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Comparative Statistical Analysis Concerning „The Boom" of the Medical Equipments and Technologies, between United States and Germany

Gabriela OPAIȚ[1]*

Abstract

The „high artillery" of the medical innovations, concerning the Medical Devices and the MedTech, determines the „accelerator boom" of these „Top Management Products" on the United States and Germany markets. These medical innovations represent the synthesis of the interdisciplinary connexions between Medical Clinics, medical researches, academicians and medical engineering. The medical researches from the medical technology sphere reflect a high level of the innovations and them are components of the continuous high tides of the medical discoveries. The "attraction point", in the "sphere of the excitements" reflected by the high-tech medical innovations, is represented by the tendency concerning the miniaturisation of the medical devices with a very striking design and in each year, at the international level, we can see a lot of events which present these medical equipments accompanied by the sophisticated medical technologies which reflect "the sweet cherry on fancy cake". The Medical Devices and MedTech Planet occupies on the Earth Planet, the principal role regarding the interventions in the view of the improvements for the health of the people. In this sense, the modern medical technologies, for the high quality of the medical devices, make the medical diagnoses and the medical interventions with the biggest precisions. In the top ten international medical technologies are Medtronic and Boston Scientific from the United States, which occupy the first two places. The American leadership in the Medical Devices sphere, at international level, and the German leadership in the Medical Technologies sphere, at European level, created two forces in the medical innovation domain with maximum effect on the Life Expectancy from these countries, where the both nations are well on in years.

Keywords: *Medical Devices; Medical Technologies, Medical Innovations, „t" Test.*

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1. Introduction

The Medical Devices production and the Medical Technology production, situated on the first place in the world top of the sales concerning the industrial products, are „governed" in the „International Sphere" by the United States of America, while in the „European Sphere" the Medical Devices production and the Medical Technology production are under the leadership of the country which dominates this „International Micro-Sphere", namely Germany.

2. Problem Statement

The „initial points", concerning state of the art in this field, are reflected by William Sealy Gosset who created in 1908 the „t" Test and Johann Carl Friedrich Gauss who elaborated in 1823 the „Least Squares Method".

This research is the first worldwide statistical analysis which compares the trends concerning the evolutions of the Medical Devices markets, respectively the Medical Technologies markets, between the United States and Germany.

3. Aims of the research

The present research wants to make evident the „trajectories" of the evolutions concerning the Medical Devices productions, respectively the Medical Technology productions, in the United States and Germany. Also, the „t" Test reflects that, there are significant differences between the United States and Germany, regarding the values of the Medical Devices productions, respectively the values of the Medical Technologies productions.

4. Research Methods

This statistical analysis is modelled through the Variation Coefficients Method and the „t" Test method for to make evident the boom of the Medical Devices, respectively the Medical Technologies in the United States and Germany and for to emphasize the existence of the significant differences concerning the booms of the Medical Devices, respectively the booms of the Medical technologies, between the United States and Germany.

The Variation Coefficients Method reveals the mathematical models regarding the researched phenomenons, the booms of the Medical Devices in the United States and Germany, respectively the booms of the Medical Technologies in the United States and Germany.

The „t" Test expresses the significants differences between the booms of the Medical Devices in the United States and Germany, respectively the booms of the Medical Technologies in the United States and Germany, through the condition which musts be accomplished, namely $t_{calculated} < t_{tabelated}$.

5. Findings

5.1. The model of the „trajectory of the boom" concerning the Medical Devices in United States, in the period 2005-2016

In the time horizon 2005-2016, we can observe the „palette" of statistical data regarding the evolutions of the Medical Devices in United States and Germany, according to the table 1:

Table 1. The values of the Medical Devices in the United States and Germany, between 2005-2016

YEARS	MEDICAL DEVICES UNITED STATES (billions $) (ξ_i)	MEDICAL DEVICES GERMANY (billions Euro) (ω_i)	MEDICAL DEVICES GERMANY (billions $) (ω_i)
2005	123,1	14,98	18,6
2006	130,5	16,24	20,4
2007	136,0	17,74	24,3
2008	146,1	19,13	28,0
2009	144,4	19,99	27,8
2010	154,5	21,72	28,8
2011	158,0	23,17	32,2
2012	165,0	24,10	31,0
2013	171,8	24,62	32,7
2014	204,0	25,44	33,8
2015	443,0	27,60	30,6
2016	799,0	28,00	30,4
TOTAL	2775,4	262,73	338,6

The source of the data: „Statistical Portal" United States of America

In the first step, the aim of this research consists in to „sketch the trajectory of the american boom" concerning the **Medical Devices in United States**.

- if the „trajectory of the american boom", for ξ = **Medical Devices in United States,** describes the function $\xi_{t_i} = a + b \cdot t_i$, a and b will be [3]:

$$a = \frac{\begin{vmatrix} \sum_{i=1}^{n} \xi_i & \sum_{i=1}^{n} t_i \\ \sum_{i=1}^{n} \xi_i t_i & \sum_{i=1}^{n} t_i^{\,2} \end{vmatrix}}{\begin{vmatrix} n & \sum_{i=1}^{n} t_i \\ \sum_{i=1}^{n} t_i & \sum_{i=1}^{n} t_i^{\,2} \end{vmatrix}} = \frac{\sum_{i=1}^{n} \xi_i \sum_{i=1}^{n} t_i^{\,2} - \sum_{i=1}^{n} \xi_i t_i \sum_{i=1}^{n} t_i}{n \sum_{i=1}^{n} t_i^{\,2} - \left(\sum_{i=1}^{n} t_i \right)^2} \qquad b = \frac{\begin{vmatrix} n & \sum_{i=1}^{n} x_i \\ \sum_{i=1}^{n} t_i & \sum_{i=1}^{n} \xi_i t_i \end{vmatrix}}{\begin{vmatrix} n & \sum_{i=1}^{n} t_i \\ \sum_{i=1}^{n} t_i & \sum_{i=1}^{n} t_i^{\,2} \end{vmatrix}} = \frac{n \sum_{i=1}^{n} \xi_i t_i - \sum_{i=1}^{n} t_i \sum_{i=1}^{n} \xi_i}{n \sum_{i=1}^{n} t_i^{\,2} - \left(\sum_{i=1}^{n} t_i \right)^2}$$

Table 2. The „picture of board" for the values of ω variable, if the Medical Devices in United States present a linear tendency

YEARS	MEDICAL DEVICES UNITED STATES (billions $) (ξ_i)	LINEAR TENDENCY				
		t_i	t_i^2	$t_i \xi_i$	$\xi_{t_i} = a + bt_i$	$\lvert \xi_i - \xi_{t_i} \rvert$
2005	**123,1**	-6	36	-738,6	33,09542122	90,0
2006	**130,5**	-5	25	-652,5	66,12673990	64,4
2007	**136,0**	-4	16	-544,0	99,15805858	36,8
2008	**146,1**	-3	9	-438,3	132,1893773	13,9
2009	**144,4**	-2	4	-288,8	165,2206959	20,8
2010	**154,5**	-1	1	-154,5	198,2520146	43,8
2011	**158,0**	+1	1	158,0	264,3146520	106,3
2012	**165,0**	+2	4	330,0	297,3459707	132,3
2013	**171,8**	+3	9	515,4	330,3772893	158,6
2014	**204,0**	+4	16	816,0	363,4086080	159,4
2015	**443,0**	+5	25	2215,0	396,4399267	46,6
2016	**799,0**	+6	36	4794,0	429,4712454	369,5
TOTAL	**2775,4**	0	182	6011,7	**2775,4**	1242,4

$$a = \frac{2775,4 \cdot 182 - 6011,7 \cdot 0}{12 \cdot 182 - 0^2} = 231,2833333$$

$$b = \frac{12 \cdot 6011,7 - 0 \cdot 2775,4}{12 \cdot 182 - 0^2} = 33,03131868$$

$$v_I = \left[\frac{\sum_{i=1}^{n} \left| \xi_i - \xi_{t_i}^{I} \right|}{n} : \frac{\sum_{i=1}^{n} x_i}{n} \right] \cdot 100 = \frac{\sum_{i=1}^{n} \left| \xi_i - \xi_{t_i}^{I} \right|}{\sum_{i=1}^{n} \xi_i} \cdot 100 = \frac{1242,4}{2775,4} \cdot 100 = 44,77\%$$

- if the „trajectory of the american boom", for ξ = **Medical Devices in United States,** presents the function $\xi_{t_i} = a + b \cdot t_i + ct_i^2$, a and b will be [3]:

$$a = \frac{\sum_{i=1}^{n} t_i^4 \sum_{i=1}^{n} \xi_i - \sum_{i=1}^{n} t_i^2 \sum_{i=1}^{n} t_i^2 \cdot \xi_i}{n\sum_{i=1}^{n} t_i^{\,4} - \left(\sum_{i=1}^{n} t_i^2\right)^2} \quad ; \quad b = \frac{\sum_{i=1}^{n} \xi_i t_i}{\sum_{i=1}^{n} t_i^{\,2}} \quad ; \quad c = \frac{n \cdot \sum_{i=1}^{n} t_i^2 \cdot \xi_i - \sum_{i=1}^{n} t_i^2 \cdot \sum_{i=1}^{n} \xi_i}{n\sum_{i=1}^{n} t_i^{\,4} - \left(\sum_{i=1}^{n} t_i^2\right)^2}$$

Table 3. The „picture of board" for the values of ω variable, if the medical devices in United States present a quadratic tendency

YEARS	MEDICAL DEVICES UNITED STATES (billions $) (ξ_i)	PARABOLIC TENDENCY						
		t_i	t_i^2	t_i^3	t_i^4	$t_i^2\xi_i$	$\xi_{t_i} = a + b\xi_i + c\xi_i^2$	$\lvert\xi_i - \xi_{t_i}\rvert$
2005	**123,1**	-6	36	-216	1296	4431,6	211,0933414	88,0
2006	**130,5**	-5	25	-125	625	3262,5	150,1417583	19,6
2007	**136,0**	-4	16	-64	256	2176,0	106,2779755	29,7
2008	**146,1**	-3	9	-27	81	1314,9	79,50199297	66,6
2009	**144,4**	-2	4	-8	16	577,6	69,81381081	74,6
2010	**154,5**	-1	1	-1	1	154,5	77,21342899	77,3
2011	**158,0**	+1	1	1	1	158,0	143,2760663	14,7
2012	**165,0**	+2	4	8	16	660,0	201,9390855	36,9
2013	**171,8**	+3	9	27	81	1546,2	277,6899051	105,9
2014	**204,0**	+4	16	64	256	3264,0	370,5285249	166,5
2015	**443,0**	+5	25	125	625	11075,0	480,4549451	37,5
2016	**799,0**	+6	36	216	1296	28764,0	607,4691656	191,5
TOTAL	**2775,4**	0	182	0	4550	57384,3	**2775,4**	908,8

$$a = \frac{\sum_{i=1}^{n} t_i^4 \sum_{i=1}^{n} \xi_i - \sum_{i=1}^{n} t_i^2 \sum_{i=1}^{n} t_i^2 \cdot \xi_i}{n\sum_{i=1}^{n} t_i^{\,4} - \left(\sum_{i=1}^{n} t_i^2\right)^2} = \frac{4550 \cdot 2775{,}4 - 182 \cdot 57384{,}3}{12 \cdot 4550 - 182^{\,2}} = 101{,}7008475$$

$$b = \frac{\sum_{i=1}^{n} \xi_i t_i}{\sum_{i=1}^{n} t_i^{\,2}} = \frac{6011{,}7}{182} = 33{,}03131868$$

$$c = \frac{n \cdot \sum_{i=1}^{n} t_i^2 \cdot \xi_i - \sum_{i=1}^{n} t_i^2 \cdot \sum_{i=1}^{n} \xi_i}{n\sum_{i=1}^{n} t_i^{\,4} - \left(\sum_{i=1}^{n} t_i^2\right)^2} = \frac{12 \cdot 57384{,}3 - 182 \cdot 2775{,}4}{12 \cdot 4550 - 182^{\,2}} = 8{,}543900168$$

$$v_{II} = \left[\frac{\sum_{i=1}^{n} \left| \xi_i - \xi_{t_i}^{II} \right|}{n} : \frac{\sum_{i=1}^{n} x_i}{n} \right] \cdot 100 = \frac{\sum_{i=1}^{n} \left| \xi_i - \xi_{t_i}^{II} \right|}{\sum_{i=1}^{n} \xi_i} \cdot 100 = \frac{908,8}{2775,4} \cdot 100 = 32,74\%$$

- if the „trajectory of the american boom", for ξ **= Medical Devices in United States,** shows the function $\xi_{t_i} = ab^{t_i}$, a and b will be [3]:

$$\lg a = \frac{\begin{vmatrix} \sum_{i=1}^{n} \lg \xi_i & \sum_{i=1}^{n} t_i \\ \sum_{i=1}^{n} t_i \lg \xi_i & \sum_{i=1}^{n} t_i^{\,2} \end{vmatrix}}{\begin{vmatrix} n & \sum_{i=1}^{n} t_i \\ \sum_{i=1}^{n} t_i & \sum_{i=1}^{n} t_i^{\,2} \end{vmatrix}} = \frac{\sum_{i=1}^{n} \lg \xi_i \sum_{i=1}^{n} t_i^{\,2} - \sum_{i=1}^{n} t_i \lg \xi_i \sum_{i=1}^{n} t_i}{n \sum_{i=1}^{n} t_i^{\,2} - \left(\sum_{i=1}^{n} t_i \right)^2}$$

$$\lg b = \frac{\begin{vmatrix} n & \sum_{i=1}^{n} \lg \xi_i \\ \sum_{i=1}^{n} t_i & \sum_{i=1}^{n} t_i \lg \xi_i \end{vmatrix}}{\begin{vmatrix} n & \sum_{i=1}^{n} t_i \\ \sum_{i=1}^{n} t_i & \sum_{i=1}^{n} t_i^{\,2} \end{vmatrix}} = \frac{n \cdot \sum_{i=1}^{n} t_i \lg \xi_i - \sum_{i=1}^{n} \lg \xi_i \sum_{i=1}^{n} t_i}{n \sum_{i=1}^{n} t_i^{\,2} - \left(\sum_{i=1}^{n} t_i \right)^2}$$

Table 4. The „picture of board" for the values of ω variable, if the Medical Devices in United States present an exponential tendency

YEARS	MEDICAL DEVICES UNITED STATES (billions $) (ξ_i)	EXPONENTIAL TENDENCY				
		$\lg \xi_i$	$t_i \lg \xi_i$	$\lg \xi_{t_i} = \lg a + t_i \lg b$	$\xi_{t_i} = ab^{t_i}$	$\left\| \xi_i - \xi_{t_i} \right\|$
2005	**123,1**	2,090258053	-12,54154832	1,997705441	99,47305154	23,6
2006	**130,5**	2,115610512	-10,57805256	2,044786454	110,8629560	19,6
2007	**136,0**	2,133538908	-8,534155633	2,091867467	123,5570319	12,4
2008	**146,1**	2,164650216	-6,493950648	2,138948480	137,7046101	8,4
2009	**144,4**	2,159567193	-4,319134386	2,186029493	153,4721202	9,1
2010	**154,5**	2,188928484	-2,188928484	2,233110506	171,0450483	16,6
2011	**158,0**	2,198657087	2,198657087	2,327272532	212,4577276	54,5
2012	**165,0**	2,217483944	4,434967888	2,374353545	236,7846500	71,8
2013	**171,8**	2,235023159	6,705069478	2,421434558	263,8970637	92,1
2014	**204,0**	2,309630167	9,238520670	2,468515571	294,1139142	90,1
2015	**443,0**	2,646403726	13,23201863	2,515596584	327,7906670	115,2
2016	**799,0**	2,902546779	17,41528068	2,562677597	365,3234893	433,7
TOTAL	**2775,4**	27,36229823	8,568744398		2496,48233	947,1

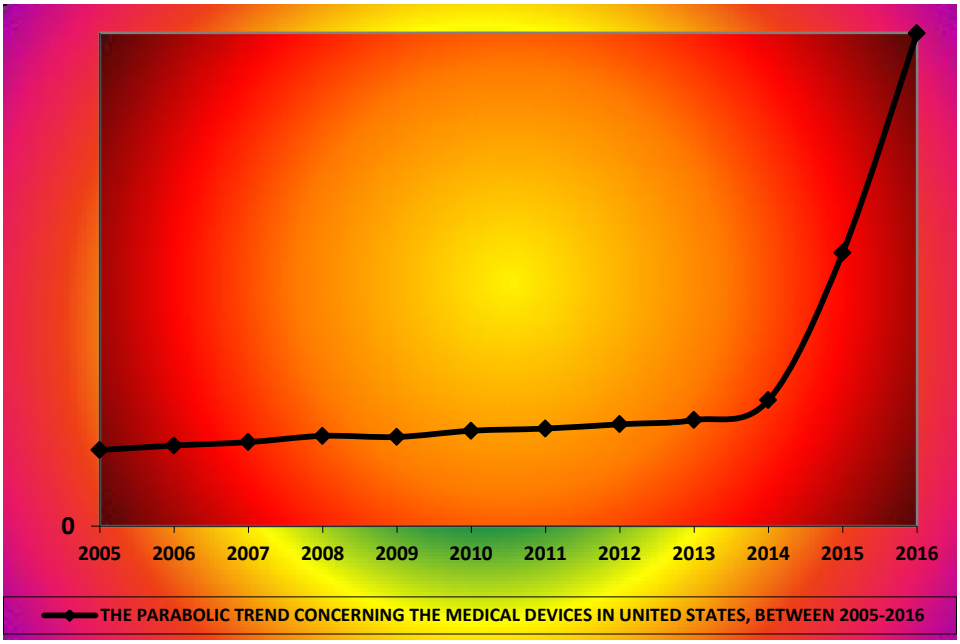
$$\lg a = \frac{27,36229823 \cdot 182 - 8,568744398 \cdot 0}{12 \cdot 182 - 0^2} = 2,280191519$$

$$\lg b = \frac{12 \cdot 8,568744398 - 27,36229823 \cdot 0}{12 \cdot 182 - 0^2} = 0,047081013$$

$$v_{\exp} = \left[\frac{\sum_{i=1}^{n} \left| \xi_i - \xi_{t_i}^{\exp} \right|}{n} : \frac{\sum_{i=1}^{n} x_i}{n} \right] \cdot 100 = \frac{\sum_{i=1}^{n} \left| \xi_i - \xi_{t_i}^{\exp} \right|}{\sum_{i=1}^{n} \xi_i} \cdot 100 = \frac{947,1}{2775,4} \cdot 100 = 34,12\%$$

$$v_{II} = 32,74\% < v_{\exp} = 34,12\% < v_I = 44,77\%$$

The „trajectory of the american boom" which is „focused" by ξ variable, namely the Medical Devices in United States, in the time horizon 2005-2016, reveals a quadratic function $\xi_{t_i} = a + b \cdot t_i + ct_i^2$, according to the graph 1.



Graph 1. The quadratic function of the statistical data for the variable which reflects the evolution of the Medical Devices in United States, in the period 2005-2016

5.2. The model of the „trajectory of the boom" regarding the Medical Devices in Germany, in the time horizon 2005-2016

„Step by step", the next target of this research is to identify and to describe the „trajectory of the german boom" regarding the **Medical Devices in Germany**, in the period 2005-2016.

- if the „trajectory of the german boom", for ω = **Medical Devices in Germany**, presents the function $\omega_{t_i} = a + b \cdot t_i$, a and b will be [3]:

Table 5. The „picture of board" for the values of ω variable, if the Medical Devices in Germany emphasizes a linear tendency

YEARS	MEDICAL DEVICES GERMANY (billions Euro) (ω_i)	LINEAR TENDENCY				
		t_i	t_i^2	$t_i \omega_i$	$\omega_{t_i} = a + bt_i$	$\lvert\omega_i - \omega_{t_i}\rvert$
2005	**14,98**	-6	36	-89,88	15,56911173	0,59
2006	**16,24**	-5	25	-81,20	16,62328755	0,38
2007	**17,74**	-4	16	-70,96	17,67746337	0,06
2008	**19,13**	-3	9	-57,39	18,73163920	0,40
2009	**19,99**	-2	4	-39,98	19,78581502	0,20
2010	**21,72**	-1	1	-21,72	20,83999085	0,88
2011	**23,17**	+1	1	23,17	22,94834249	0,22
2012	**24,10**	+2	4	48,20	24,00251832	0,10
2013	**24,62**	+3	9	73,86	25,05669414	0,44
2014	**25,44**	+4	16	101,76	26,11086997	0,67
2015	**27,60**	+5	25	138,00	27,16504579	0,43
2016	**28,00**	+6	36	168,00	28,21922161	0,22
TOTAL	**262,73**	0	182	191,86	**262,73**	4,59

$$a = \frac{\begin{vmatrix} \sum_{i=1}^{n} \omega_i & \sum_{i=1}^{n} t_i \\ \sum_{i=1}^{n} \omega_i t_i & \sum_{i=1}^{n} t_i^2 \end{vmatrix}}{\begin{vmatrix} n & \sum_{i=1}^{n} t_i \\ \sum_{i=1}^{n} t_i & \sum_{i=1}^{n} t_i^2 \end{vmatrix}} = \frac{\sum_{i=1}^{n} \omega_i \sum_{i=1}^{n} t_i^2 - \sum_{i=1}^{n} \omega_i t_i \sum_{i=1}^{n} t_i}{n \sum_{i=1}^{n} t_i^2 - \left(\sum_{i=1}^{n} t_i\right)^2} = \frac{262,73 \cdot 182 - 191,86 \cdot 0}{12 \cdot 182 - 0^2} = 21,89416667$$

$$b = \frac{\begin{vmatrix} n & \sum_{i=1}^{n} \omega_i \\ \sum_{i=1}^{n} t_i & \sum_{i=1}^{n} \omega_i t_i \end{vmatrix}}{\begin{vmatrix} n & \sum_{i=1}^{n} t_i \\ \sum_{i=1}^{n} t_i & \sum_{i=1}^{n} t_i^2 \end{vmatrix}} = \frac{n \sum_{i=1}^{n} \omega_i t_i - \sum_{i=1}^{n} t_i \sum_{i=1}^{n} \omega_i}{n \sum_{i=1}^{n} t_i^2 - \left(\sum_{i=1}^{n} t_i\right)^2} = \frac{12 \cdot 191,86 - 0 \cdot 262,73}{12 \cdot 182 - 0^2} = 1,054175824$$

$$v_I = \left[\frac{\sum_{i=1}^{n} \left| \omega_i - y_{t_i}^I \right|}{n} : \frac{\sum_{i=1}^{n} \omega_i}{n} \right] \cdot 100 = \frac{\sum_{i=1}^{n} \left| \omega_i - \omega_{t_i}^I \right|}{\sum_{i=1}^{n} \omega_i} \cdot 100 = \frac{4,59}{262,73} \cdot 100 = 1,75\%$$

- if the „trajectory of the german boom" for ω = **Medical Devices in Germany**, describes the function $\omega_{t_i} = a + b \cdot t_i + ct_i^2$, a and b will be [3]:

Table 6. The „picture of board" for the values of ω variable, if the Medical Devices in Germany emphasizes a quadratic tendency

YEARS	MEDICAL DEVICES GERMANY (billions Euro) (ω_i)	PARABOLIC TENDENCY				
		t_i^3	t_i^4	$t_i^2\omega_i$	$\omega_{t_i} = a + b\xi_i + c\xi_i^2$	$\lvert\omega_i - \omega_{t_i}\rvert$
2005	**14,98**	-216	1296	539,28	15,15494789	0,18
2006	**16,24**	-125	625	406,00	16,42780223	0,19
2007	**17,74**	-64	256	283,84	17,66089683	0,08
2008	**19,13**	-27	81	172,17	18,85423171	0,28
2009	**19,99**	-8	16	79,96	20,00780686	0,02
2010	**21,72**	-1	1	21,72	21,12162228	0,60
2011	**23,17**	1	1	23,17	23,22997393	0,06
2012	**24,10**	8	16	96,40	24,38354908	0,28
2013	**24,62**	27	81	221,58	25,53712423	0,92
2014	**25,44**	64	256	407,04	26,73045911	1,29
2015	**27,60**	125	625	690,00	27,96355372	0,36
2016	**28,00**	216	1296	1008,00	29,23640805	1,24
TOTAL	**262,73**	0	4550	3949,16		5,50

$$a = \frac{\sum_{i=1}^{n} t_i^4 \sum_{i=1}^{n} \omega_i - \sum_{i=1}^{n} t_i^2 \sum_{i=1}^{n} t_i^2 \cdot \omega_i}{n\sum_{i=1}^{n} t_i^{\,4} - \left(\sum_{i=1}^{n} t_i^2\right)^2} = \frac{4550 \cdot 262{,}73 - 182 \cdot 3949{,}16}{12 \cdot 4550 - 182^{\,2}} = 22{,}19567797$$

$$b = \frac{\sum_{i=1}^{n} \omega_i t_i}{\sum_{i=1}^{n} t_i^{\,2}} = \frac{191{,}86}{182} = 1{,}054175824$$

$$c = \frac{n \cdot \sum_{i=1}^{n} t_i^2 \cdot \omega_i - \sum_{i=1}^{n} t_i^2 \cdot \sum_{i=1}^{n} \omega_i}{n\sum_{i=1}^{n} t_i^{\,4} - \left(\sum_{i=1}^{n} t_i^2\right)^2} = \frac{12 \cdot 3949{,}16 - 182 \cdot 262{,}73}{12 \cdot 4550 - 182^{\,2}} = -0{,}019879865$$

$$v_{II} = \left[\frac{\sum_{i=1}^{n} \left|\omega_i - \omega_{t_i}^{II}\right|}{n} : \frac{\sum_{i=1}^{n} \omega_i}{n}\right] \cdot 100 = \frac{\sum_{i=1}^{n} \left|\omega_i - \omega_{t_i}^{II}\right|}{\sum_{i=1}^{n} \omega_i} \cdot 100 = \frac{5{,}50}{262{,}73} \cdot 100 = 2{,}09\%$$

- if the „trajectory of the german boom", for ω = **Medical Devices in Germany**, shows the function $\omega_{t_i} = ab^{t_i}$, a and b will be [3]:

Table 7. The „picture of board" for the values of ω variable, if the Medical Devices in Germany emphasizes an exponential tendency

YEARS	MEDICAL DEVICES GERMANY (billions Euro) (ω_i)	EXPONENTIAL TENDENCY				
		$\lg \omega_i$	$t_i \lg \omega_i$	$\lg \omega_{t_i} = \lg a + t_i \lg b$	$\omega_{t_i} = ab^{t_i}$	$\lvert\omega_i - \omega_{t_i}\rvert$
2005	**14,98**	1,175511813	-7,053070880	1,202728307	15,94881083	0,97
2006	**16,24**	1,210586025	-6,052930125	1,224304885	16,76119138	0,52
2007	**17,74**	1,248953616	-4,995814462	1,245881481	17,61495269	0,12
2008	**19,13**	1,281714970	-3,845144910	1,267458077	18,51220185	0,62
2009	**19,99**	1,300812794	-2,601625588	1,289034673	19,45515401	0,53
2010	**21,72**	1,336859821	-1,336859821	1,310611272	20,44613726	1,27
2011	**23,17**	1,364926034	1,364926034	1,353764461	22,58210701	0,59
2012	**24,10**	1,382017043	2,764034085	1,375341057	23,73236707	0,37
2013	**24,62**	1,391288049	4,173864146	1,396917653	24,94121769	0,32
2014	**25,44**	1,405517107	5,622068428	1,418494249	26,21164329	0,77
2015	**27,60**	1,440909082	7,204545410	1,440070845	27,54678028	0,05
2016	**28,00**	1,447158031	8,682948188	1,461647441	28,94992487	0,95
TOTAL	**262,73**	15,98625439	3,926940505			7,08

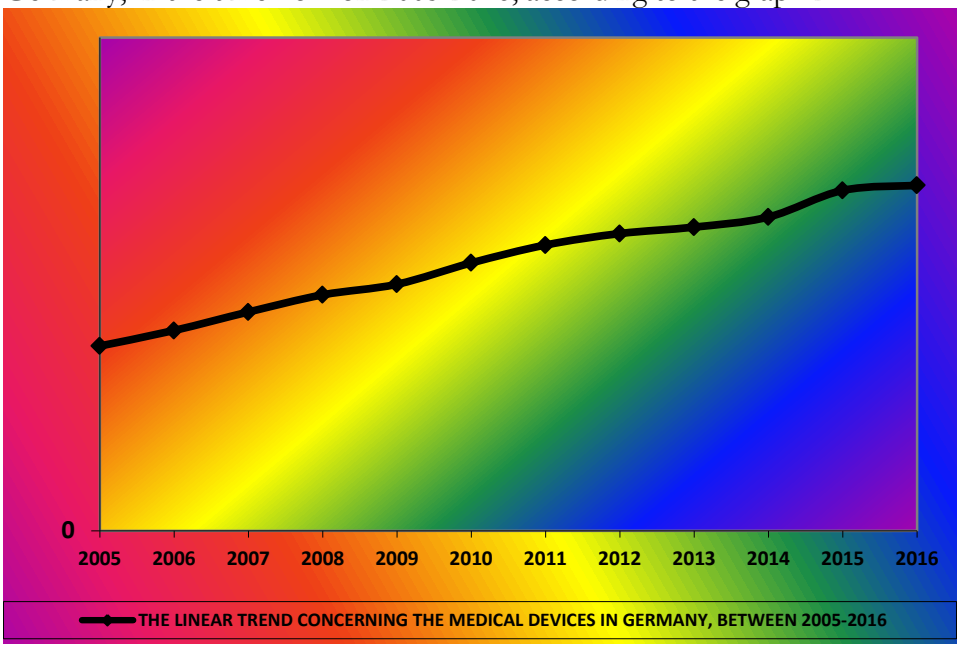
$$\lg a = \frac{\begin{vmatrix} \sum_{i=1}^{n} \lg \omega_i & \sum_{i=1}^{n} t_i \\ \sum_{i=1}^{n} t_i \lg \omega_i & \sum_{i=1}^{n} t_i^2 \end{vmatrix}}{\begin{vmatrix} n & \sum_{i=1}^{n} t_i \\ \sum_{i=1}^{n} t_i & \sum_{i=1}^{n} t_i^2 \end{vmatrix}} = \frac{\sum_{i=1}^{n} \lg \omega_i \sum_{i=1}^{n} t_i^2 - \sum_{i=1}^{n} t_i \lg \omega_i \sum_{i=1}^{n} t_i}{n\sum_{i=1}^{n} t_i^2 - \left(\sum_{i=1}^{n} t_i\right)^2} = \frac{15,98625439 \cdot 182 - 3,926940505 \cdot 0}{12 \cdot 182 - 0^2} = 1,332187865$$

$$\lg b = \frac{\begin{vmatrix} n & \sum_{i=1}^{n} \lg \omega_i \\ \sum_{i=1}^{n} t_i & \sum_{i=1}^{n} t_i \lg \omega_i \end{vmatrix}}{\begin{vmatrix} n & \sum_{i=1}^{n} t_i \\ \sum_{i=1}^{n} t_i & \sum_{i=1}^{n} t_i^2 \end{vmatrix}} = \frac{n \cdot \sum_{i=1}^{n} t_i \lg \omega_i - \sum_{i=1}^{n} \lg \omega_i \sum_{i=1}^{n} t_i}{n\sum_{i=1}^{n} t_i^2 - \left(\sum_{i=1}^{n} t_i\right)^2} = \frac{12 \cdot 3,926940505 - 15,98625439 \cdot 0}{12 \cdot 182 - 0^2} = 0,021576596$$

$$v_{\exp} = \left[\frac{\sum_{i=1}^{n} \left| \omega_i - \omega_{t_i}^{\exp} \right|}{n} : \frac{\sum_{i=1}^{n} \omega_i}{n} \right] \cdot 100 = \frac{\sum_{i=1}^{n} \left| \omega_i - \omega_{t_i}^{\exp} \right|}{\sum_{i=1}^{n} \omega_i} \cdot 100 = \frac{7,08}{262,73} \cdot 100 = 2,69\%$$

$$v_I = 1,75\% < v_{II} = 2,09\% < v_{\exp} = 2,69\%$$

The development of the „cloud of points" is around of the linear function $\omega_{t_i} = a + b \cdot t_i$, for ω variable, where $\omega =$ Medical Devices in Germany, in the time horizon 2005-2016, according to the graph 2.



Graph 2. The linear function of the statistical data for the variable which describes the evolution of the Medical Devices in Germany, in the period 2005-2016

5.3. The model of the „trajectory of the boom" concerning the Medical Technology in United States in the period 2008-2016

Table 8. The values which expresses the Medical Technologies from United States and Germany in the time horizon 2008-2016

YEARS	MEDICAL TECHNOLOGY UNITED STATES (millions $) (ξ_i)	MEDICAL TECHNOLOGY GERMANY (millions $) (ω_i)
2008	27,763	4,864
2009	23,487	4,320
2010	25,839	3,580
2011	25,460	3,516
2012	28,241	3,338
2013	28,531	3,553
2014	28,553	3,500
2015	30,574	3,565
2016	30,325	3,602
TOTAL	248,773	33,838

The source of the data: „Statistical Portal" United States of America

- if the „trajectory of the american boom", for $\xi =$ **MedTech in United States**, describes the function $\xi_{t_i} = a + b \cdot t_i$, a and b will be [3]:

Table 9. The „picture of board" for the values of ξ variable, if the Medical Technology in United States presents a linear tendency

YEARS	MEDICAL TECHNOLOGY UNITED STATES (millions $) (ξ_i)	LINEAR TENDENCY				
		t_i	t_i^2	$t_i \xi_i$	$\xi_{t_i} = a + bt_i$	$\lvert \xi_i - \xi_{t_i} \rvert$
2008	**27,763**	-4	16	-111,052	24,97424444	2,789
2009	**23,487**	-3	9	-70,461	25,64104444	2,154
2010	**25,839**	-2	4	-51,678	26,30784444	0,469
2011	**25,460**	-1	1	-25,460	26,97464444	1,515
2012	**28,241**	0	0	0	27,64144444	0,600
2013	**28,531**	+1	1	28,531	28,30824444	0,223
2014	**28,553**	+2	4	57,106	28,97504444	0,422
2015	**30,574**	+3	9	91,722	29,64184444	0,932
2016	**30,325**	+4	16	121,300	30,30864444	0,016
TOTAL	**248,773**	0	60	40,008	**248,773**	9,120

$$a = \frac{\begin{vmatrix} \sum_{i=1}^{n} \xi_i & \sum_{i=1}^{n} t_i \\ \sum_{i=1}^{n} \xi_i t_i & \sum_{i=1}^{n} t_i^2 \end{vmatrix}}{\begin{vmatrix} n & \sum_{i=1}^{n} t_i \\ \sum_{i=1}^{n} t_i & \sum_{i=1}^{n} t_i^2 \end{vmatrix}} = \frac{\sum_{i=1}^{n} \xi_i \sum_{i=1}^{n} t_i^2 - \sum_{i=1}^{n} \xi_i t_i \sum_{i=1}^{n} t_i}{n \sum_{i=1}^{n} t_i^2 - \left(\sum_{i=1}^{n} t_i \right)^2} = \frac{248,773 \cdot 60 - 40,008 \cdot 0}{9 \cdot 60 - 0^2} = 27,64144444$$

$$b = \frac{\begin{vmatrix} n & \sum_{i=1}^{n} x_i \\ \sum_{i=1}^{n} t_i & \sum_{i=1}^{n} \xi_i t_i \end{vmatrix}}{\begin{vmatrix} n & \sum_{i=1}^{n} t_i \\ \sum_{i=1}^{n} t_i & \sum_{i=1}^{n} t_i^2 \end{vmatrix}} = \frac{n \sum_{i=1}^{n} \xi_i t_i - \sum_{i=1}^{n} t_i \sum_{i=1}^{n} \xi_i}{n \sum_{i=1}^{n} t_i^2 - \left(\sum_{i=1}^{n} t_i \right)^2} = \frac{9 \cdot 40,008 - 0 \cdot 248,773}{9 \cdot 60 - 0^2} = 0,6668$$

$$v_I = \left[\frac{\sum_{i=1}^{n} \left| \xi_i - \xi_{t_i}^I \right|}{n} : \frac{\sum_{i=1}^{n} x_i}{n} \right] \cdot 100 = \frac{\sum_{i=1}^{n} \left| \xi_i - \xi_{t_i}^I \right|}{\sum_{i=1}^{m} \xi_i} \cdot 100 = \frac{9,120}{248,773} \cdot 100 = 3,67\%$$

- if the „trajectory of the american boom", for $\xi =$ **MedTech in United States**, shows the function $\xi_{t_i} = a + b \cdot t_i + ct_i^2$, a and b will be [3]:

Table 10. The „picture of board" for the values of ξ variable, if the Medical Technology in United States presents a quadratic tendency

YEARS	MEDICAL TECHNO-LOGY UNITED STATES (millions $) (ξ_i)	PARABOLIC TENDENCY						
		t_i	t_i^2	t_i^3	t_i^4	$t_i^2\xi_i$	$\xi_{t_i} = a + b\xi_i + c\xi_i^2$	$\lvert\xi_i - \xi_{t_i}\rvert$
2008	**27,763**	-4	16	-64	256	444,208	25,82361818	1,939
2009	**23,487**	-3	9	-27	81	211,383	25,85338789	2,366
2010	**25,839**	-2	4	-8	16	103,356	26,06516624	0,226
2011	**25,460**	-1	1	-1	1	25,460	26,45895325	0,999
2012	**28,241**	0	0	0	0	0	27,03474892	1,206
2013	**28,531**	+1	1	+1	1	28,531	27,79375325	0,737
2014	**28,553**	+2	4	+8	16	114,212	28,73476624	0,182
2015	**30,574**	+3	9	27	81	275,166	29,85418788	0,720
2016	**30,325**	+4	16	64	256	485,200	31,16281818	0,838
TOTAL	**248,773**	0	60	0	708	1686,516	**248,773**	9,213

$$a = \frac{\sum_{i=1}^{n} t_i^4 \sum_{i=1}^{n} \xi_i - \sum_{i=1}^{n} t_i^2 \sum_{i=1}^{n} t_i^2 \cdot \xi_i}{n\sum_{i=1}^{n} t_i^{\,4} - \left(\sum_{i=1}^{n} t_i^2\right)^2} = \frac{708 \cdot 248{,}773 - 60 \cdot 1686{,}516}{9 \cdot 708 - 60^2} = 27{,}03474892$$

$$b = \frac{\sum_{i=1}^{n} \xi_i t_i}{\sum_{i=1}^{n} t_i^{\,2}} = \frac{40{,}008}{60} = 0{,}6668$$

$$c = \frac{n \cdot \sum_{i=1}^{n} t_i^2 \cdot \xi_i - \sum_{i=1}^{n} t_i^2 \cdot \sum_{i=1}^{n} \xi_i}{n\sum_{i=1}^{n} t_i^{\,4} - \left(\sum_{i=1}^{n} t_i^2\right)^2} = \frac{9 \cdot 1686{,}516 - 60 \cdot 248{,}773}{9 \cdot 708 - 60^2} = 0{,}091004329$$

$$v_{II} = \left[\frac{\sum_{i=1}^{n} \left|\xi_i - \xi_{t_i}^{II}\right|}{n} : \frac{\sum_{i=1}^{n} x_i}{n}\right] \cdot 100 = \frac{\sum_{i=1}^{n} \left|\xi_i - \xi_{t_i}^{II}\right|}{\sum_{i=1}^{n} \xi_i} \cdot 100 = \frac{9{,}213}{248{,}773} \cdot 100 = 3{,}70\%$$

- if the „trajectory of the american boom", for ξ = **MedTech in United States**, presents the function $\xi_{t_i} = ab^{t_i}$, a and b will be [3]:

Table 11. The „picture of board" for the values of ξ variable, if the Medical Technology in United States presents an exponential tendency

YEARS	MEDICAL TECHN-OLOGY UNITED STATES (millions $) (ξ_i)	EXPONENTIAL TENDENCY				
		$\lg \xi_i$	$t_i \lg \xi_i$	$\lg \xi_{t_i} = \lg a + t_i \lg b$	$\xi_{t_i} = ab^{t_i}$	$\lvert \xi_i - \xi_{t_i} \rvert$
2008	**27,763**	1,443466393	-5,773865572	1,397950716	25,00061637	2,762
2009	**23,487**	1,370827548	-4,112482643	1,408502757	25,61549525	2,129
2010	**25,839**	1,412275702	-2,824551404	1,419054798	26,24549680	0,407
2011	**25,460**	1,405858399	-1,405858399	1,429606839	26,89099296	1,431
2012	**28,241**	1,450880071	0	1,440158880	27,55236480	2,689
2013	**28,531**	1,455316994	1,455316994	1,450710921	28,23000279	0,301
2014	**28,553**	1,455651745	2,911303491	1,461262962	28,92430697	0,371
2015	**30,574**	1,485352261	4,456056784	1,471815003	29,63568725	0,938
2016	**30,325**	1,481800810	5,927203238	1,482367044	30,36456361	0,040
TOTAL	**248,773**	12,96142992	0,633122489			11,068

$$\lg a = \frac{\begin{vmatrix} \sum_{i=1}^{n} \lg \xi_i & \sum_{i=1}^{n} t_i \\ \sum_{i=1}^{n} t_i \lg \xi_i & \sum_{i=1}^{n} t_i^{\,2} \end{vmatrix}}{\begin{vmatrix} n & \sum_{i=1}^{n} t_i \\ \sum_{i=1}^{n} t_i & \sum_{i=1}^{n} t_i^{\,2} \end{vmatrix}} = \frac{\sum_{i=1}^{n} \lg \xi_i \sum_{i=1}^{n} t_i^{\,2} - \sum_{i=1}^{n} t_i \lg \xi_i \sum_{i=1}^{n} t_i}{n \sum_{i=1}^{n} t_i^{\,2} - \left(\sum_{i=1}^{n} t_i \right)^2}$$

$$\lg b = \frac{\begin{vmatrix} n & \sum_{i=1}^{n} \lg \xi_i \\ \sum_{i=1}^{n} t_i & \sum_{i=1}^{n} t_i \lg \xi_i \end{vmatrix}}{\begin{vmatrix} n & \sum_{i=1}^{n} t_i \\ \sum_{i=1}^{n} t_i & \sum_{i=1}^{n} t_i^{\,2} \end{vmatrix}} = \frac{n \cdot \sum_{i=1}^{n} t_i \lg \xi_i - \sum_{i=1}^{n} \lg \xi_i \sum_{i=1}^{n} t_i}{n \sum_{i=1}^{n} t_i^{\,2} - \left(\sum_{i=1}^{n} t_i \right)^2}$$

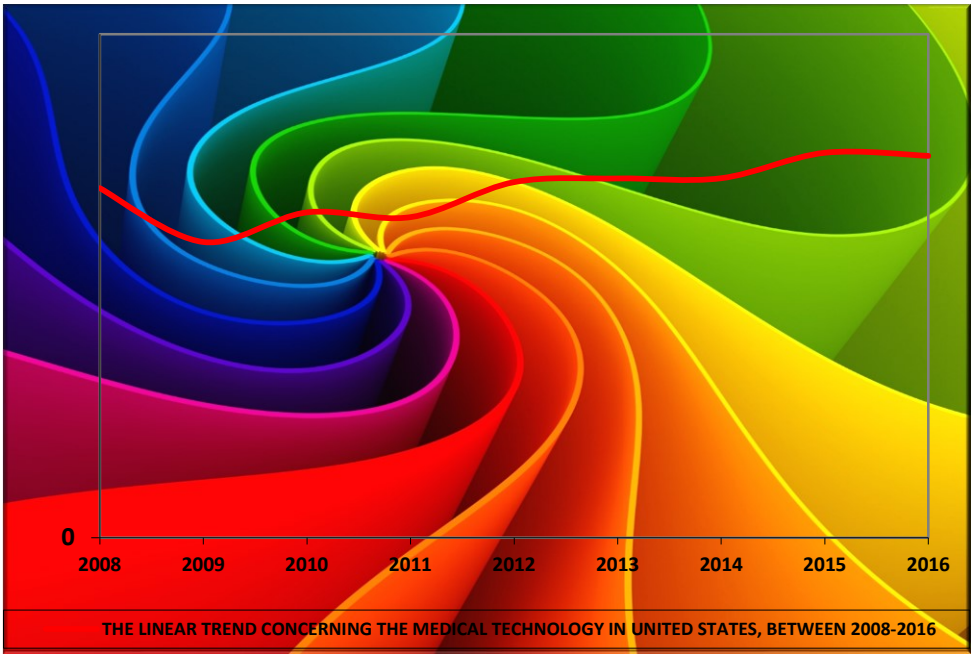
$$\lg a = \frac{12{,}96142992 \cdot 60 - 0{,}633122489 \cdot 0}{9 \cdot 60 - 0^2} = 1{,}44015888$$

$$\lg b = \frac{9 \cdot 0{,}633122489 - 12{,}96142992 \cdot 0}{9 \cdot 60 - 0^2} = 0{,}010552041$$

$$v_{\exp} = \left[\frac{\sum_{i=1}^{n} \left| \xi_i - \xi_{t_i}^{\exp} \right|}{n} : \frac{\sum_{i=1}^{n} x_i}{n} \right] \cdot 100 = \frac{\sum_{i=1}^{n} \left| \xi_i - \xi_{t_i}^{\exp} \right|}{\sum_{i=-m}^{m} \xi_i} \cdot 100 = \frac{11{,}068}{248{,}773} \cdot 100 = 4{,}45\%$$

$$v_I = 3{,}67\% < v_{II} = 3{,}70\% < v_{\exp} = 4{,}45\%$$

The development of the „cloud of points", which represents the values of the Medical Technology in United States, between 2008-2016, is around of the linear function $\xi_{t_i} = a + b \cdot t_i$, according to the graph 3.



Graph 3. The linear trend of the statistical data for the variable which reflects the evolution of the Medical Technology in United States, in the period 2008-2016

5.4. The model of the „trajectory of the boom" concerning the Medical Technology in Germany in the period 2008-2016

- if the „trajectory of the german boom", for $\omega =$ **MedTech in Germany**, shows the function $\omega_{t_i} = a + b \cdot t_i$, a and b will be [3]:

Table 12. The „picture of board" for the values of ω variable, if the MedTech in Germany reflects a linear tendency

YEARS	MEDICAL TECHNOLOGY GERMANY (millions $) (ω_i)	LINEAR TENDENCY				
		t_i	t_i^2	$t_i \omega_i$	$\omega_{t_i} = a + bt_i$	$\lvert\omega_i - \omega_{t_i}\rvert$
2008	**4,864**	-4	16	-19,456	4,255511110	0,608
2009	**4,320**	-3	9	-12,960	4,131577777	0,188
2010	**3,580**	-2	4	-7,160	4,007644444	0,428
2011	**3,516**	-1	1	-3,516	3,883711111	0,368
2012	**3,338**	0	0	0	3,759777778	0,422
2013	**3,553**	+1	1	3,553	3,635844445	0,083

2014	**3,500**	+2	4	7,000	3,511911112	0,012
2015	**3,565**	+3	9	10,695	3,387977779	0,177
2016	**3,602**	+4	16	14,408	3,264044446	0,338
TOTAL	**33,838**	0	60	-7,436	**33,838**	2,624

$$a=\frac{\begin{vmatrix}\sum_{i=1}^{n}\omega_i & \sum_{i=1}^{n}t_i\\ \sum_{i=1}^{n}\omega_i t_i & \sum_{i=1}^{n}t_i^{\,2}\end{vmatrix}}{\begin{vmatrix}n & \sum_{i=1}^{n}t_i\\ \sum_{i=1}^{n}t_i & \sum_{i=1}^{n}t_i^{\,2}\end{vmatrix}}=\frac{\sum_{i=1}^{n}\omega_i\sum_{i=1}^{n}t_i^{\,2}-\sum_{i=1}^{n}\omega_i t_i\sum_{i=1}^{n}t_i}{n\sum_{i=1}^{n}t_i^{\,2}-\left(\sum_{i=1}^{n}t_i\right)^2}=\frac{33{,}838\cdot 60-(-7{,}436)\cdot 0}{9\cdot 60-0^2}=3{,}759777778$$

$$b=\frac{\begin{vmatrix}n & \sum_{i=1}^{n}\omega_i\\ \sum_{i=1}^{n}t_i & \sum_{i=1}^{n}\omega_i t_i\end{vmatrix}}{\begin{vmatrix}n & \sum_{i=1}^{n}t_i\\ \sum_{i=1}^{n}t_i & \sum_{i=1}^{n}t_i^{\,2}\end{vmatrix}}=\frac{n\sum_{i=1}^{n}\omega_i t_i-\sum_{i=1}^{n}t_i\sum_{i=1}^{n}\omega_i}{n\sum_{i=1}^{n}t_i^{\,2}-\left(\sum_{i=1}^{n}t_i\right)^2}=\frac{9\cdot(-7{,}436)-0\cdot 33{,}838}{9\cdot 60-0^2}=-0{,}123933333$$

$$v_I=\left[\frac{\sum_{i=1}^{n}\left|\omega_i-y_{t_i}^{I}\right|}{n}:\frac{\sum_{i=1}^{n}\omega_i}{n}\right]\cdot 100=\frac{\sum_{i=1}^{n}\left|\omega_i-\omega_{t_i}^{I}\right|}{\sum_{i=1}^{n}\omega_i}\cdot 100=\frac{2{,}624}{33{,}838}\cdot 100=7{,}76\%$$

- if the „trajectory of the german boom", for $\omega=$ **MedTech in Germany,** describes the function $\omega_{t_i}=a+b\cdot t_i+ct_i^2$, a and b will be [3]:

Table 13. The „picture of board" for the values of ω variable, if the MedTech in Germany reflects a quadratic tendency

YEARS	MEDICAL TECHNO-LOGY GERMANY (millions $) (ω_i)	PARABOLIC TENDENCY						
		t_i	t_i^2	t_i^3	t_i^4	$t_i^2\omega_i$	$\omega_{t_i}=a+b\xi_i+c\xi_i^2$	$\lvert\omega_i-\omega_{t_i}\rvert$
2008	**4,864**	-4	16	-64	256	77,824	4,747127269	0,117
2009	**4,320**	-3	9	-27	81	38,880	4,254481816	0,066
2010	**3,580**	-2	4	-8	16	14,320	3,867182683	0,287
2011	**3,516**	-1	1	-1	1	3,516	3,585229870	0,069
2012	**3,338**	0	0	0	0	0	3,408623377	0,071
2013	**3,553**	+1	1	+1	1	3,553	3,337363204	0,216
2014	**3,500**	+2	4	+8	16	14,000	3,371449351	0,129
2015	**3,565**	+3	9	27	81	32,085	3,510881818	0,054
2016	**3,602**	+4	16	64	256	57,632	3,755660605	0,154
TOTAL	**33,838**	0	60	0	708	241,810	33,83799999	1,163

$$a = \frac{\sum_{i=1}^{n} t_i^4 \sum_{i=1}^{n} \omega_i - \sum_{i=1}^{n} t_i^2 \sum_{i=1}^{n} t_i^2 \cdot \omega_i}{n\sum_{i=1}^{n} t_i^{\,4} - \left(\sum_{i=1}^{n} t_i^2\right)^2} = \frac{708 \cdot 33{,}838 - 60 \cdot 241{,}810}{9 \cdot 708 - 60^2} = 3{,}408623377$$

$$b = \frac{\sum_{i=1}^{n} \omega_i t_i}{\sum_{i=1}^{n} t_i^{\,2}} = \frac{-7{,}436}{60} = -0{,}123933333$$

$$c = \frac{n \cdot \sum_{i=1}^{n} t_i^2 \cdot \omega_i - \sum_{i=1}^{n} t_i^2 \cdot \sum_{i=1}^{n} \omega_i}{n\sum_{i=1}^{n} t_i^{\,4} - \left(\sum_{i=1}^{n} t_i^2\right)^2} = \frac{9 \cdot 241{,}810 - 60 \cdot 33{,}838}{9 \cdot 708 - 60^2} = 0{,}05267316$$

$$v_{II} = \left[\frac{\sum_{i=1}^{n} \left|\omega_i - \omega_{t_i}^{II}\right|}{n} : \frac{\sum_{i=1}^{n} \omega_i}{n} \right] \cdot 100 = \frac{\sum_{i=1}^{n} \left|\omega_i - \omega_{t_i}^{II}\right|}{\sum_{i=1}^{n} \omega_i} \cdot 100 = \frac{1{,}163}{33{,}838} \cdot 100 = 3{,}44\%$$

- if the „trajectory of the german boom", for $\omega =$ **MedTech in Germany**, presents the function $\omega_{t_i} = ab^{t_i}$, a and b will be [3]:

Table 14. The „picture of board" for the values of ω variable, if the MedTech in Germany reflects an exponential tendency

YEARS	MEDICAL TECHNO-LOGY GERMANY (millions $) (ω_i)	EXPONENTIAL TENDENCY				
		$\lg \omega_i$	$t_i \lg \omega_i$	$\lg \omega_{t_i} = \lg a + t_i \lg b$	$\omega_{t_i} = ab^{t_i}$	$\left\|\omega_i - \omega_{t_i}\right\|$
2008	**4,864**	0,686993566	-2,747974265	0,781419489	6,045322707	1,181
2009	**4,320**	0,635483746	-1,906451240	0,610869096	4,081963302	0,238
2010	**3,580**	0,553883026	-1,107766053	0,597749835	3,960498335	0,380
2011	**3,516**	0,546048866	-0,546048866	0,584630574	3,842647740	0,327
2012	**3,338**	0,523486332	0	0,571511313	3,728303967	0,390
2013	**3,553**	0,550595207	0,550595207	0,584630574	3,842647740	0,290
2014	**3,500**	0,544068044	1,088136089	0,545272791	3,509722590	0,010
2015	**3,565**	0,552059534	1,656178603	0,532153530	3,405285507	0,160
2016	**3,602**	0,556543708	2,226174834	0,519034269	3,303956106	0,298
TOTAL	**33,838**	5,143601823	-0,787155691			3,274

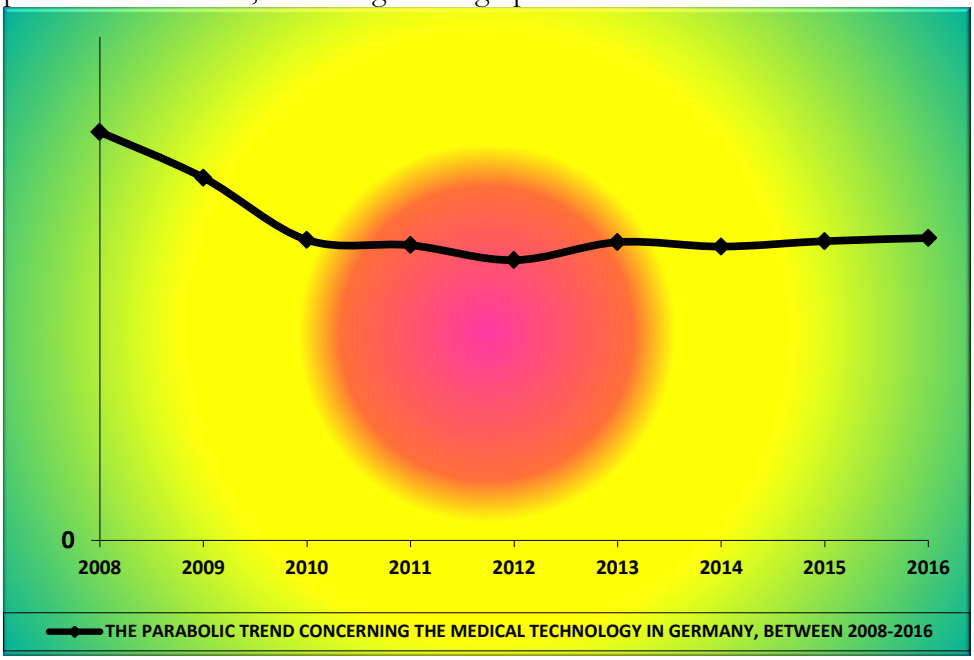
$$\lg a = \frac{\sum_{i=1}^{n} \lg \omega_i \sum_{i=1}^{n} t_i^2 - \sum_{i=1}^{n} t_i \lg \omega_i \sum_{i=1}^{n} t_i}{n\sum_{i=1}^{n} t_i^2 - \left(\sum_{i=1}^{n} t_i\right)^2} = \frac{5{,}143601823 \cdot 60 - (-0{,}787155691) \cdot 0}{9 \cdot 60 - 0^2} = 0{,}571511313$$

$$\lg b = \frac{n \cdot \sum_{i=1}^{n} t_i \lg \omega_i - \sum_{i=1}^{n} \lg \omega_i \sum_{i=1}^{n} t_i}{n\sum_{i=1}^{n} t_i^2 - \left(\sum_{i=1}^{n} t_i\right)^2} = \frac{9 \cdot (-0{,}787155691) - 5{,}143601823 \cdot 0}{9 \cdot 60 - 0^2} = -0{,}013119261$$

$$v_{\exp} = \left[\frac{\sum_{i=1}^{n} \left| \omega_i - \omega_{t_i}^{\exp} \right|}{n} : \frac{\sum_{i=1}^{n} \omega_i}{n} \right] \cdot 100 = \frac{\sum_{i=1}^{n} \left| \omega_i - \omega_{t_i}^{\exp} \right|}{\sum_{i=1}^{n} \omega_i} \cdot 100 = \frac{3{,}274}{33{,}838} \cdot 100 = 9{,}68\%$$

$$v_{II} = 3{,}44\% < v_I = 7{,}76\% < v_{\exp} = 9{,}68\%$$

The „trajectory of the german boom" for ω factor, which represents the Medical Technology in Germany, in the period 2008-2016, is a parabolical function, according to the graph 4.



Graph 4 The quadratic function of the statistical data for the variable which describes the evolution of the Medical Technology in Germany, in the time horizon 2008-2016

5.5. The architecture of the comparative analysis through „t" test, between United States and Germany, concerning the „boom" of the Medical Devices, respectively Medical Technology, between 2005-2016, respectively 2008-2016

Table 15. The values which present the algorithm for to apply „t" Test for the Medical Devices in United States and Germany in the period 2005-2016

YEARS	MEDICAL DEVICES UNITED STATES (billions $) (ξ_i)	MEDICAL DEVICES GERMANY (billions $) (ω_i)	$(\xi_i - \overline{\xi})^2$	$(\omega_i - \overline{\omega})^2$
2005	**123,1**	**18,6**	11707,24	92,16
2006	**130,5**	**20,4**	10160,64	60,84
2007	**136,0**	**24,3**	9082,09	15,21
2008	**146,1**	**28,0**	7259,04	0,04
2009	**144,4**	**27,8**	7551,61	0,16
2010	**154,5**	**28,8**	5898,24	0,36
2011	**158,0**	**32,2**	5372,89	16,00
2012	**165,0**	**31,0**	4395,69	7,84
2013	**171,8**	**32,7**	3540,25	20,25
2014	**204,0**	**33,8**	745,29	31,36
2015	**443,0**	**30,6**	44816,89	5,76
2016	**799,0**	**30,4**	322283,29	4,84
TOTAL	**2775,4**	**338,6**	432813,16	254,82

$$\overline{\xi} = \frac{\sum_{i=1}^{n} \xi_i}{n_1} = \frac{2775,4}{12} = 231,28 \approx 231,3 \text{ billions \$} \qquad \overline{\omega} = \frac{\sum_{i=1}^{n} \omega_i}{n_2} = \frac{338,6}{12} = 28,17 \approx 28,2 \text{ billions \$}$$

$$s_1^2 = \frac{\sum_{i=1}^{n} (\xi_i - \overline{\xi})^2}{n_1 - 1} = \frac{432813,16}{11} = 39346,65091 \qquad s_2^2 = \frac{\sum_{i=1}^{n} (\omega_i - \overline{\omega})^2}{n_2 - 1} = \frac{254,82}{11} = 23,16545455$$

$$F_{calc} = \frac{s_1^2}{s_2^2} = \frac{39346,65091}{23,16545455} = 1698,505455$$

$$F_{tab} = F_{f_1;f_2;\alpha} = F_{11;11;0,01} = 4,5$$

$$F_{calc} = 1698,505455 > F_{tab} = F_{f_1;f_2;\alpha} = F_{11;11;0,01} = 4,5$$

$$t = \frac{\left|\overline{\omega} - \overline{\xi}\right|}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}} = \frac{\left|28,2 - 231,3\right|}{\sqrt{\frac{39346,65091}{12} + \frac{23,16545455}{12}}} = 3,545837689$$

$$f = \frac{1}{\frac{c^2}{n_1 - 1} + \frac{1 - c^2}{n_2 - 1}} = \frac{1}{\frac{(16,53029667)^2}{11} + \frac{1 - (16,53029667)^2}{11}} = 11$$

$$c = \frac{s_1}{n_1} + \frac{1}{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}} = \frac{198,3599025}{12} + \frac{1}{\frac{39346,65091}{12} + \frac{23,16545455}{12}} = 16,53029667$$

$$t_{tab} = t_{f;\alpha} = t_{11;0,01} = 3,106$$

$t_{calc} = 3,545837689 > t_{tab} = t_{f;\alpha} = t_{11;0,01} = 3,106 \Rightarrow$ there is a significant difference between the United States and Germany concerning the Medical Devices

Table 16. The values which reflect the algorithm for to apply „t" Test for the MedTech in United States and Germany in the period 2008-2016

YEARS	MEDICAL TECHNOLOGY UNITED STATES (millions $) (γ_i)	MEDICAL TECHNOLOGY GERMANY (millions $) (δ_i)	$(\gamma_i - \bar{\gamma})^2$	$(\delta_i - \bar{\delta})^2$
2008	**27,763**	**4,864**	0,014884	1,218816
2009	**23,487**	**4,320**	17,255716	0,313600
2010	**25,839**	**3,580**	3,247204	0,032400
2011	**25,460**	**3,516**	4,756761	0,059536
2012	**28,241**	**3,338**	0,360000	0,178084
2013	**28,531**	**3,553**	0,792100	0,042849
2014	**28,553**	**3,500**	0,831744	0,067600
2015	**30,574**	**3,565**	8,602489	0,038025
2016	**30,325**	**3,602**	7,203856	0,024964
TOTAL	**248,773**	**33,838**	43,064754	1,925946

$$\bar{\gamma} = \frac{\sum_{i=1}^{n} \gamma_i}{n_1} = \frac{248,773}{9} = 27,641 \text{ millions \$} \quad \bar{\delta} = \frac{\sum_{i=1}^{n} \delta_i}{n_2} = \frac{33,838}{9} = 3,760 \text{ millions \$}$$

$$s_1^2 = \frac{\sum_{i=1}^{n} (\gamma_i - \bar{\gamma})^2}{n_1 - 1} = \frac{43,064754}{8} = 5,38309425 \quad s_2^2 = \frac{\sum_{i=1}^{n} (\delta_i - \bar{\delta})^2}{n_2 - 1} = \frac{1,925946}{8} = 0,24074325$$

$$F_{calc} = \frac{s_1^2}{s_2^2} = \frac{5,38309425}{0,24074325} = 22,36031228$$

$$F_{tab} = F_{f_1;f_2;\alpha} = F_{8;8;0,01} = 6,03$$

$$F_{calc} = 22,36031228 > F_{tab} = F_{f_1;f_2;\alpha} = F_{8;8;0,01} = 6,03$$

$$t = \frac{\left|\overline{\delta} - \overline{\lambda}\right|}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}} = \frac{\left|3{,}760 - 27{,}641\right|}{\sqrt{\frac{5{,}38309425}{9} + \frac{0{,}24074325}{9}}} = 30{,}21046305$$

$$f = \frac{1}{\frac{c^2}{n_1 - 1} + \frac{1 - c^2}{n_2 - 1}} = \frac{1}{\frac{(1{,}858125138\ )^2}{8} + \frac{1 - (1{,}858125138\ )^2}{8}} = 8$$

$$c = \frac{s_1}{n_1} + \frac{1}{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}} = \frac{2{,}320149618}{9} + \frac{1}{\frac{5{,}38309425}{9} + \frac{0{,}24074325}{9}} = 1{,}858125138$$

$$t_{tab} = t_{f;\alpha} = t_{8;0{,}01} = 3{,}355$$

$t_{calc} = 30{,}21046305 > t_{tab} = t_{f;\alpha} = t_{8;0{,}01} = 3{,}355 \Rightarrow$ there is a significant difference between the United States and Germany regarding the Medical Technologies

6. Discussions

The tendencies of the values which express the distributions of the Medical Devices in the United States, respectively in Germany, are represented by a quadratic function, respectively a linear function, between 2005-2016.

The tendencies of the values which reflect the evolutions of the Medical Technologies in the United States, respectively in Germany, are represented by a linear function, respectively a quadratic function, between 2008-2016.

The "t" test reflects that, there is a significant difference between the distributions of the values concerning the Medical Devices from the United States and Germany, between 2005-2016. Also, the "t" test expresses that, there is a significant difference between the evolutions of the values regarding the Medical Technologies from the United States and Germany between 2008-2016.

7. Conclusions

The statistical analysis at international level, focused on two high „poles", the United States, where there is the Medical Innovation Centre, and Germany, where there is the Medical Technology Centre, reflects through the „t" test, the existence of the significant differences between these countries, concerning the „boom" of the Medical Devices and Medical Technologies. These two „World MedTech Powers" drive in the „International Medical Galaxy", Germany, where there is the maximum of quality regarding the Medical Devices and the United States, where there is the maximum of concentration of the Medical Innovation and the maximum of weight regarding the Health percentage from the Gross Domestic Product and as effect, the maximum of Health Expenditures from world, in the favour of the rise concerning the Life Expectancy for the american nation.

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