a clear demonstration of the way the calculated magnitude of S_{su} (GDP_{su}) changes under the various values of the variables.

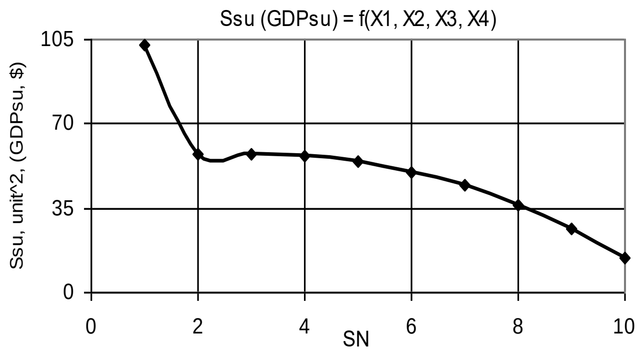


Figure 17: S_{su} (GDP_{su}) = f(X1, X2, X3, X4)
when X1 = 1…10, X2 = X3 = 1…0.1, X4 = 0.99….0.1

If we use the following variables X1 = 1…10, X2 = X3 = 1…0.1, X4 = 0.99….0.1 for S_{su} (GDP_{su}) we shall get the next Figure 17. This Figure 17 is obviously a mirror image of Figure 15, i.e. the values of the curve S_{su} (GDP_{su}) decrease significantly in the beginning between points 1 and 2 by a factor of 1.79 from 102.86 to 57.53. Then, between points 2 and 3, the curve S_{su} (GDP_{su}) slightly decreases from 57.53 to 57.04, i.e. by a factor of 1.79, followed by the further decrease to the value 14.58, that is by a factor of 3.91.

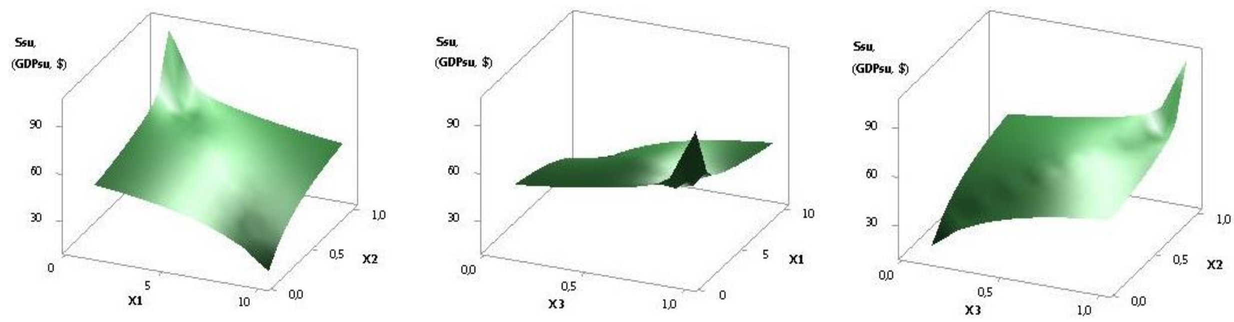


Figure 18: 3D graphics: *a* – S_{su} (GDP_{su}) = f(X1, X2); *b* – S_{su} (GDP_{su}) = f(X3, X1);
c – S_{su} (GDP_{su}) = f(X3, X2)
when X1 = 1…10, X2 = X3 = 1…0.1, X4 = 0.99….0.1

Figure 18 with three options of 3D graphs of S_{su} (GDP_{su}), clearly demonstrates how the variables t vat were used affect S_{su} (GDP_{su}).

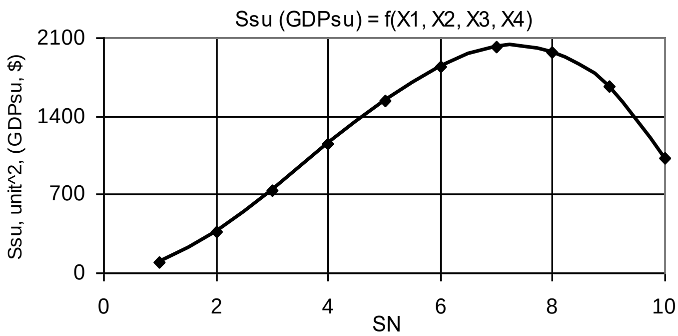


Figure 19: S_{su} (GDP_{su}) = f(X1, X2, X3, X4)
when X1 = 1…0.1, X2 = 1…10, X3 = 1, X4 = 0.99

The next Figure 19 represents the dependency of S_{su} (GDP_{su}) plotted with the values of the variables being X1 = 1…0.1, X2 = 1…10, X3 = 1, X4 = 0.99. As seen in this Figure, the plotted curve S_{su} (GDP_{su}) increases first from 102.86 to its maximum value $S_{su\,max}$ = 2016.08, that is by a factor of 19.6, then drops down to 1028.61, i.e. by a factor of 1.96.
If we plot now the 3D graphs for S_{su} (GDP_{su}) we shall get the following surfaces shown in Figure 20.

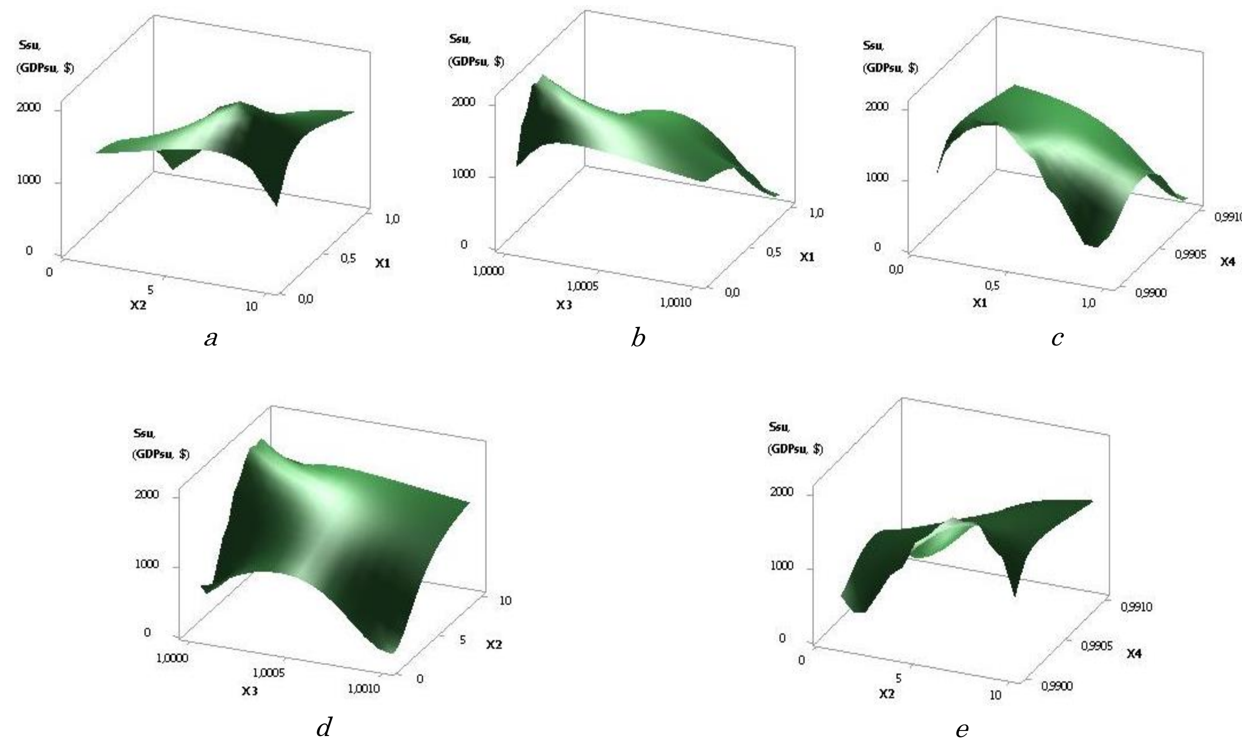


Figure 20: 3D graphics: *a* – S_{su} (GDP_{su}) = f(X2, X1); *b* – S_{su} (GDP_{su}) = f(X3, X1); *c* – S_{su} (GDP_{su}) = f(X1, X4); *d* – S_{su} (GDP_{su}) = f(X3, X2); *e* – S_{su} (GDP_{su}) = f(X2, X4) when X1 = 1…0.1, X2 = 1…10, X3 = 1, X4 = 0.99

Now let's evaluate the impact of the following variables X1 = 1…0.1, X2 = X3 = 1…10, X4 = 0.99 on the calculated values of S_{su} (GDP_{su}) as represented in Figure 21. As seen in Figure 21, the plotted curve is symmetrical and increases from 102.86 to its maximum $S_{su\,max}$ = 308.56 in points 5 and 6, i.e. by a factor of 3, then decreases to 102.86 by the same factor of 3.

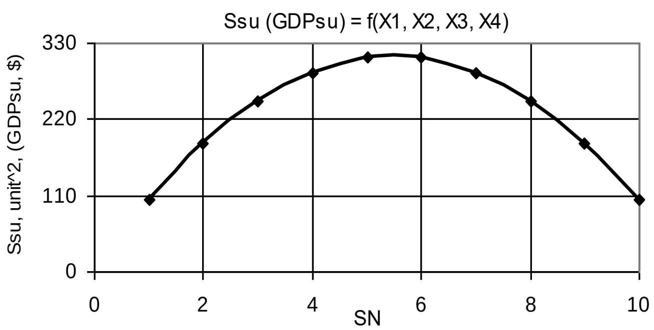


Figure 21: Зависимость S_{su} (GDP_{su}) = f(X1, X2, X3, X4) when X1 = 1…0.1, X2 = X3 = 1…10, X4 = 0.99

Below are five 3D graphs of S_{su} (GDP_{su}) with these values of the variables.

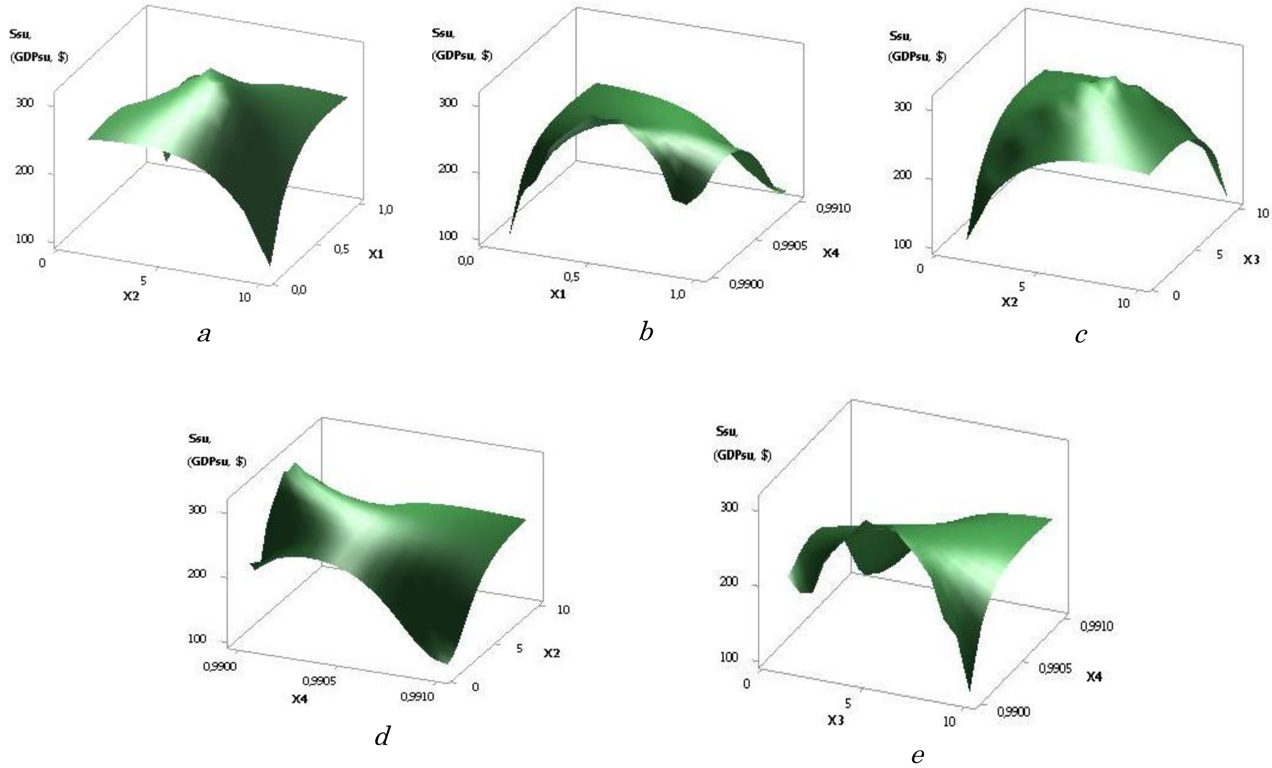


Figure 22: 3D graphics: *a* – S_{su} (GDP_{su}) = f(X2, X1); *b* – S_{su} (GDP_{su}) = f(X1, X4); *c* – S_{su} (GDP_{su}) = f(X2, X3); *d* – S_{su} (GDP_{su}) = f(X4, X2); *e* – S_{su} (GDP_{su}) = f(X3, X4) when X1 = 1…0.1, X2 = X3 = 1…10, X4 = 0.99

The next Figure 23 for calculated values of S_{su} (GDP_{su}) was plotted with variables X1 = 1, X2 = X3 = 1…10, X4 = 0.99…0.1. As we can see from the plotted curve S_{su} (GDP_{su}) it plummets between points 1 and 2 from 102.86 to 63.92, i.e. by a factor of 1.61, followed by the gradual increase in an almost straight line to 145.82, i.e. by a factor of 2.28.

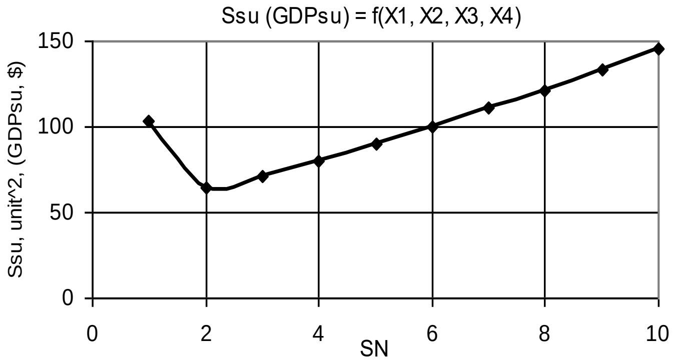


Figure 23: S_{su} (GDP_{su}) = f(X1, X2, X3, X4) when X1 = 1, X2 = X3 = 1…10, X4 = 0.99…0.1

The last Figure 24 represents six 3D graphs of S_{su} (GDP_{su}) with these values of the variables.

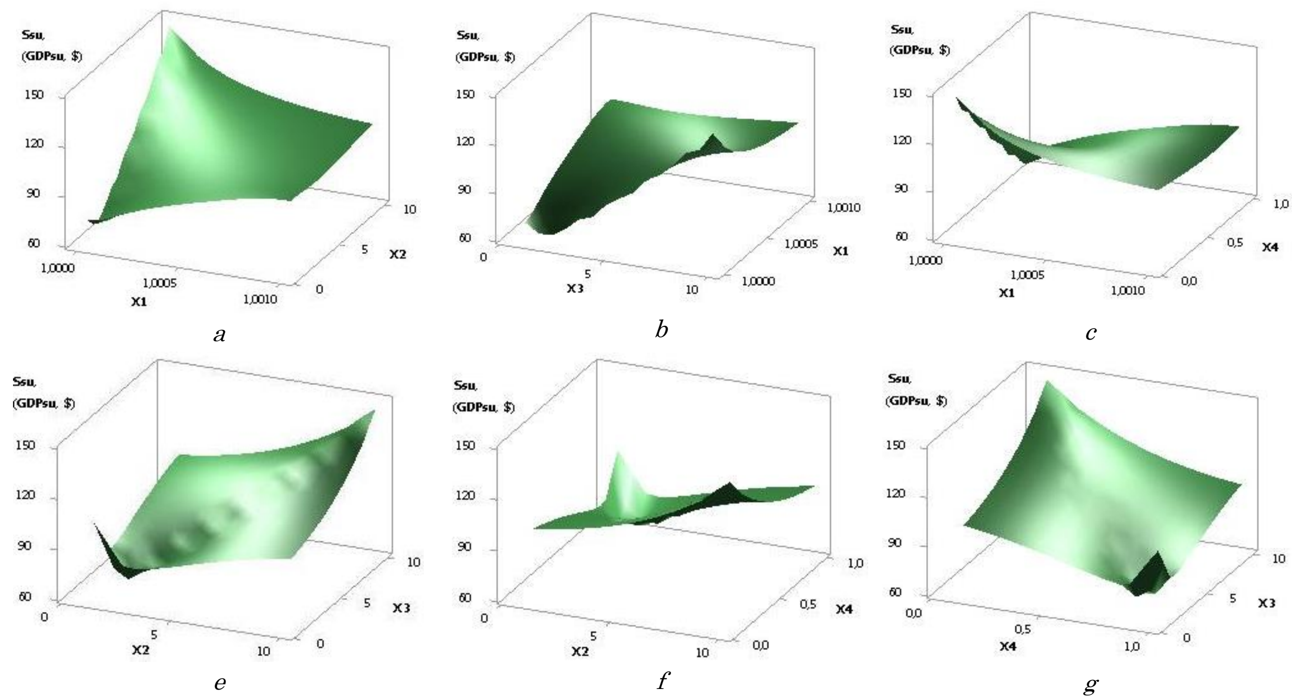


Figure 24: 3D graphics: *a* – S_{su} (GDP_{su}) = f(X1, X2); *b* – S_{su} (GDP_{su}) = f(X3, X1);
c – S_{su} (GDP_{su}) = f(X1, X3); *d* – S_{su} (GDP_{su}) = f(X2, X3); *e* – S_{su} (GDP_{su}) = f(X2, X4);
g – S_{su} (GDP_{su}) = f(X4, X1)
when X1 = 1, X2 = X3 = 1…10, X4 = 0.99…0.1

After the calculations were made, their results were gathered into a summary Table, which contains 95 lines despite the fact that 81 two-dimensional graphs were plotted. The reason for this is a number of plotted graphs having maximums and minimums.
This summary Table includes such ratios as:

- S_{sub}…S_{suf}, where S_{sub} is the initial value of the economic shell surface area, units^2; S_{suf} is the final value of the economic shell surface area, units^2;
- S_{suf}/S_{sub} is the ratio of the final value of the economic shell surface area to the initial one.

The ratio of the final value of the economic shell surface area S_{suf} to the initial one S_{sub} shows what fold their values increased (decreased) as affected by various external forces. Thus, having these data we can choose the values of the variables X1, X2, X3 and X4 at which the economic shell surface area will stay unchanged or even increase under the influence of external forces. Thus, during the economic crisis, the selected variable values will allow preserving the country's GDP_{su} at the same level, or even increasing it.
After the summary Table with 95 lines was plotted, it was transformed the following way, and only the values where $S_{suf}/S_{sub} \geq 1$ were left. On the basis of this transformation, we obtained the final summary Table, which included 48 lines. Thus, we obtained 48 variants that allow countries to come out of yet another economic crisis. Below, you can see Table 1, which includes only a part of the summary Table with 22 lines. Here the ratios S_{suf}/S_{sub} in the last column are given in descending order.
Table 1 shows that there are two variants at which GDP of a country will not change in the time of an economic crisis, even if we change the variables. These lines are 21 and 22, where the ratios S_{suf}/S_{sub} = 1.

Table 1: Statistics of theoretical relation S_{suf} / S_{sub} where S_{suf} / $S_{sub} \geq 1$

No. in sequence	X1, unit	X2, unit	X3, unit	X4, unit	S_{sub}… S_{suf}, unit ^{2} (GDP_{sub}…GDP_{suf}), $	S_{suf} / S_{sub} (GDP_{suf} / GDP_{sub})
1	1…10	1…10	1…0.1	0.1…0.99	14.58…1.029E+06	70539.88

2	1…10	1…10	1…0.1	0.99	102.86…1.03E+06	10000.00
3	1…10	1…10	1	0.1…0.99	14.58…1.03E+05	7053.99
4	1	1…10	1…0.1	0.1…0.99	14.58…1.03E+05	7053.99
5	1…10	1…10	1	0.99	102.86…1.03E+05	1000.00
6	1	1…10	1…0.1	0.99	102.86…1.03E+05	1000.00
7	1	1…10	1	0.1…0.99	14.58…10286.14	705.40
8	1…10	1	1…0.1	0.99	102.86…10286.14	100.00
9	1	1…10	1	0.99	102.86…10286.14	100.00
10	1…10	1	1	0.1…0.99	14.58…1028.61	70.54
11	1…0.1	1…10	1	0.1…0.99	14.58…1028.61	70.54
12	1…10	1	1…0.1	0.99…0.1	71.02…1458.20	20.53
13	1…0.1	1…10	1	0.99	102.86…2016.08	19.60
14	1	1…10	1	0.99…0.1	102.86…1458.20	14.18
15	1…10	1	1	0.99	102.86…1028.61	10.00
16	1	1	1…0.1	0.99	102.86…1028.61	10.00
17	1	1	1	0.1…0.99	14.58…102.82	7.05
18	1	1	1…0.1	0.99…0.1	28.75…145.82	5.07
19	1…10	1	1	0.99…0.1	63.92…145.82	2.28
20	1…10	1…0.1	1	0.99	102.86…201.61	1.96
21	1…10	1	1…10	0.99	102.86…102.86	1.00
22	1…0.1	1	1…0.1	0.99	102.86…102.86	1.00

Now let us transform Table 1 into Table 2, and for this we will group the lines according to the number of variables they include. Thus, Table 2 includes the following four groups: with 1 variable; with 2 variables; with 3 variables and all the variables.

Table 2: The statistics of constant parameters for S_{suf} / S_{sub} in descending order

No. in sequence	X1, unit	X2, unit	X3, unit	X4, unit	Ssub… Ssuf, unit 2 (GDPsub…GDPsuf), $	Ssuf / Ssub (GDPsuf / GDPsub)
1 variable						
1	1…10	1…10	1…0.1	0.99	102.86…1.03E+06	10000.00
2	1…10	1…10	1	0.1…0.99	14.58…1.03E+05	7053.99
3	1	1…10	1…0.1	0.1 …0.99	14.58…1.03E+05	7053.99
2 variables						
4	1…10	1…10	1	0.99	102.86…1.03E+05	1000.00
5	1	1…10	1…0.1	0.99	102.86…1.03E+05	1000.00
6	1…0.1	1…10	1	0.1…0.99	14.58…1028.61	70.54
7	1…10	1	1…0.1	0.99…0.1	71.02…1458.20	20.53
8	1	1…10	1	0.1…0.99	14.58…10286.14	705.40
9	1…10	1	1…0.1	0.99	102.86…10286.14	100.00
10	1…10	1	1	0.1…0.99	14.58…1028.61	70.54
11	1…0.1	1…10	1	0.99	102.86…2016.08	19.60

12	1	1…10	1	0.99…0.1	102.86…1458.20	14.18
13	1	1	1…0.1	0.99…0.1	28.75…145.82	5.07
14	1…10	1	1	0.99…0.1	63.92…145.82	2.28
15	1…10	1…0.1	1	0.99	102.86…201.61	1.96
16	1…10	1	1…10	0.99	102.86…102.86	1.00
17	1…0.1	1	1…0.1	0.99	102.86…102.86	1.00
3 variables						
18	1	1…10	1	0.99	102.86…10286.14	100.00
19	1…10	1	1	0.99	102.86…1028.61	10.00
20	1	1	1…0.1	0.99	102.86…1028.61	10.00
21	1	1	1	0.1…0.99	14.58…102.82	7.05
all the variables						
22	1…10	1…10	1…0.1	0.1…0.99	14.58…1.029E+06	70539.88

The obtained Table 2 gives us a clear idea that it suffices to change even one variable out of four for the country to successfully come out of an economic crisis.
Thus, depending on the number of variables applied, Table 2 allows us to use a different number of variants:

- with 1 variable (3 variants);
- with 2 variables (14 variants);
- with 3 variables (4 variants);
- all the variables (1 variant).

As we can see, the largest number of variants is available for two variables. However, if we apply all the variables to come out of an economic crisis, in this case we will have the strongest economic effect.

Below is Table 3 which shows the extent to which values of Ssu (GDPsu) change depending on the increase in the number of digits after comma for the X4 variable, where values of the rest equal one, i.e. X1 = X2 =X3 = 1. In other words, that is another option of recovering country's economy from the crisis. In our case the X4 variable may be referred to taxes or to the key rate.

Table 3: The change in values of Ssu after the change in the number of digits after comma for the X4 variable

No. in sequence	X1, unit	X2, unit	X3, unit	X4, unit	Ssu, unit2 (GDPsu, $)
1	1	1	1	0.9	33.29
2	1	1	1	0.99	102.86
3	1	1	1	0.999	324.54
4	1	1	1	0.9999	1026.06
5	1	1	1	0.99999	3244.63
6	1	1	1	0.999999	10260.39
7	1	1	1	0.9999999	32446.20
8	1	1	1	0.99999999	102603.90
9	1	1	1	0.999999999	324462.02
10	1	1	1	0.9999999999	1026038.96

References

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