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14 April 2023

Online at https://mpra.ub.uni-muenchen.de/117076/
MPRA Paper No. 117076, posted 15 Apr 2023 06:57 UTC

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Construction of a production function in the form of series of exponents of a function of a complex variable (on the example of the Czech Republic 2006-2021)

Abstract

Economic and mathematical models allow researchers to find out the causal relationship between various economic indicators and determine internal and external factors of interaction.
Production functions allow us to model the dependence of the dynamics of factors of production on the dynamics of economic growth.
Interpolation of numerical series by the Dirichlet series makes it possible to achieve good results of approximation of numerical series by analytical functions .
Public authorities need accurate and up-to-date information about the state of the economy in order to make effective management decisions.
In the opinion of the author, interpolation methods in economic analysis are undeservedly relegated to the background. Therefore, within the framework of this study, the production function of the Czech Republic was constructed on the basis of interpolation of numerical series by series of exponents of a complex variable.
Interpolation of numerical series by series of exponents of a multiplex variable allows to achieve an approximation accuracy not inferior to regression analysis

.Keywords

Production function , complex variable function , Dirichlet series , Czech Republic

Introduction

In modern conditions, the importance of regional economic development is increasing. Regions with a high level of competitiveness have the opportunity to attract labor and capital on more favorable terms, which in turn has a positive effect on the well-being of these regions.

According to [1] for effective economic development and successful financing of the social sphere, monitoring the effectiveness of budget spending is of great importance. Such expenses include education expenses . State authorities should be able to correctly predict the need for training of labor resources, as well as the demand for them for different sectors of the economy.

According to [2], solving problems in the disproportion of socio-economic development of regions requires measures to stimulate investment activity at the state and regional levels. And this requires a promising comprehensive assessment of the evolution of the industrial and economic potential of the region based on the use of effective economic and mathematical models.

According to [3], forecasting trends of economic growth plays a primary role for the implementation of an effective economic policy of the state.

According to [4], an important element of the construction of an economic and mathematical model is its possibility of practical use.

The authors [5] note that for large industrial enterprises to function successfully, it is necessary to solve the following tasks (Fig.1)

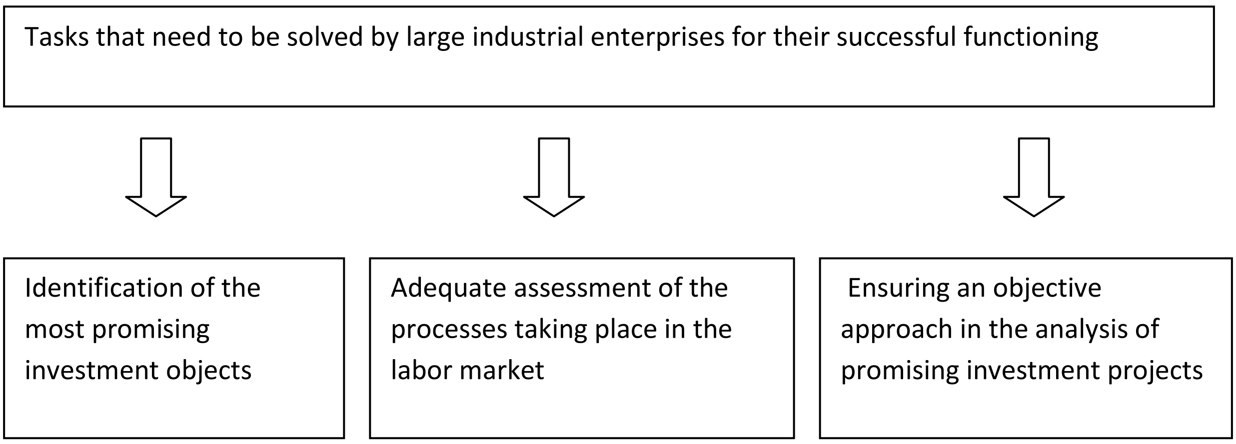

Fig.1. Tasks that need to be solved by large industrial enterprises for their successful functioning

Согласно [6] одной из наиболее эффективных экономико-матических моделей описывающих производственные возможности регионов , отдельных отраслей экономики и целого государства являются производственные функции.

Согласно [7] производственная функция основывается на допущении , что величина производства продукции однозначно определяется набором определенных производственных факторов . При этом делается предположение , внутреняя структура исследуемого объекта не играет существенной роли.

Согласно [8] главными целями производственной деятельности является максимизации прибыли и оптимизация издержек с целью их минимизации.
По мнению [9] определение производственной функции может позволить решить проблемы недостаточной загруженности производственных фондов.
В общем случае прозводственную функцию можно представить в виде
According to [6], one of the most effective economic-static models describing the production capabilities of regions, individual sectors of the economy and the whole state are production functions.
According to [7], the production function is based on the assumption that the value of production is uniquely determined by a set of certain production factors. At the same time, the assumption is made that the internal structure of the object under study does not play a significant role.
According to [8], the main objectives of production activities are to maximize profits and optimize costs in order to minimize them.
According to [9], the definition of the production function can solve the problems of insufficient workload of production assets.
In general , the production function can be represented as

(1)

where K – capital , L – resources used
Among two-factor production functions, the Cobb-Douglas function has become widespread [10]

(2)

where - the normalizing multiplier, – resources used labor and capital , indicators of the elasticity of GDP relative to capital and relative to labor . At work [11] the production function of the form is considered

(3)

where
In [1] it is proposed to use a production function of the form:

(4)

Y – output volume, L – labour, K- capital , M- materials and raw materials , T – technologies , N- entrepreneurial skills.
According to [12], the further development of the Cobb-Douglas production function develops in the direction of including additional factors in it.
According to [13], the Cobb-Douglas function does not fully reflect the economic system, since this function has a simplified form.
According to [14], the availability of adequate statistical data is indispensable for the effective use of production functions in economic and mathematical modeling.
According to [15], the production function in the economic domain G must satisfy four conditions :

1) The production function on the domain G must be continuous.

2) The production function on the domain G must be quasi-convex.

3) The production function on the domain G must have a positive value.

4) The production function on the area G must strictly increase.

Methods

When constructing economic and mathematical models, the interpolation and approximation of logarithmic exponential, power and linear, functions, and polynomials have become widespread. Thus, for convenience and simplicity of calculations, economic phenomena are described in a simplified form.However , such simplifications may reduce the accuracy of the models themselves , which may make it impossible for them to be successfully applied in practice . Regression analysis has become an indispensable tool for the study of economic phenomena . According to the author , the main disadvantage of regression models is the fact that the algorithms for solving these models use the least squares method . Since the least squares method has some disadvantages .Then the calculation of regression models with its help , in some cases , can lead to incorrect results . There is a widespread opinion in the economic literature that many economic values have a pronounced random character . In this regard, the author adheres to the point of view that any randomness is some kind of regularity , and to describe economic phenomena, it is worth using not only indicators of variance and correlation, but more complex mathematical tools. In the book [16] the theorem is formulated

Let's say there is some analytical function of a complex variable . Then this function can be decomposed into a series of exponentials.

(5)

That is, for any convex domain D there is a sequence of indicators , such that any function The analytic in D can be represented as a series uniformly converging within the domain D.

Results

Within the framework of this study , the author considered the production function of the following type

:

(6)

where ,

Y - GDP indicator,

- Foreign direct investment, net inflows (BoP, current US$)
- Total reserves (includes gold, current US$)
- Domestic credit to private sector (% of GDP)
- Tax revenue (% of GDP)
- Exports of goods and services (% of GDP)
- Gross fixed capital formation (% of GDP)
- Imports of goods and services (% of GDP)
- Manufacturing, value added (% of GDP)
- Industry (including construction), value added (% of GDP)
- Inflation, GDP deflator (annual %)
- Gross savings (% of GDP)
- Population, total
- Population growth (annual %)
- Agriculture, forestry, and fishing, value added (% of GDP)
- Deposit interest rate (%)
- Real interest rate (%)

To find the function (4), we interpolate the time series describing the indicators

Dirichlet rows consisting of eight members

.

We show that the numerical sequence

{ 156264095664.643 , 190183800884.018 , 236816485762.988 , 207434296805.33 ,209069940963.177, 229562733398.948 , 208857719320.649 , 211685616592.931 , 209358834156.329 , 188033050459.881, 196272068576.338 , 218628940951.675 , 249000540729.179 , 252548179964.897 , 245974558654.043, 281777887121.451}

A numerical series characterizing the Czech Republic's GDP for the period 2006-2021, can be interpolated using the WY function

WY= (73.9646575769216-
34.0196463495336i)*exp((1.32074261422715+2.03858207285486i)*h)+(73.9646
575769216+34.0196463495335i)*exp((1.32074261422715-
2.03858207285486i)*h)+(130722072.689756+101508313.823773i)*exp((0.38345
1070541717+0.883849499148551i)*h)+(130722072.689756-
101508313.823773i)*exp((0.383451070541717-
0.883849499148551i)*h)+(221290234917.274-8.10438746838409e-05i)*exp((-
0.00565578140807628+0i)*h)+(15585621633.8755-10388628625.4215i)*exp((-
0.179664256364207+2.22375838366087i)*h)+(15585621633.8755+10388628625
.4215i)*exp((-0.179664256364207-2.22375838366087i)*h)+(-
455013410530.529+0.000376360188405461i)*exp((-
1.99712381303883+0i)*h)+(-0.00131118266090027-
0.000172122922701465i)*exp((1.32074261422715+2.03858207285486i)*(-h))+(-
0.00141936890827811+0.000202193263012131i)*exp((1.32074261422715-
2.03858207285486i)*(-h))+(9.08878491915332e-05-
0.000114722343140817i)*exp((0.383451070541717+0.883849499148551i)*(-
h))+(8.00728242687559e-
05+0.000102069646558476i)*exp((0.383451070541717-0.883849499148551i)*(-
h))+(-0.030483568334267+7.69313441445378e-05i)*exp((-
0.00565578140807628+0i)*(-h))+(-3.74250835781874e-06-1.15538122806545e-
07i)*exp((-0.179664256364207+2.22375838366087i)*(-h))+(-
3.25571787841601e-06+2.3852766465679e-07i)*exp((-0.179664256364207-
2.22375838366087i)*(-h))+(6.20232070443842e-17-1.54543276158622e-
18i)*exp((-1.99712381303883+0i)*(-h)) (7)

Really,

Table 1. Calculation of the Czech Republic's GDP for the period 2006-2021 using the formula (7)

h	Year	Calculated by the formula (7)	Tabular data [17]
1	2006	156264095664.643	156264095668.847
2	2007	190183800884.018	190183800883.4
3	2008	236816485762.988	236816485762.465
4	2009	207434296805.33	207434296799.454
5	2010	209069940963.177	209069940964.271
6	2011	229562733398.948	229562733409.535
7	2012	208857719320.649	208857719321.73
8	2013	211685616592.931	211685616593.725
9	2014	209358834156.329	209358834157.483
10	2015	188033050459.881	188033050460.19
11	2016	196272068576.338	196272068577.01
12	2017	218628940951.675	218628940949.414
13	2018	249000540729.179	249000540725.889
14	2019	252548179964.897	252548179963.335
15	2020	245974558654.043	245974558652.214
16	2021	281777887121.451	281777887123.053

We show that the numerical sequence

{ 156264095664.643 , 190183800884.018 , 236816485762.988 , 207434296805.33 ,209069940963.177, 229562733398.948 , 208857719320.649 , 211685616592.931 , 209358834156.329 , 188033050459.881, 196272068576.338 , 218628940951.675 , 249000540729.179 , 252548179964.897 , 245974558654.043, 281777887121.451}

A numerical series characterizing the Foreign direct investment, net inflows (BoP, current US$) for the period 2006-2021, can be interpolated using the W1 function

W1= (-236345028.718171-116004325.951769i)*exp((0.138437854886426+1.23745180218354i)*h)+(-236345028.718171+116004325.951769i)*exp((0.138437854886426-1.23745180218354i)*h)+(1950511642.92823-3.99510926510649e-07i)*exp((0.113581700606085+0i)*h)+(11810634864.9454-2.98622663258396e-06i)*exp((-0.214858451123749+0i)*h)+(-293528152.374425+364039346.332952i)*exp((0.0970835603358079+2.01816717589881i)*h)+(-293528152.374425-364039346.332952i)*exp((0.0970835603358079-2.01816717589881i)*h)+(3443569022.73415-2752351900.5431i)*exp((-0.163508240228555+2.84243126687177i)*h)+(3443569022.73415+2752351900.5431i)*exp((-0.163508240228555-2.84243126687177i)*h)+(1.22378206321808e-05+8.67298138726553e-07i)*exp((0.138437854886426+1.23745180218354i)*(-h))+(1.28426232316276e-05-1.4484647373904e-06i)*exp((0.138437854886426-

1.23745180218354i)*(-h))+(-0.0001823242353423+2.89896240319695e-06i)*exp((0.113581700606085+0i)*(-h))+(5.30540128544788e-06+4.13472126968569e-09i)*exp((-0.214858451123749+0i)*(-h))+(7.11675325684393e-06-4.64446587033711e-06i)*exp((0.0970835603358079+2.01816717589881i)*(-h))+(7.23549653523963e-06+4.72311747617787e-06i)*exp((0.0970835603358079-2.01816717589881i)*(-h))+(-4.43475283262059e-07-2.09692376453148e-07i)*exp((-0.163508240228555+2.84243126687177i)*(-h))+(-3.16971447693242e-07+2.69517767618367e-07i)*exp((-0.163508240228555-2.84243126687177i)*(-h)) (8)

Really,

Table 2. Calculation of the Foreign direct investment, net inflows (BoP, current US$) for the period 2006-2021 using the formula (8)

h	Year	Calculated by the formula (8)	Tabular data [17]
1	2006	7132002407.74227+23.90625i	7132002407.70599+0i
2	2007	13815656003.7177+268.0625i	13815656003.7033+0i
3	2008	8815393021.96039+145.0625i	8815393022.10815+0i
4	2009	5271613701.74941-303.4375i	5271613701.7927+0i
5	2010	10167834374.8071+108i	10167834374.8186+0i
6	2011	4188736491.26426-49.5625i	4188736491.29368+0i
7	2012	9433199804.77929-57.0625i	9433199804.77647+0i
8	2013	7357578652.63143+55.6875i	7357578652.57+0i
9	2014	8088661929.88625+28.5625i	8088661929.8803+0i
10	2015	1699914616.56241-6.6875i	1699914616.60242+0i
11	2016	10850612308.2296+45.75i	10850612308.2062+0i
12	2017	11234740946.0915-52.75i	11234740946.0941+0i
13	2018	8324668391.38284+308.25i	8324668391.46793+0i
14	2019	10752120870.8558+224.25i	10752120870.768+0i
15	2020	8515481807.43946-545i	8515481807.56744+0i
16	2021	7611819078.40936+69i	7611819078.50094+0i

We show that the numerical sequence

{ 156264095664.643 , 190183800884.018 , 236816485762.988 , 207434296805.33 ,209069940963.177, 229562733398.948 , 208857719320.649 , 211685616592.931 , 209358834156.329 , 188033050459.881, 196272068576.338 , 218628940951.675 , 249000540729.179 , 252548179964.897 , 245974558654.043, 281777887121.451}

A numerical series characterizing the Total reserves (includes gold, current US$) for the period 2006-2021, can be interpolated using the W2 function

W2= (222135075.503196-21198802.5972096i)*exp((0.38647089922278+0.498103150727728i)*h)+(222135075.503196+21198802.5972098i)*exp((0.38647089922278-0.498103150727728i)*h)+(29201028053.5546-5.21451403944317e-06i)*exp((0.0826064596131552+0i)*h)+(240056146.733855-74018669.5213478i)*exp((0.302488977096926+1.59863755174924i)*h)+(240056146.733855+74018669.5213478i)*exp((0.302488977096926-1.59863755174924i)*h)+(284323947.739667-263513721.832254i)*exp((0.141236791360524+2.68878853883752i)*h)+(284323947.739667+263513721.832253i)*exp((0.141236791360524-2.68878853883752i)*h)+(621967955.767857+2.15575006118742e-06i)*exp((0.148871530285203+3.14159265358979i)*h)+(-7.66527747352012e-05+0.000292043721923782i)*exp((0.38647089922278+0.498103150727728i)*(-h))+(-0.000109033595304473-0.000280438809942974i)*exp((0.38647089922278-0.498103150727728i)*(-h))+(-0.000662208332216968+1.885924926554e-05i)*exp((0.0826064596131552+0i)*(-h))+(-4.93585459569566e-05+2.54845829438135e-05i)*exp((0.302488977096926+1.59863755174924i)*(-h))+(-5.76658146064515e-05-1.97491274309026e-05i)*exp((0.302488977096926-1.59863755174924i)*(-h))+(7.59482149443231e-05-0.000182055703403266i)*exp((0.141236791360524+2.68878853883752i)*(-h))+(7.11958956656853e-05+0.000193357280108008i)*exp((0.141236791360524-2.68878853883752i)*(-h))+(-0.000472731694821564-1.04461302702699e-05i)*exp((0.148871530285203+3.14159265358979i)*(-h))

(9)

Really,

Table 3. Calculation of the the Total reserves (includes gold, current US$) for the period 2006-2021 using the formula (9)

h	Year	Calculated by the formula (9)	Tabular data [17]
1	2006	31456871274.6125+8.71816037152894i	31456871274.5685+0i
2	2007	34907225299.1869+144.282565695932i	34907225299.1543+0i
3	2008	37021634956.7652+70.8907625661232i	37021634956.8126+0i
4	2009	41608025692.2249+147.318584933877i	41608025692.2174+0i
5	2010	42482660898.3219+40.1064688542392i	42482660898.3128+0i
6	2011	40283016690.7104-17.738533935044i	40283016690.7132+0i
7	2012	44884691026.5856-6.58282800251618i	44884691026.5825+0i
8	2013	56217652210.6347+6.02839136356488i	56217652210.6233+0i
9	2014	54495067818.3825+3.49366731243208i	54495067818.3817+0i
10	2015	64490290734.1547+6.45103019056842i	64490290734.1553+0i
11	2016	85725304288.2406-3.72644196636975i	85725304288.2449+0i
12	2017	147976372277.273+38.8756654504687i	147976372277.252+0i
13	2018	142511752519.547-39.3274988080375i	142511752519.564+0i
14	2019	149855634729.53+51.0203330339864i	149855634729.53+0i
15	2020	166125554207.113-62.5467337630689i	166125554207.071+0i
16	2021	173617578519.948-206.022833276074i	173617578519.974+0i

We show that the numerical sequence

{ 156264095664.643 , 190183800884.018 , 236816485762.988 , 207434296805.33 ,209069940963.177, 229562733398.948 , 208857719320.649 , 211685616592.931 , 209358834156.329 , 188033050459.881, 196272068576.338 , 218628940951.675 , 249000540729.179 , 252548179964.897 , 245974558654.043, 281777887121.451}

A numerical series characterizing the Domestic credit to private sector (% of GDP) for the period 2006-2021, can be interpolated using the W3 function

W3= (-1.11286419231551e-11-1.65831073118375e-25i)*exp((1.63686601094737+3.14159265358979i)*h)+(-0.0224096209645087-0.124216842342508i)*exp((0.0581029204425335+2.51356709440627i)*h)+(-0.0224096209645097+0.124216842342501i)*exp((0.0581029204425335-2.51356709440627i)*h)+(-0.118485622327732+0.199647112095123i)*exp((0.0522871316789005+1.41364841867732i)*h)+(-0.11848562232773-0.199647112095124i)*exp((0.0522871316789005-1.41364841867732i)*h)+(0.00475903508416659+7.16102740807415e-17i)*exp((0.464777030244337+0i)*h)+(63.1643391059987-3.40863724086822e-13i)*exp((-0.0170195847346729+0i)*h)+(-35.3044068176495+1.32578166077862e-13i)*exp((-

0.231670941453211+0i)*h)+(-3.8818767719225e-13+6.94528799296032e-14i)*exp((1.63686601094737+3.14159265358979i)*(-h))+(1.16923926194342e-14+3.49819280801391e-15i)*exp((0.0581029204425335+2.51356709440627i)*(-h))+(1.35147542335211e-14-1.18997929684617e-15i)*exp((0.0581029204425335-2.51356709440627i)*(-h))+(-3.7103423507077e-14+2.82089598928257e-14i)*exp((0.0522871316789005+1.41364841867732i)*(-h))+(-3.1397876717099e-14-1.691856733092e-14i)*exp((0.0522871316789005-1.41364841867732i)*(-h))+(-2.18901355951891e-12-3.96264274076699e-14i)*exp((0.464777030244337+0i)*(-h))+(6.92632211550238e-12+2.6619233902651e-13i)*exp((-0.0170195847346729+0i)*(-h))+(-1.05685655540252e-13-4.82045173099856e-15i)*exp((-0.231670941453211+0i)*(-h))

(10)

Really,

Table 4. Calculation of the the Domestic credit to private sector (% of GDP) for the period 2006-2021 using the formula (10)

h	Year	Calculated by the formula (10)	Tabular data [17]
1	2006	33.84079100733+0.0120136779733002i	33.84078931009+0i
2	2007	38.6820167734155+0.0128144090995193i	38.6820115283378+0i
3	2008	43.227039390295-0.0134924398735166i	43.2270471893659+0i
4	2009	44.976435136633+8.66129994392395e-08i	44.976430840195+0i
5	2010	46.3307634966232-6.51925802230835e-07i	46.3307595789495+0i
6	2011	48.3228915618648+4.02098521590233e-07i	48.3228930835879+0i
7	2012	49.4085467044101-0.00747131090611219i	49.4085468212571+0i
8	2013	50.6079122291878-0.0069484191481024i	50.6079084949808+0i
9	2014	49.456726779433-1.80210918188095e-07i	49.4567294568092+0i
10	2015	49.5419821779388-4.49363142251968e-08i	49.5419833795206+0i
11	2016	51.0588051783729-0.0124266664497554i	51.0588043502507+0i
12	2017	50.9067002974145-0.0248509151861072i	50.9067076939694+0i
13	2018	51.3279061810905-2.90572643280029e-07i	51.3279185682014+0i
14	2019	50.2713479427069+0.0671129077672958i	50.2713287650276+0i
15	2020	53.0682296049456-0.216054883785546i	53.0682165114095+0i
16	2021	54.1245985369622+5.27128577232361e-07i	54.12459721+0i

We show that the numerical sequence

{ 156264095664.643 , 190183800884.018 , 236816485762.988 , 207434296805.33 ,209069940963.177, 229562733398.948 , 208857719320.649 , 211685616592.931 , 209358834156.329 , 188033050459.881, 196272068576.338 , 218628940951.675 , 249000540729.179 , 252548179964.897 , 245974558654.043, 281777887121.451}

A numerical series characterizing the Tax revenue (% of GDP) for the period 2006-2021, can be interpolated using the W4 function

W4= (6.47354432660991+11.0488935587669i)*
exp((0.0534575366944603+0.0182435979900091i)*h)+(6.47354432660991-
11.0488935587669i)*exp((0.0534575366944603-0.0182435979900091i)*h)+(-
0.44320441039995-0.709309991769248i)*exp((-
0.199493130614909+1.18354186613629i)*h)+(-
0.443204410399952+0.709309991769244i)*exp((-0.199493130614909-
1.18354186613629i)*h)+(-0.0617203418291508-0.0762317556522038i)*exp((-
0.0541512274491137+1.960913543602i)*h)+(-
0.061720341829149+0.0762317556522013i)*exp((-0.0541512274491137-
1.960913543602i)*h)+(-0.0363010635419727+0.142618731633907i)*exp((-
0.114746461318418+2.93762410702115i)*h)+(-0.0363010635419746-
0.142618731633907i)*exp((-0.114746461318418-2.93762410702115i)*h)+(-
7.2622355085343e-15+1.82649008471999e-
13i)*exp((0.0534575366944603+0.0182435979900091i)*(-
h))+(6.23019406362283e-14-1.79937580739315e-
13i)*exp((0.0534575366944603-0.0182435979900091i)*(-
h))+(1.98843892792918e-17+9.57409552978966e-17i)*exp((-
0.199493130614909+1.18354186613629i)*(-h))+(-2.96834619313255e-17-
1.44772556482444e-16i)*exp((-0.199493130614909-1.18354186613629i)*(-
h))+(-1.39066390085142e-15+5.7622435576484e-16i)*exp((-
0.0541512274491137+1.960913543602i)*(-h))+(4.20258663301714e-
16+3.82527978827123e-16i)*exp((-0.0541512274491137-1.960913543602i)*(-
h))+(2.09381020968528e-16-2.61305846035374e-16i)*exp((-
0.114746461318418+2.93762410702115i)*(-h))+(-1.71960899647705e-16+
3.97957145032936e-16i)*exp((-0.114746461318418-2.93762410702115i)*(-h))

(11)

Really,

Table 5. Calculation of the the Tax revenue (% of GDP) for the period 2006-2021 using the formula (11)

h	Year	Calculated by the formula (11)	Tabular data [17]
1	2006	14.2222302668565+0.00526720865790139i	14.2222295228868+0i
2	2007	14.6116924390958+0.0058031952992606 3i	14.6116900671662+0i
3	2008	13.6730891871061-0.00626857111754494i	13.6730928105351+0i
4	2009	13.5702239682228-3.88424119784903e-07i	13.5702219344919+0i
5	2010	13.6507590983815-1.36498471373092e-07i	13.6507574751995+0i
6	2011	14.5202628316582+7.61590722812844e-08i	14.5202634059379+0i
7	2012	14.928763406471-0.00258332851682945i	14.9287634461197+0i
8	2013	15.081162322086-0.00231668709213788i	15.0811610763803+0i
9	2014	14.4296532281321-1.6025232418837e-08i	14.4296540586861+0i
10	2015	14.7695600598109-2.29848551719369e-08i	14.7695604553833+0i
11	2016	14.9127778140388-0.00391805761781345i	14.9127775532102+0i
12	2017	15.0055262196038-0.00783509401961928i	15.0055285503497+0i
13	2018	14.8333990527901+5.80282501633222e-08i	14.8334032865248+0i
14	2019	14.7687766961866+0.0245882303873217i	14.7687696689181+0i
15	2020	14.3389122396067-0.0819978225465487i	14.3389072697754+0i
16	2021	14.1278946238742+2.24950603616714e-07i	14.12789415+0i

We show that the numerical sequence

{ 156264095664.643 , 190183800884.018 , 236816485762.988 , 207434296805.33 ,209069940963.177, 229562733398.948 , 208857719320.649 , 211685616592.931 , 209358834156.329 , 188033050459.881, 196272068576.338 , 218628940951.675 , 249000540729.179 , 252548179964.897 , 245974558654.043, 281777887121.451}

A numerical series characterizing the Exports of goods and services (% of GDP) for the period 2006-2021, can be interpolated using the W5 function

W5= (0.000564327938550094+1.77741708611761e-17i)*exp((0.539980378541124+3.14159265358979i)*h)+(1.07791334992836+0.809268337705725i)*exp((-0.0691539627313413+1.94928935547074i)*h)+(1.0779133499284-0.809268337705759i)*exp((-0.0691539627313413-1.94928935547074i)*h)+(111.015433138654-9.01315144817572e-13i)*exp((-0.0310078246381622+0i)*h)+(0.153932725626287+60.7865084067079i)*exp((-0.280573487384481+0.304329928053488i)*h)+(0.153932725625769-60.7865084067077i)*exp((-0.280573487384481-0.304329928053488i)*h)+(-3.5723994573109-3.45487921491889e-15i)*exp((-0.174886377797788+3.14159265358979i)*h)+(63.460194407641-4.24232410482516e-13i)*exp((-

1.35885411345169+3.14159265358979i)*h)+(1.09061398028264e-12+7.9064370584333e-14i)*exp((0.539980378541124+3.14159265358979i)*(-h))+(-1.59842788676672e-14+1.38788769170224e-14i)*exp((-0.0691539627313413+1.94928935547074i)*(-h))+(-6.758818505777e-15-2.82043711669442e-15i)*exp((-0.0691539627313413-1.94928935547074i)*(-h))+(-1.90424340414188e-12+5.34871807852536e-13i)*exp((-0.0310078246381622+0i)*(-h))+(-1.48767792049722e-15+1.10666007753512e-15i)*exp((-0.280573487384481+0.304329928053488i)*(-h))+(2.01827869579114e-15+2.68405957503508e-15i)*exp((-0.280573487384481-0.304329928053488i)*(-h))+(1.03396348064515e-14-1.24128425394845e-15i)*exp((-0.174886377797788+3.14159265358979i)*(-h))+(1.51760740002927e-22-5.81491973282571e-23i)*exp((-1.35885411345169+3.14159265358979i)*(-h))

(12)

Really,

Table 6. Calculation of the the Exports of goods and services (% of GDP) for the period 2006-2021 using the formula (12)

h	Year	Calculated by the formula (12)	Tabular data [17]
1	2006	64.8754237687392+0.00230932363634512i	64.875423442478+0i
2	2007	66.1007702604795+0.00262815222421108i	66.1007691863238+0i
3	2008	62.9516464071446-0.00291234645040228i	62.9516480907081+0i
4	2009	58.345430770976+1.42732756083092e-09i	58.3454298084121+0i
5	2010	65.5430060794885+2.5657620646l578e-10i	65.5430054071382+0i
6	2011	70.8218669757848+1.46548361987242e-10i	70.8218671927368+0i
7	2012	75.6461865513288-0.000893208703199136i	75.6461865650325+0i
8	2013	76.0583820311279-0.000772426694054179i	76.0583816157677+0i
9	2014	81.9542743169347+9.87814517683372e-12i	81.9542745743788+0i
10	2015	80.5587779846895+1.17831821556946e-10i	80.5587781149995+0i
11	2016	79.1070767131986-0.00123535714015153i	79.1070766309635+0i
12	2017	79.0271387632788-0.00247025031328505i	79.0271394981121+0i
13	2018	76.9435745119829+1.06051184327327e-10i	76.9435759590934+0i
14	2019	73.8797829008423+0.00900840450707847i	73.8797803262645+0i
15	2020	69.9487734242621-0.0311200168297073i	69.9487715380852+0i
16	2021	72.7316751598748-2.12040052530171e-09i	72.731674990685+0i

We show that the numerical sequence

{ 156264095664.643 , 190183800884.018 , 236816485762.988 , 207434296805.33 ,209069940963.177, 229562733398.948 , 208857719320.649 , 211685616592.931 , 209358834156.329 , 188033050459.881, 196272068576.338 , 218628940951.675 , 249000540729.179 , 252548179964.897 , 245974558654.043, 281777887121.451}

A numerical series characterizing the Gross fixed capital formation (% of GDP) for the period 2006-2021, can be interpolated using the W6 function

W6= (0.0227672173815348-0.0266401702150428i)*exp((0.153891199201617+2.60743089821493i)*h)+(0.0227672173815345+0.0266401702150424i)*exp((0.153891199201617-2.60743089821493i)*h)+(-0.0464287910496266+0.0561418244846179i)*exp((0.15873875977912+1.67444582690648i)*h)+(-0.0464287910496266-0.056141824484618i)*exp((0.15873875977912-1.67444582690648i)*h)+(0.00227130316441172-4.23750921786244e-16i)*exp((0.457415969277387+0i)*h)+(25.9119024053247-3.14694059289042e-13i)*exp((-0.00306382503867923+0i)*h)+(18.7039675478728-7.66178285252334e-13i)*exp((-0.476675952286041+0i)*h)+(-24.9170487485134+2.65022639546391e-14i)*exp((-1.03275766060989+0i)*h)+(1.7690247143252e-15-2.85696574958527e-15i)*exp((0.153891199201617+2.60743089821493i)*(-h))+(1.32879969667668e-15+4.02833390905028e-15i)*exp((0.153891199201617-2.60743089821493i)*(-h))+(7.72673463491903e-15-8.11646697770264e-15i)*exp((0.15873875977912+1.67444582690648i)*(-h))+(8.89585790660035e-15+9.71097975800972e-15i)*exp((0.15873875977912-1.67444582690648i)*(-h))+(-2.17073230708196e-11+7.59109422077889e-13i)*exp((0.457415969277387+0i)*(-h))+(-1.55615191787735e-11+2.99049264081748e-13i)*exp((-0.00306382503867923+0i)*(-h))+(-8.21161440818068e-15+3.12533797290673e-16i)*exp((-0.476675952286041+0i)*(-h))+(2.40955457860892e-20-1.11136212337788e-21i)*exp((-1.03275766060989+0i)*(-h))

(13)

Really,

Table 7. Calculation of the the Gross fixed capital formation (% of GDP) for the period 2006-2021 using the formula (13)

h	Year	Calculated by the formula (13)	Tabular data [17]
1	2006	28.4436945071411+0.00101247982525032i	28.4436943640978+0i
2	2007	29.9332333412748+0.00119012807878719i	29.9332328548558+0i
3	2008	29.2484025758122-0.00135311035291215i	29.2484033580188+0i
4	2009	27.614811598833+3.1469790747749e-09i	27.614811143256+0i
5	2010	27.1488180461644+8.39545758696515e-10i	27.1488177676709+0i
6	2011	26.7548640684296+4.22987847770119e-10i	26.7548641503888+0i
7	2012	26.1553684649187-0.00030883178089272i	26.1553684696565+0i
8	2013	25.3598825951125-0.000257543172851862i	25.3598824566218+0i
9	2014	25.4036226647292+8.26830143850208e-11i	25.4036227445288+0i
10	2015	26.5380472258584+3.48893187140596e-10i	26.5380472687854+0i
11	2016	24.9426449531553-0.00038950452641303i	24.9426449272265+0i
12	2017	24.9162790646965-0.000778826161092417i	24.9162792963763+0i
13	2018	26.2998859723599+5.1452358345073e-10i	26.2998864669868+0i
14	2019	27.0676438915828+0.00330040822024142i	27.0676429483356+0i
15	2020	26.5474209799795-0.0118107423832706i	26.5474202641348+0i
16	2021	25.9697913062092-7.22612337110552e-09i	25.9697912458001+0i

We show that the numerical sequence

{ 156264095664.643 , 190183800884.018 , 236816485762.988 , 207434296805.33 ,209069940963.177, 229562733398.948 , 208857719320.649 , 211685616592.931 , 209358834156.329 , 188033050459.881, 196272068576.338 , 218628940951.675 , 249000540729.179 , 252548179964.897 , 245974558654.043, 281777887121.451}

A numerical series characterizing the Imports of goods and services (% of GDP) for the period 2006-2021, can be interpolated using the W7 function

W7= (5.56950420446098e-05+4.55228404034679e-18i)*exp((0.697866787946354+3.14159265358979i)*h)+(0.37278809317648+1.09598475776607i)*exp((-0.0251268998858734+1.85854853920579i)*h)+(0.372788093176411-1.09598475776608i)*exp((-0.0251268998858734-1.85854853920579i)*h)+(87.6614221108597-1.56499578622729e-13i)*exp((-0.0194285537886068+0i)*h)+(9.62147217019167+38.6524252239305i)*exp((-0.299012347922366+0.38369204493573i)*h)+(9.62147217019165-38.6524252239304i)*exp((-0.299012347922366-0.38369204493573i)*h)+(-7.6541329073628+7.65050084921872e-14i)*exp((-0.300956893491084+3.14159265358979i)*h)+(73.5896002506478+6.94028429406515e-13i)*exp((-

1.35390735130143+3.14159265358979i)*h)+(7.5818446552618e-13-3.85151205422046e-13i)*exp((0.697866787946354+3.14159265358979i)*(-h))+(3.32915372920936e-14+3.61739045660739e-14i)*exp((-0.0251268998858734+1.85854853920579i)*(-h))+(-1.01619833088242e-14-2.73934124512079e-14i)*exp((-0.0251268998858734-1.85854853920579i)*(-h))+(3.7469562621161e-13+1.21416054109123e-13i)*exp((-0.0194285537886068+0i)*(-h))+(-1.42912949761041e-15+1.52938391092106e-15i)*exp((-0.299012347922366+0.38369204493573i)*(-h))+(-5.00852736837461e-16-1.24340464031832e-15i)*exp((-0.299012347922366-0.38369204493573i)*(-h))+(-9.62194223879264e-17-5.0628211138638e-16i)*exp((-0.300956893491084+3.14159265358979i)*(-h))+(5.86475089368583e-23-1.32625762669412e-22i)*exp((-1.35390735130143+3.14159265358979i)*(-h))

(14)

Really,

Table 8. Calculation of the the Imports of goods and services (% of GDP) for the period 2006-2021 using the formula (14)

h	Year	Calculated by the formula (14)	Tabular data [17]
1	2006	62.1529584886721+0.000443904669101236i	62.1529584259566+0i
2	2007	63.6782483399267+0.000538938974664905i	63.6782481196559+0i
3	2008	60.7908506677726-0.000628667140494323i	60.7908510312007+0i
4	2009	54.4518149397733+7.70189875315374e-09i	54.4518147241498+0i
5	2010	62.4859062430261+2.26047158447212e-09i	62.4859061276726+0i
6	2011	67.0409516609622+1.16859929987825e-09i	67.040951691926+0i
7	2012	70.8826700093587-0.000106781853000241i	70.8826700109956+0i
8	2013	70.3640354800895-8.58676186160911e-05i	70.3640354339119+0i
9	2014	75.6207075789414+2.95794467748191e-10i	75.6207076036768+0i
10	2015	74.6168853517677+1.08289244847649e-09i	74.6168853659096+0i
11	2016	71.4791907226267-0.000122807892270435i	71.4791907144509+0i
12	2017	71.5055129218383-0.000245546439014171i	71.5055129948816+0i
13	2018	71.0049471941602+1.59301181814594e-09i	71.0049473632267+0i
14	2019	67.8912436819297+0.00120917610648498i	67.8912433363527+0i
15	2020	63.1995485041477-0.00448245710226144i	63.1995482324718+0i
16	2021	69.770078346136-2.17962719932157e-08i	69.7700783245706+0i

We show that the numerical sequence

{ 156264095664.643 , 190183800884.018 , 236816485762.988 , 207434296805.33 ,209069940963.177, 229562733398.948 , 208857719320.649 , 211685616592.931 , 209358834156.329 , 188033050459.881, 196272068576.338 , 218628940951.675 , 249000540729.179 , 252548179964.897 , 245974558654.043, 281777887121.451}

A numerical series characterizing the Manufacturing, value added (% of GDP) for the period 2006-2021, can be interpolated using the W8 function

W8= (22.029297933406+5.83421681844685e-15i)*exp((0.00241152577761205+0i)*h)+(0.48188257172263+0.153284336677573i)*exp((0.0294179134069685+0.569197973092729i)*h)+(0.48188257172263-0.153284336677572i)*exp((0.0294179134069685-0.569197973092729i)*h)+(-0.983181817380737+0.117476253527492i)*exp((-0.182137874689391+1.58915323599846i)*h)+(-0.983181817380737-0.117476253527492i)*exp((-0.182137874689391-1.58915323599846i)*h)+(-0.103870670922669-0.0458995994038577i)*exp((0.0271085402731682+2.41252205227898i)*h)+(-0.103870670922669+0.0458995994038577i)*exp((0.0271085402731682-2.41252205227898i)*h)+(-0.633552158171925+5.62276795579506e-17i)*exp((-0.340667449876329+3.14159265358979i)*h)+(4.72081524672741e-12-5.97349245714995e-15i)*exp((0.00241152577761205+0i)*(-h))+(7.61074528314341e-15-1.08699864970953e-14i)*exp((0.0294179134069685+0.569197973092729i)*(-h))+(8.01045546687131e-15+1.03998130958951e-14i)*exp((0.0294179134069685-0.569197973092729i)*(-h))+(8.50373146447491e-17+4.36183454403323e-18i)*exp((-0.182137874689391+1.58915323599846i)*(-h))+(8.3780577499406e-17-1.25389041350346e-18i)*exp((-0.182137874689391-1.58915323599846i)*(-h))+(2.13860964677823e-15-1.65535577283453e-15i)*exp((0.0271085402731682+2.41252205227898i)*(-h))+(2.62947161463233e-15+1.5403935414554e-15i)*exp((0.0271085402731682-2.41252205227898i)*(-h))+(4.9902944255288e-18+4.64345910893941e-19i)*exp((-0.340667449876329+3.14159265358979i)*(-h)) (15)

Really,

Table 9. Calculation of the the Manufacturing, value added (% of GDP) for the period 2006-2021 using the formula (15)

h	Year	Calculated by the formula (15)	Tabular data [17]
1	2006	23.255329221545+0.000194626721514575i	23.2553291940453+0i
2	2007	23.1985321501317+0.000244060926723385i	23.1985320503802+0i
3	2008	21.9661079822969-0.000292076845316016i	21.9661081511603+0i
4	2009	20.3629449320131+1.61013328156269e-08i	20.3629448299581+0i
5	2010	20.9596606427872+5.54120298041093e-09i	20.9596605950106+0i
6	2011	22.1069570175665+3.07542588953013e-09i	22.1069570292663+0i
7	2012	21.9438080344353-3.69255066529049e-05i	21.9438080349981+0i
8	2013	21.9633963663335-2.86212951065621e-05i	21.9633963509318+0i
9	2014	23.7144843893305+9.80806201024715e-10i	23.714484396997+0i
10	2015	23.9216773155496+3.25886195952457e-09i	23.9216773202104+0i
11	2016	24.0310927582147-3.87148656756182e-05i	24.0310927556348+0i
12	2017	23.5333296709186-7.74038001827426e-05i	23.5333296939408+0i
13	2018	22.6748510398638+4.7432049022437e-09i	22.6748510976552+0i
14	2019	22.6170846874609+0.000443024395762134i	22.6170845608511+0i
15	2020	21.352128824614-0.00170124112133621i	21.3521287215165+0i
16	2021	21.0803172349688-6.15668588439952e-08i	21.0803172272801+0i

We show that the numerical sequence

{ 156264095664.643 , 190183800884.018 , 236816485762.988 , 207434296805.33 ,209069940963.177, 229562733398.948 , 208857719320.649 , 211685616592.931 , 209358834156.329 , 188033050459.881, 196272068576.338 , 218628940951.675 , 249000540729.179 , 252548179964.897 , 245974558654.043, 281777887121.451}

A numerical series characterizing the Industry (including construction), value added (% of GDP) for the period 2006-2021, can be interpolated using the W9 function

W9= (0.0431023408498437-0.0254079718704333i)*exp((0.195379557136675+0.683156400944376i)*h)+(0.0431023408498435+0.0254079718704332i)*exp((0.195379557136675-0.683156400944376i)*h)+(34.0051779392045+1.59515031551191e-15i)*exp((-0.00328251584256853+0i)*h)+(-0.0262432647403303-2.10955040510377e-16i)*exp((0.0255518051064831+3.14159265358979i)*h)+(0.00190090567904728-0.0750411878904048i)*exp((0.0559259606052691+2.27917889661253i)*h)+(0.0019009056790469+0.0750411878904041i)*exp((0.0559259606052691-2.27917889661253i)*h)+(-0.260981264229525-0.0938163747951525i)*exp((-0.0317561029470434+1.55617664187075i)*h)+(-0.260981264229528+0.0938163747951491i)*exp((-0.0317561029470434-

1.55617664187075i)*h)+(-3.28429067128987e-15-1.65884437959032e-16i)*exp((0.195379557136675+0.683156400944376i)*(-h))+(-3.52837505181331e-15-1.05149469159457e-15i)*exp((0.195379557136675-0.683156400944376i)*(-h))+(-1.17022229352591e-12-1.4648982339277e-15i)*exp((-0.00328251584256853+0i)*(-h))+(-2.77087522071724e-16+2.01496513705356e-16i)*exp((0.0255518051064831+3.14159265358979i)*(-h))+(2.11120148431157e-15+6.83763512339784e-15i)*exp((0.0559259606052691+2.27917889661253i)*(-h))+(1.88299234043786e-15-5.54131809269316e-15i)*exp((0.0559259606052691-2.27917889661253i)*(-h))+(1.16125479850514e-15-4.35415885293229e-15i)*exp((-0.0317561029470434+1.55617664187075i)*(-h))+(-6.89912838066162e-16+7.04829755001169e-15i)*exp((-0.0317561029470434-1.55617664187075i)*(-h))

(16)

Really,

Table 10. Calculation of the the Industry (including construction), value added (% of GDP) for the period 2006-2021 using the formula (16)

h	Year	Calculated by the formula (16)	Tabular data [17]
1	2006	34.3332159997858+8.53422532554227e-05i	34.3332159877379+0i
2	2007	34.1827366612427+0.000110540369471277i	34.1827366160621+0i
3	2008	33.6576333790193-0.000135681079435705i	33.6576334575029+0i
4	2009	32.9876945192065+3.4888706395815e-08i	32.9876944708572+0i
5	2010	33.1707518849696+1.3502265160611e-08i	33.1707518651997+0i
6	2011	33.6505738174804+8.18191636036882e-09i	33.6505738219241+0i
7	2012	32.9223275040296-1.2782183012175e-05i	32.9223275042358+0i
8	2013	32.6460705113814-9.51628085433038e-06i	32.6460705062336+0i
9	2014	33.8393507587904+3.17470084115547e-09i	33.8393507611777+0i
10	2015	33.7818228029796+9.93020717788815e-09i	33.7818228045362+0i
11	2016	33.4093272855217-1.21870995820265e-05i	33.4093272846707+0i
12	2017	32.7082970055346-2.43634582449438e-05i	32.7082970127827+0i
13	2018	31.7708543942545+1.39174595006984e-08i	31.7708544140094+0i
14	2019	31.5302362650738+0.000162362634319493i	31.5302362186778+0i
15	2020	30.6869294509522-0.000645790217109945i	30.6869294118492+0i
16	2021	30.267787394145-1.73603699857034e-07i	30.2677873914533+0i

We show that the numerical sequence

{ 156264095664.643 , 190183800884.018 , 236816485762.988 , 207434296805.33 ,209069940963.177, 229562733398.948 , 208857719320.649 , 211685616592.931 , 209358834156.329 , 188033050459.881, 196272068576.338 , 218628940951.675 , 249000540729.179 , 252548179964.897 , 245974558654.043, 281777887121.451}

A numerical series characterizing the Inflation, GDP deflator (annual %) for the period 2006-2021, can be interpolated using the W10 function

W10= (0.387262216915382+0i)*exp((0.139347146080267+0i)*h)+(-0.0216100088579247-0.0541366429601801i)*exp((0.16584327208428+1.011933064488i)*h)+(-0.0216100088579244+0.0541366429601802i)*exp((0.16584327208428-1.011933064488i)*h)+(-0.249084238553146-3.26182161274731e-16i)*exp((-0.0577771715870325+3.14159265358979i)*h)+(-2.36483728744204+0.999876709973698i)*exp((-0.273577066099693+2.48363461701414i)*h)+(-2.36483728744204-0.999876709973702i)*exp((-0.273577066099693-2.48363461701414i)*h)+(-4.08002705886314-0.545140091508127i)*exp((-0.356919632544248+1.07902347605488i)*h)+(-4.08002705886314+0.545140091508125i)*exp((-0.356919632544248-1.07902347605488i)*h)+(-3.69769787669255e-15+1.06106988820008e-16i)*exp((0.139347146080267+0i)*(-h))+(8.97310880826768e-15-2.25158520994633e-14i)*exp((0.16584327208428+1.011933064488i)*(-h))+(1.12141122266617e-14+2.25846938468407e-14i)*exp((0.16584327208428-1.011933064488i)*(-h))+(-2.36078286300338e-15-6.93576214331149e-17i)*exp((-0.0577771715870325+3.14159265358979i)*(-h))+(-3.92142319270527e-17-6.59781182088562e-18i)*exp((-0.273577066099693+2.48363461701414i)*(-h))+(-3.9405123116877e-17+3.7186289406808e-18i)*exp((-0.273577066099693-2.48363461701414i)*(-h))+(-9.63488983008377e-18-3.01761427405519e-17i)*exp((-0.356919632544248+1.07902347605488i)*(-h))+(-8.15228538552292e-18+1.46003728083457e-17i) *exp((-0.356919632544248-1.07902347605488i)*(-h))

(17)

Really,

Table 11. Calculation of the the Inflation, GDP deflator (annual %) for the period 2006-2021 using the formula (17)

h	Year	Calculated by the formula (17)	Tabular data [17]
1	2006	0.654105341798315+8.85798670789259e-05i	0.654105320869675+0i
2	2007	3.54038190172121+0.000186671999832907i	3.5403818069683+0i
3	2008	2.00958098501258+0.000148064360339133i	2.00958123723267+0i
4	2009	2.58782079600876+0.000360201727824241i	2.58782068092624+0i
5	2010	-1.42531401896661+5.24396350446154e-05i	-1.42531399212487+0i
6	2011	-0.0205720031507365+2.70130399827023e-05i	-0.02057195800937+0i
7	2012	1.45092108515328-3.5224931105797e-05i	1.45092107055808+0i
8	2013	1.36470476078817+4.58690557162789e-05i	1.36470473782452+0i
9	2014	2.57853631308956+1.53302472687247e-06i	2.57853631569476+0i
10	2015	0.992276149068517+1.88589806007612e-05i	0.992276160290274+0i
11	2016	1.14145061369384+2.31105315062808e-05i	1.14145060120347+0i
12	2017	1.30694433643102+5.45405184440226e-05i	1.30694431650136+0i
13	2018	2.56757393042551+1.81708876172828e-05i	2.56757397075347+0i
14	2019	3.88895346309467+0.00014580359613131i	3.88895344602105+0i
15	2020	4.31840276451226-0.000754125842298024i	4.31840283925935+0i
16	2021	3.33170018039155-0.000368136238229838i	3.3317002737171+0i

We show that the numerical sequence

{ 156264095664.643 , 190183800884.018 , 236816485762.988 , 207434296805.33 ,209069940963.177, 229562733398.948 , 208857719320.649 , 211685616592.931 , 209358834156.329 , 188033050459.881, 196272068576.338 , 218628940951.675 , 249000540729.179 , 252548179964.897 , 245974558654.043, 281777887121.451}

A numerical series characterizing the Gross savings (% of GDP) for the period 2006-2021, can be interpolated using the W11 function

W11= (6.5667316476935e-30-2.02969324442048e-44i)*exp((4.21086723670244+0i)*h)+(0.35668600528298+0.0441111469409092i)*exp((-0.0346766654558432+2.55185262234699i)*h)+(0.356686005282979-0.0441111469409111i)*exp((-0.0346766654558432-2.55185262234699i)*h)+(23.0429955573954-2.16872664100744e-15i)*exp((0.01143545432877+0i)*h)+(2.25903459018979-2.59705955728255i)*exp((-0.19881841124787+0.625229910594799i)*h)+(2.25903459018979+2.59705955728255i)*exp((-0.19881841124787-0.625229910594799i)*h)+(0.801350640426187+1.0086617360756i)*exp((-0.246563775757608+1.79599690354002i)*h)+(0.801350640426184-1.0086617360756i)*exp((-0.246563775757608-

1.79599690354002i)*h)+(1.81973658557304e-12-5.14744723365602e-13i)*exp((4.21086723670244+0i)*(-h))+(4.69082013976794e-15+3.14292179964628e-15i)*exp((-0.0346766654558432+2.55185262234699i)*(-h))+(2.7699687700553e-15-3.09325354936903e-15i)*exp((-0.0346766654558432-2.55185262234699i)*(-h))+(3.47887759928766e-12+3.57072895504101e-15i)*exp((0.01143545432877+0i)*(-h))+(5.10717209234061e-16-2.94433215980368e-16i)*exp((-0.19881841124787+0.625229910594799i)*(-h))+(4.07173638960767e-16+1.90509056770277e-16i)*exp((-0.19881841124787-0.625229910594799i)*(-h))+(1.31432863163958e-16-8.03030057762307e-17i)*exp((-0.246563775757608+1.79599690354002i)*(-h))+(1.43085555571015e-16 +9.15509429156022e-17i)*exp((-0.246563775757608 -1.79599690354002i)*(-h))

(18)

Really,

Table 12. Calculation of the the Gross savings (% of GDP) for the period 2006-2021 using the formula (18)

h	Year	Calculated by the formula (18)	Tabular data [17]
1	2006	26.3663607519896+0.000209505509602318i	26.3663606951784+0i
2	2007	27.8295008037141+0.000369206222087112i	27.8295006274918+0i
3	2008	27.1074464115145+0.000417458942410618i	27.1074469334495+0i
4	2009	23.2832061470858+0.000670800950166207i	23.2832059734177+0i
5	2010	22.6566431863676+0.00015492436147818i	22.6566432862838+0i
6	2011	22.4606373248167+6.92981311580506e-05i	22.4606374472755+0i
7	2012	24.0235051965434-0.000103068886307533i	24.0235051475921+0i
8	2013	24.1106808624105+0.000159951499745428i	24.1106807865193+0i
9	2014	25.3104533714716+1.23629350236121e-05i	25.3104533771396+0i
10	2015	27.093775023895+4.98258225194585e-05i	27.0937750624148+0i
11	2016	26.3493691384125+9.70920512711707e-05i	26.3493690967401+0i
12	2017	27.2757680245717+0.000201612040590209i	27.2757679429422+0i
13	2018	26.9474976496288+8.24418002156269e-05i	26.9474977490713+0i
14	2019	26.9533056809007+0.000469789645407816i	26.9533056724369+0i
15	2020	27.4245167215311-0.00143994168048547i	27.4245169560101+0i
16	2021	28.1690248074019-0.00114663827236363i	28.1690250732006+0i

We show that the numerical sequence

{ 156264095664.643 , 190183800884.018 , 236816485762.988 , 207434296805.33 ,209069940963.177, 229562733398.948 , 208857719320.649 , 211685616592.931 , 209358834156.329 , 188033050459.881, 196272068576.338 , 218628940951.675 , 249000540729.179 , 252548179964.897 , 245974558654.043, 281777887121.451}

A numerical series characterizing the Population, total for the period 2006-2021, can be interpolated using the W12 function

W12= (-2.28043326281985e-07-4.31404711856892e-07i)*exp((1.63863433931104+1.91512762532189i)*h)+(-2.28043326281869e-07+4.31404711856686e-07i)*exp((1.63863433931104-1.91512762532189i)*h)+(527.189726621648-2392.04307723043i)*exp((-0.0662945051495291+2.00886884543756i)*h)+(527.189726625815+2392.04307722871i)*exp((-0.0662945051495291-2.00886884543756i)*h)+(10279607.4891106-1.90967567243394e-07i)*exp((0.00266436293121959+0i)*h)+(-75096.7202454565-25077.9202599205i)*exp((-0.184124252665825+0.496328516225354i)*h)+(-75096.720245449+25077.9202599232i)*exp((-0.184124252665825-0.496328516225354i)*h)+(-79774.6680605452+1.79332654906362e-07i)*exp((-1.47616572906911+3.14159265358979i)*h)+(1.82231604276544e-06+1.97642794995043e-06i)*exp((1.63863433931104+1.91512762532189i)*(-h))+(2.12623611214944e-06-1.66974185600369e-06i)*exp((1.63863433931104-1.91512762532189i)*(-h))+(5.55332686899707e-10+4.55775604381547e-09i)*exp((-0.0662945051495291+2.00886884543756i)*(-h))+(1.63618597970869e-09-4.52150718077917e-09i)*exp((-0.0662945051495291-2.00886884543756i)*(-h))+(5.95772738524479e-06+1.99872765153066e-07i)*exp((0.00266436293121959+0i)*(-h))+(4.58247728355498e-09+1.77653836788229e-09i)*exp((-0.184124252665825+0.496328516225354i)*(-h))+(4.60746848121787e-09-1.33846679542625e-09i)*exp((-0.184124252665825-0.496328516225354i)*(-h))+(2.57339910314018e-17+1.32069296604225e-18i)*exp((-1.47616572906911+3.14159265358979i)*(-h))

(19)

Really,

Table 13. Calculation of the the Population, total for the period 2006-2021 using the formula (19)

h	Year	Calculated by the formula (19)	Tabular data [17]
1	2006	10238905.0000001+0.000450902145843815i	10238905+0i
2	2007	10298828.0000004+0.000824306773560069i	10298828+0i
3	2008	10384602.9999989+0.00097487485153347i	10384603+0i
4	2009	10443936.0000004+0.0014523293335688i	10443936+0i
5	2010	10474409.9999997+0.000380814787366075i	10474410+0i
6	2011	10496087.9999997+0.000177895485635196i	10496088+0i
7	2012	10510785.0000001-0.000295390698645573i	10510785+0i
8	2013	10514272.0000002+0.000486435077782574i	10514272+0i
9	2014	10525347+4.13244079817211e-05i	10525347+0i
10	2015	10546058.9999999+0.000148046681013434i	10546059+0i
11	2016	10566332.0000001+0.000309259146221274i	10566332+0i
12	2017	10594438.0000003+0.00064384667968165i	10594438+0i
13	2018	10629927.9999997+0.000237991386526217i	10629928+0i
14	2019	10671870+0.0012380948689591 4i	10671870+0i
15	2020	10697857.9999994-0.00365390686208587i	10697858+0i
16	2021	10505771.9999992-0.0032712478953414 7i	10505772+0i

We show that the numerical sequence

{ 156264095664.643 , 190183800884.018 , 236816485762.988 , 207434296805.33 ,209069940963.177, 229562733398.948 , 208857719320.649 , 211685616592.931 , 209358834156.329 , 188033050459.881, 196272068576.338 , 218628940951.675 , 249000540729.179 , 252548179964.897 , 245974558654.043, 281777887121.451}

A numerical series characterizing the Population growth (annual %) for the period 2006-2021, can be interpolated using the W13 function

W13= (-6.60067129970724e-21-8.92886623206803e-37i)*exp((2.95876611156599+0i)*h)+(1.68966909467607e-05+6.80723490845694e-20i)*exp((0.527209032575118+3.14159265358979i)*h)+(-0.0688888412882421+5.62298080897221e-16i)*exp((-0.384427329699414+3.14159265358979i)*h)+(0.0656069649884286-0.00673774932985758i)*exp((-0.125665751617054+1.92470093364163i)*h)+(0.0656069649884286+0.00673774932985747i)*exp((-0.125665751617054-1.92470093364163i)*h)+(0.0512525234779563+1.14828993088437e-17i)*exp((0.140635246333016+0i)*h)+(-0.420764639574251-0.968999257708866i)*exp((-0.369010616420638+0.54277412039091i)*h)+(-

0.420764639574251+0.968999257708866i)*exp((-0.369010616420638-0.54277412039091i)*h)+(4.09572566439699e-14-5.89548258188306e-15i)*exp((2.95876611156599+0i)*(-h))+(4.36727421621757e-15-9.23046590421825e-16i)*exp((0.527209032575118+3.14159265358979i)*(-h))+(4.10023536919077e-18-1.0630149718968e-19i)*exp((-0.384427329699414+3.14159265358979i)*(-h))+(4.94820260067536e-17+2.2828273811324e-17i)*exp((-0.125665751617054+1.92470093364163i)*(-h))+(4.70197654081127e-17-6.02463831949721e-19i)*exp((-0.125665751617054-1.92470093364163i)*(-h))+(-1.30448599860001e-16-5.88093648098157e-17i)*exp((0.140635246333016+0i)*(-h))+(-5.43480899225305e-19-9.10392592322174e-18i)*exp((-0.369010616420638+0.54277412039091i)*(-h))+(-8.90276771175411e-19+8.88293783529607e-18i)*exp((-0.369010616420638-0.54277412039091i)*(-h)) (20)

Really,

Table 14. Calculation of the the Population growth (annual %) for the period 2006-2021 using the formula (20)

h	Year	Calculated by the formula (20)	Tabular data [17]
1	2006	0.270795916778744+0.00102837586324259i	0.270795629232185+0i
2	2007	0.583543028091749+0.0018202143970894i	0.583542205385113+0i
3	2008	0.829410203748041+0.00209811759297177i	0.829412602993033+0i
4	2009	0.569730234963473+0.00306833595297978i	0.569729451418061+0i
5	2010	0.291361082758733+0.00091936818201671 8i	0.29136167418042+0i
6	2011	0.2067467996598+0.000470889337257358i	0.206747667335417+0i
7	2012	0.139926072320063-0.000854335981597517i	0.139925655740972+0i
8	2013	0.0331706337987663+0.0014588885441719i	0.0331699460503076+0i
9	2014	0.105277519674957+0.000133312306378527i	0.105277581527518+0i
10	2015	0.196588378432756+0.000449387743988646i	0.196588748472653+0i
11	2016	0.192048838617772+0.000980847375835197i	0.192048415842684+0i
12	2017	0.265643525377902+0.00204209157074907i	0.265642663548985+0i
13	2018	0.334426418462849+0.000696305135590232i	0.334427262299794+0i
14	2019	0.393788862545744+0.00337931859834085i	0.393788864202175+0i
15	2020	0.243221003148646-0.0096275118394236 1i	0.243222682211879+0i
16	2021	-1.81187352407759-0.00916160096657403i	-1.81187141002542+0i

We show that the numerical sequence

{ 156264095664.643 , 190183800884.018 , 236816485762.988 , 207434296805.33 ,209069940963.177, 229562733398.948 , 208857719320.649 , 211685616592.931 , 209358834156.329 , 188033050459.881, 196272068576.338 , 218628940951.675 , 249000540729.179 , 252548179964.897 , 245974558654.043, 281777887121.451}

A numerical series characterizing the Agriculture, forestry, and fishing, value added (% of GDP) for the period 2006-2021, can be interpolated using the W14 function

W14= (-0.000146739370359545+0.000151382473317215i)*exp((0.373023058684301+1.89483778334213i)*h)+(-0.000146739370359548-0.000151382473317214i)*exp((0.373023058684301-1.89483778334213i)*h)+(-0.205877707826439-0.155997683192705i)*exp((-0.30511576964848+2.34848523607469i)*h)+(-0.205877707826441+0.155997683192702i)*exp((-0.30511576964848-2.34848523607469i)*h)+(0.0878856781927539-0.966911880843282i)*exp((-0.288741923683397+0.884597309401682i)*h)+(0.0878856781927509+0.966911880843278i)*exp((-0.288741923683397-0.884597309401682i)*h)+(3.80469531155352+1.47440270692998e-14i)*exp((-0.0464097526664783+0i)*h)+(-4.11426692886653-1.47941568905567e-14i)*exp((-0.299961626890504+0i)*h)+(-4.04671364580324e-15+1.58092249375667e-15i)*exp((0.373023058684301+1.89483778334213i)*(-h))+(-2.37561665667122e-15-4.06055183766377e-15i)*exp((0.373023058684301-1.89483778334213i)*(-h))+(-9.8639917670998e-18+2.51963377613572e-19i)*exp((-0.30511576964848+2.34848523607469i)*(-h))+(-1.26974400698392e-17-4.5554435971841e-18i)*exp((-0.30511576964848-2.34848523607469i)*(-h))+(-5.24198357786042e-18+1.57995737160016e-18i)*exp((-0.288741923683397+0.884597309401682i)*(-h))+(-2.16474502479422e-17-1.29906971611395e-17i)*exp((-0.288741923683397-0.884597309401682i)*(-h))+(-6.61327399485703e-15-6.55245227371335e-15i)*exp((-0.0464097526664783+0i)*(-h))+(2.1161509532109e-17+7.96549651865165e-17i)*exp((-0.299961626890504+0i)*(-h))
(21)

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Table 15. Calculation of the the Agriculture, forestry, and fishing, value added (% of GDP) for the period 2006-2021 using the formula (21)

h	Year	Calculated by the formula (21)	Tabular data [17]
1	2006	2.16495617691855+0.00234540338932654i	2.164955431803+0i
2	2007	2.08890734835395+0.00401939214874664i	2.08890557484545+0i
3	2008	1.9199291036116+0.00451527394689216i	1.91992797178235+0i
4	2009	1.75678903495269+0.0064826256118764i	1.75678751340306+0i
5	2010	1.5405945210981+0.00221927097592947i	1.54059611257066+0i
6	2011	1.98250888095581+0.00124667137180468i	1.98251099186352+0i
7	2012	2.2511866463623-0.00247083592701148i	2.25118564547244+0i
8	2013	2.36477293627707+0.00437522722403894i	2.36477116624437+0i
9	2014	2.41345248471337+0.000430173151738713i	2.41345254208349+0i
10	2015	2.21121279604555+0.00136419129653186i	2.21121387268241+0i
11	2016	2.0870482901091+0.0031109057918575i	2.08704712424115+0i
12	2017	2.05760934472776+0.00647708163143619i	2.0576068880787+0i
13	2018	1.93624999435662+0.00203679180046326i	1.93625258997764+0i
14	2019	1.86084852102647+0.0092235977727083i	1.86084843679476+0i
15	2020	1.9606091954181-0.0253673484318288i	1.96061362053174+0i
16	2021	1.84559174048212-0.0256581211129245i	1.84559759073857+0i

We show that the numerical sequence

{ 156264095664.643 , 190183800884.018 , 236816485762.988 , 207434296805.33 ,209069940963.177, 229562733398.948 , 208857719320.649 , 211685616592.931 , 209358834156.329 , 188033050459.881, 196272068576.338 , 218628940951.675 , 249000540729.179 , 252548179964.897 , 245974558654.043, 281777887121.451}

A numerical series characterizing the Deposit interest rate (%) for the period 2006-2021, can be interpolated using the W15 function

W15= (1.63534432691867e-07+5.81428122414844e-21i)*exp((0.850947485798848+3.14159265358979i)*h)+(0.00271117525396975+0.000655833540398767i)*exp((0.276849897879384+0.841565454444911i)*h)+(0.00271117525396973-0.000655833540398636i)*exp((0.276849897879384-0.841565454444911i)*h)+(0.84689958270353+1.70885644757495i)*exp((0.000276639474595738+0.0303412674047438i)*h)+(0.846899582605828-1.70885644719066i)*exp((0.000276639474595738-0.0303412674047438i)*h)+(-0.102991826402062-7.83296823950412e-16i)*exp((-0.338705454081659+3.14159265358979i)*h)+(0.141808792594214+0.363860148435315i)*exp((-0.424307678437004+1.5969940530805i)*h)+(0.141808792594222-0.363860148435316i)*exp((-0.424307678437004-

1.5969940530805i)*h)+(3.25036002808896e-15+6.58670738173535e-15i)*exp((0.850947485798848+3.14159265358979i)*(-h))+(9.72991343688177e-15-5.03277494840552e-16i)*exp((0.276849897879384+0.841565454444911i)*(-h))+(-7.34894791017668e-15+9.32126905822428e-16i)*exp((0.276849897879384-0.841565454444911i)*(-h))+(6.41836522879673e-12-2.07748082462656e-10i)*exp((0.000276639474595738+0.0303412674047438i)*(-h))+(-9.87198492072954e-11-1.76510592700113e-10i)*exp((0.000276639474595738-0.0303412674047438i)*(-h))+(-4.13665580469461e-18-2.06474742875069e-18i)*exp((-0.338705454081659+3.14159265358979i)*(-h))+(-6.04016278185852e-20+2.79684437104929e-18i)*exp((-0.424307678437004+1.5969940530805i)*(-h))+(-2.59420637250553e-19+3.73464457728754e-18i)*exp((-0.424307678437004-1.5969940530805i)*(-h)) (22)

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Table 16. Calculation of the Deposit interest rate (%) for the period 2006-2021 using the formula (22)

h	Year	Calculated by the formula (22)	Tabular data [17]
1	2006	1.18912666210851+10.5437989922379i	1.18586572166667+0i
2	2007	1.33899999727867+28.0698741684671i	1.32368590627749+0i
3	2008	1.56459576263706+46.4433815120381i	1.61203333333333+0i
4	2009	1.2882277951159+90.9025440807898i	1.26501666666667+0i
5	2010	1.0744925531176+10.7181786708091i	1.08158333333333+0i
6	2011	1.03027500708155+4.9793289466111i	1.03825+0i
7	2012	1.02684090281598-5.2357378315251i	1.02430263320933+0i
8	2013	0.865139695889183+8.32860588368492i	0.861548172781148+0i
9	2014	0.701212054291031+0.2379702564187i	0.701499898080767+0i
10	2015	0.527620967345732+3.01850071961734i	0.52933284578413+0i
11	2016	0.375110070369879+4.47640647907388i	0.373113336623673+0i
12	2017	0.278817868889927+10.3558565915841i	0.275124598576577+0i
13	2018	0.270133503989445+3.11359043716702i	0.275896366580548+0i
14	2019	0.388557294630385+15.8884452271404i	0.388557809322386+0i
15	2020	0.18545843842821-102.503519749495i	0.203558184400765+0i
16	2021	0.217051679002299-63.9166602099034i	0.233401665658425+0i

We show that the numerical sequence

{ 156264095664.643 , 190183800884.018 , 236816485762.988 , 207434296805.33 ,209069940963.177, 229562733398.948 , 208857719320.649 , 211685616592.931 , 209358834156.329 , 188033050459.881, 196272068576.338

, 218628940951.675 , 249000540729.179 , 252548179964.897 , 245974558654.043, 281777887121.451}

A numerical series characterizing the Real interest rate (%) for the period 2006-2021, can be interpolated using the W16 function

W16= (0.0703944382904789+6.08393452310311e-
16i)*exp((0.0640736357081278+3.14159265358979i)*h)+(2.21328750187958-
0.929881794219719i)*exp((-
0.260583791117574+2.47434049799303i)*h)+(2.21328750187957+0.929881794
219718i)*exp((-0.260583791117574-2.47434049799303i)*h)+(-
0.00457326106246412+0.0257268638054554i)*exp((0.254857663890325+0.5434
36279438888i)*h)+(-0.004573261062464-
0.0257268638054554i)*exp((0.254857663890325-
0.543436279438888i)*h)+(8.03863387766113-5.72047703615893e-15i)*exp((-
0.108773963803401+0i)*h)+(2.71652855130164+2.02875518599914i)*exp((-
0.220338520492393+1.00118196637256i)*h)+(2.71652855130164-
2.02875518599913i)*exp((-0.220338520492393-1.00118196637256i)*h)+(-
3.63578470342569e-15-1.33093745832831e-
15i)*exp((0.0640736357081278+3.14159265358979i)*(-
h))+(4.66750396607602e-18-1.19176777006091e-17i)*exp((-
0.260583791117574+2.47434049799303i)*(-h))+(1.15536816954577e-
17+3.71148890203835e-17i)*exp((-0.260583791117574-2.47434049799303i)*(-
h))+(-3.48233334682191e-15+7.62425274932987e-
14i)*exp((0.254857663890325+0.543436279438888i)*(-
h))+(5.31786719997635e-15-7.85512026882429e-14i)*exp((0.254857663890325-
0.543436279438888i)*(-h))+(-1.76342550374802e-15+8.22630561411628e-
16i)*exp((-0.108773963803401+0i)*(-h))+(-1.83279856085786e-
17+3.26031953307766e-16i)*exp((-0.220338520492393+1.00118196637256i)*(-
h))+(6.81104913366616e-17-2.86744449585045e-16i)*exp((-
0.220338520492393-1.00118196637256i)*(-h))

(23)

Really,

Table 17. Calculation of the Real interest rate (%)for the period 2006-2021 using the formula (23)

h	Year	Calculated by the formula (23)	Tabular data [17]
1	2006	4.91713232742677+36.0194637976316i	4.90746073898372+0i
2	2007	2.2000702246594+61.647099755798i	2.17113143442282+0i
3	2008	4.06326189614351+82.8834785517903i	4.15855750474576+0i
4	2009	3.3492780425296+138.148492329083i	3.31631730728405+0i
5	2010	7.40019228241284+28.2576541120959i	7.41888979983558+0i
6	2011	5.71957468394585+11.1752743283786i	5.73958603657205+0i
7	2012	3.90675128219168-15.6645823551017i	3.89922745397054+0i
8	2013	3.56786301368061+24.7677761213456i	3.5566504980595+0i
9	2014	2.01357469882556+1.84579345211484i	2.01442643165214+0i
10	2015	3.25222659390067+7.01183118561186i	3.25792951109147+0i
11	2016	2.74079317672847+14.8101938285905i	2.73458177446628+0i
12	2017	2.26563411570856+30.5324707170091i	2.25334930605008+0i
13	2018	0.934726914118257+13.145830861811i	0.949658716637955+0i
14	2019	-0.195319531340262+77.2597814554449i	-0.195325158058853+0i
15	2020	-0.576372348052006-237.403054920273i	-0.533771769719319+0i
16	2021	-0.167029220393366-180.333383309278i	-0.125397085283852+0i

Using table data 1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16 after simple calculations , we find the coefficients A1 , A2 , A3 , A4 , A5 , A6 , A7 , A8 , A9 , A10 , A11 , A12 ,A13, A14 , A15 ,A16

Table 17. Coefficient values A1 , A2 , A3 , A4 , A5 , A6 , A7 , A8 , A9 , A10 , A11 , A12 ,A13, A14 , A15 ,A16

	A1	A2	A3	A4	A5	A6	A7	A8
A 1.0e+13 *	0.6288	-0.6291	-0.1219	-0.0266	-1.1593	0.8855	4.8531	-4.6465

	A9	A10	A11	A12	A13	A14	A15	A16
A 1.0e+13 *	-0.6322	-0.1574	0.9343	0.0007	0.2452	-1.5146	1.3701	-0.0369

Thus , we finally have the model

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(24)

Since the Hessian is composed of the second derivatives of functions

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has positive all major minors , then the production function of the form (24) is concave.

Discussion

The production function has become widely used to study the costs of production in relation to the results of production activities. The Cobb-Douglas production function has received the greatest fame in the scientific literature. However, it describes economic processes too simplistically.Public authorities need accurate and up-to-date information about the state of the economy in order to make effective management decisions.

Mathematical models used for economic analysis should be as simple and understandable as possible, but at the same time describe complex economic processes effectively enough.

There are two main methods of approximation of numerical series in the form of a function. This is interpolation and approximation . Approximation is the basis of regression analysis.In the opinion of the author, interpolation methods in economic analysis are undeservedly relegated to the background. Therefore, within the framework of this study, the production function of the Czech Republic was constructed on the basis of interpolation of numerical series by series of exponents of a complex variable.

The interpolation of numerical series by series of exponents of a multiplex variable makes it possible to achieve an approximation accuracy not inferior to regression analysis .While the complexity of calculations in regression analysis increases with the number of variables, when interpolating with series of exponents, everything turns out to be much simpler.

In this paper, we consider a production function with sixteen parameters, many of which do not have a normal distribution.

Conclusions

Economic and mathematical models allow researchers to find out the causal relationship between various economic indicators and determine internal and external factors of interaction.

Production functions allow us to model the dependence of the dynamics of factors of production and the dynamics of economic growth.
Interpolation of numerical series by the Dirichlet series makes it possible to achieve good results of approximation of numerical series by analytical functions .

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